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OIL and GAS DIVISION

WELL COMPLETION REPORT

Bridgewater Bay No. 1

0 7 JUN 1984

PHILLIPS PETROLEUM 66

PHILLIPS AUSTRALIAN OIL COMPANY
PERTH, WESTERN AUSTRALIA

OIL and GAS DIVISION

WELL COMPLETION REPORT

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Phillips Australian Oil Company

June, 1984

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1. SUMMARY

Drilling

The Bridgewater Bay No. 1 well was drilled from the semi-submersible drilling unit, Diamond M "Epoch", in a water depth of 109 metres to a total depth of 4200 metres RKB*. The operation took a total of 97 days, from 5th September, 1983 to 9th December, 1983.

The target depth of the well was extended beyond the original 3400 metres to 4200 metres due to the top of the prospective Waarre Formation being at 4102 metres (13,458 feet) instead of the predicted 3000 metres.

The formations were overpressured from approximately 3050 metres to total depth, although this condition did not manifest itself until a depth of 3548 metres had been reached.

The resultant hole problems necessitated the setting of an intermediate string of 9-5/8 inch casing and the use of a 15.0 ppg drilling fluid thereafter. This high mud density resulted in a greatly reduced rate of penetration from 3548 to 4101 metres and another drastic reduction thereafter, due to mud losses to the Waarre Formation at that depth making it necessary to change from turbodrilling to conventional rotary drilling to the total depth of 4200 metres.

The drilling operation was subjected to various delays. The location was directly exposed to the Southern Ocean. Continuous heavy swells and occasional gales with winds up to 65 knots and seas up to 11 metres affected this part of the Southern Ocean. Moreover, the seabed at the

*All depths quoted hereafter are below Rotary Kelly Bushing, which was 22 metres above mean sea level.

location was a very hard limestone crust approximately 1.2 metres thick, underlain by soft limestone. The combination of hard bottom and bad weather made it necessary to lay out eight primary and fifteen piggyback anchors. Even so, on two occasions of storms, some anchors slipped and had to be reset. The weather also caused delays in the running and pulling of anchors; delays in the running of the BOP stack and riser; damages to the subsea equipment which necessitated the stack and riser being pulled twice for repairs, damage to a BOP test plug while being set resulting in a fishing job; delays in the off-loading of the workboats; and several instances of suspension of drilling operations.

Other delays resulted from a fishing job following a twist-off of the drilling string while reaming undergauge hole; and the mechanical failure of the 13-3/8 inch top cementing plug to seal, necessitating a secondary squeeze cementation of the 13-3/8 inch shoe joint.

After reaching a total depth of 4200 metres, the well was logged, plugged, and abandoned.

Geology

Bridgewater Bay No. 1 was the second exploration well drilled in Permit Vic/P14. The well was drilled on a seismically-defined structural anomaly, comprised of a faulted anticlinal structure mapped on an horizon correlated with the top of the Otway Group. In addition, a significantly faulted anticlinal closure was developed on a shallower horizon correlated with the Near-Top Belfast Formation level. Two reservoir targets were postulated for Bridgewater Bay No. 1. The uppermost target was anticipated to be Upper Cretaceous sands developed near the top of the Belfast Formation and/or near the base of the Paaratte Formation. The second, and deepest target was correlated with the Cenomanian-aged sandstones of the Waarre Formation which unconformably overlie the Lower Cretaceous Otway Group.

No samples were collected prior to drilling out of the 20-inch casing shoe at 493.11 metres. The first sediments encountered were massive, white to cream calcarenites and calcilutites of the Middle to Late Pliocene Whalers Bluff Formation Equivalent. These sediments extended from 513 metres to 822 metres. It is postulated that the Whalers Bluff Formation equivalent outcrops on the seafloor at the Bridgewater Bay No. 1 well location therefore giving a total thickness of 690 metres. A major hiatus separates the Whalers Bluff Formation Equivalent from the underlying Mid-to-Late Miocene section. Much of the Miocene section is missing at Bridgewater Bay No. 1 due to Late Miocene to Early Pliocene erosion. The Gambier Limestone was penetrated between 822 metres and 861.3 metres, giving a total thickness of 39.3 metres. It consists of a Mid-to-Late Miocene sequence of interbedded calcarenite and dolomite with very minor amounts of very coarse grained sandstone, chert and black shale. The top of the Nelson Formation was penetrated at 861.3 metres, the formation having a total thickness of 39.7 metres. The Mid-Eocene Nelson Formation is comprised of calcareous claystone and very minor chert, dolomite and medium-to-coarse grained sandstone.

A major unconformity exists at 901 metres where the Mid-Eocene Nelson Formation is in contact with the underlying Late Paleocene to Early Eocene Dilwyn Formation. This is a basinwide unconformity and is the top of the Wangerrip Group. The Dilwyn Formation is comprised of very fine-to-coarse grained sandstone with interbedded siltstone and claystone. Coal beds of one-to-two metres in thickness occur at the top of this 267-metre thick section. At a depth of 1168 metres the overlying Dilwyn Formation passes conformably into the 33.5-metre thick Pember Mudstone, comprised of siltstone. The Late Paleocene Pember Mudstone passes conformably into the Middle Paleocene Pebble Point Formation at 1201.5 metres. The Pebble Point Formation is 39 metres thick and is comprised of iron-stained, medium-to-very coarse grained sandstone with rare glauconite and pyrite grains.

The top of the Upper Cretaceous (Maastrichtian) Sherbrook Group - the Curdies Formation, was encountered at 1240.5 metres. The Curdies Formation, is 308.5 metres thick and is comprised of fine-to-very coarse grained quartz sandstone with minor interbedded siltstone and traces of coal. The Upper Cretaceous (Santonian) Paaratte Formation lies conformably below the Curdies Formation and was encountered at 1549 metres. Interbedded sandstone and siltstone with claystone and minor coal comprise this 1133 metre thick section. At 2682 metres, the 1420 metre thick Upper Cretaceous (Mid-to-Early Turonian) Belfast Formation was penetrated. The Belfast Formation is comprised of a sequence of massive siltstone and claystone with minor sandstone interbeds and trace amounts of coal in the lowermost portion.

The top of the Upper Cretaceous (Cenomanian) Waarre Formation was encountered at 4102 metres. The Waarre Formation is comprised of a sequence of interbedded very fine-to-fine grained argillaceous sandstone and claystone with minor siltstone. Some 98 metres of Waarre Formation were penetrated before the well was terminated at 4200 metres.

No indications of hydrocarbons were encountered in the Bridgewater Bay No. 1 well.

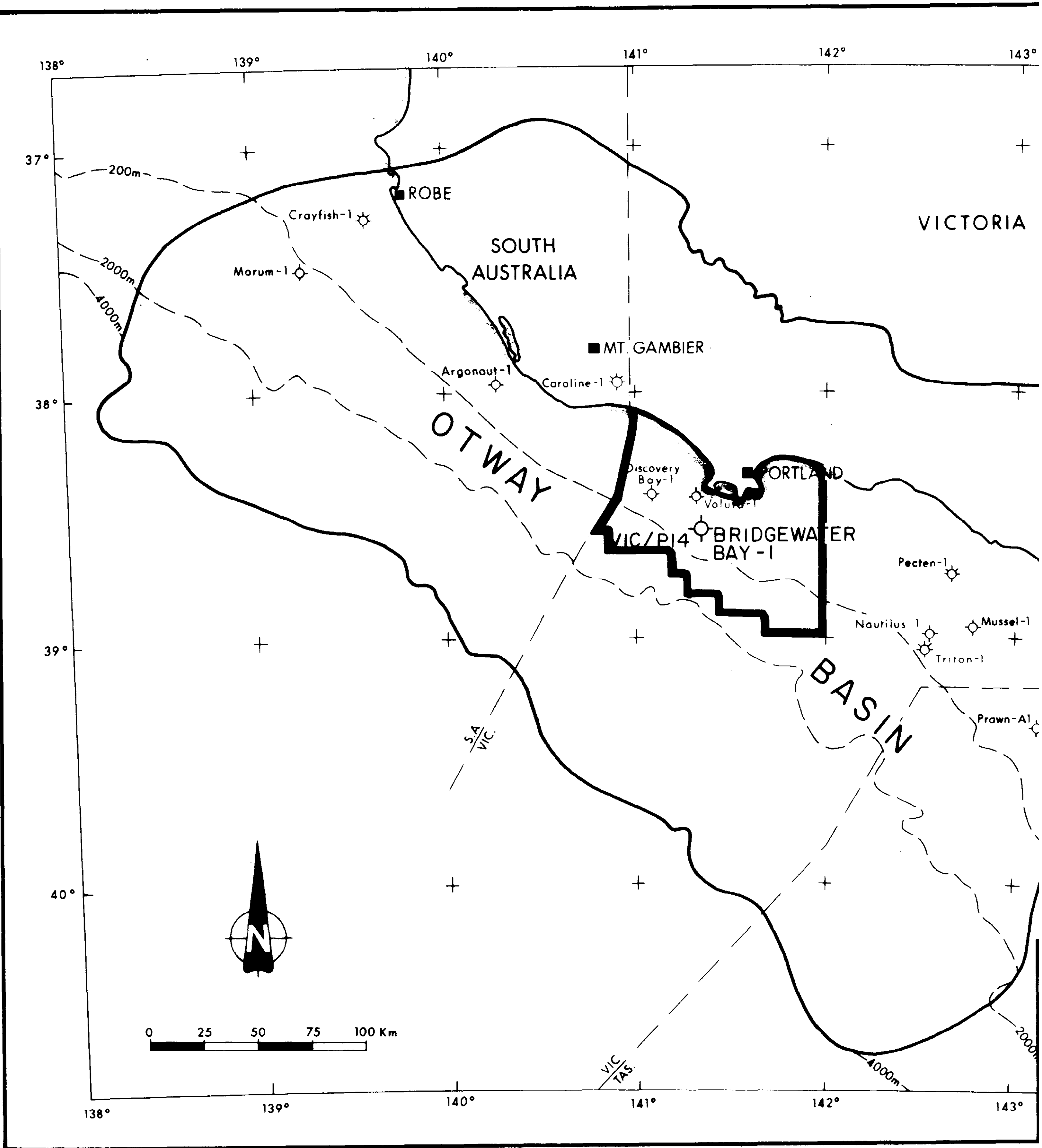
2. INTRODUCTION

Bridgewater Bay No. 1 was the second well to be drilled in Exploration Permit Vic/P14 off the southwestern coast of Victoria, Australia. The permit is held by a group consisting of Phillips Australian Oil Company (Operator), Mount Isa Mines Limited, and Victoria Gas and Fuel Exploration N.L. Bridgewater Bay No. 1 was located at Latitude 38° 32' 25.9698" South and Longitude 141° 21' 47.9468" East placing it 32 kilometres south-southwest of Portland (Figure 1). Drilling was performed from the semi-submersible drilling unit, Diamond M "Epoch" in 109 metres of water.

The Bridgewater Bay No. 1 well was located in the Otway Basin on a seismically-defined structural anomaly. The anomaly was comprised of a faulted anticlinal structure mapped on an horizon correlated with the top of the Otway Group. Significant faulted anticlinal closure was also developed at the Near-Top Belfast Formation level.

The primary exploration target was Cenomanian-aged transgressive marine sandstones of the Waarre Formation overlying the Lower Cretaceous Otway Group unconformity. Thick siltstones, shales, and mudstones of the Belfast Formation were expected to provide a good seal over the Bridgewater Bay structure.

A secondary target was Upper Cretaceous lower delta plain sands developed near the base of the Paaratte Formation and/or near the top of the Belfast Formation. Seal for this target was expected to be inter-distributary bay shales overlying thick marginal marine siltstones and shales comprising the bulk of the Belfast Formation.



138°
139°
140°
141°
142°
143°
37°
38°
39°
40°
200m
2000m
4000m
ROBE
Crayfish-1
Morum-1
SOUTH
AUSTRALIA
VICTORIA
MT. GAMBIER
Argonaut-1
Caroline-1
OTWAY
BASIN
Discovery
Bay-1
PORTLAND
Voluta-1
BRIDGEWATER
BAY-1
VIC/P14
Pecten-1
Nautilus 1
Mussel-1
Triton-1
Prawn-A1
S.A.
VIC.
VIC
TAS.
N
0
25
50
75
100 Km

FIGURE

3. DRILLING

a) Well History

The Bridgewater Bay No. 1 well was drilled from the semi-submersible drilling unit, Diamond M "Epoch" in a water depth of 109 metres. The well was drilled to a total depth of 4200 metres. The entire operation took 97 days from 0000 hours, September 5, 1983 to 1800 hours, December 9, 1983.

The Diamond M "Epoch" commenced the tow from the Athene No. 1 well in Permit Vic/P18 at 0000 hours on September 5, 1983 and arrived on location at 1030 hours on Septemer 9, 1983. The seabed was a very hard and crusted limestone approximately 1.2 metres thick, underlain by soft limestone. The eight primary anchors with 15 piggyback anchors were run, all 23 anchors being required to prevent the anchors slipping when tension tested. Of the 6 days spent in anchoring, 2 days were operational, and 4 days in workboat crews rest periods and "waiting on weather". To avoid further delay, the rig was allowed to remain 140 metres on bearing 89.25 degrees from the programmed location.

A temporary guide base was set on the seabed at 131 metres. The well was spudded at 1730 hours on September 15. A 36-inch hole was drilled in limestone to 186 metres. The 30-inch conductor was run and cemented with the casing shoe at 182 metres. The 26-inch hole was drilled in limestone to 504 metres. The 20-inch conductor with the 16-3/4 inch wellhead was run and cemented with the casing shoe at 493 metres. The weather deteriorated.

While waiting 6 days on weather to run the blowout preventor stack, the tension on the Numbers 2 and 3 anchor warps decreased indicating the anchors had slipped. The anchor warps were re-run with an additional piggyback anchor on each and tested (total of 25 anchors were set).

The 16-3/4 inch blowout preventor stack was run with the 18-5/8 inch riser. The blowout preventor was latched up to the wellhead and successfully tested to Phillips Australian Oil Company's specifications.

A 14-3/4 inch bit and 17-1/2 inch underreamer were made up and run in the hole to the top of the cement at 488 metres. The 17-1/2 inch hole was drilled in limestone and sandstone to 1120 metres. At this point a possible leak was noticed at the wellhead. The test plug was run in the hole and the stack was tested to Phillips Australian Oil Company's specifications. After the test was completed the test plug was found to be stuck in the wellhead (possibly due to rough weather while engaging the plug before the test). The string was backed off and pulled out of the hole. A fishing bottom hole assembly was run in the hole. After several attempts the test plug was jarred loose and pulled out of the hole. The 17-1/2 inch hole was drilled ahead in sandstone to 1603 metres. Electric logs were run. The 13-3/8 inch casing was run and cemented with the casing shoe at 1594 metres.

While cementing, the SSR top cementing plug was bumped, but failed to hold pressure, thereby allowing mud to displace the cement from both the inside and outside of the shoe joint. After the 13-3/8 inch casing seal assembly was installed and the cement had sufficient time to set, the 13-3/8 inch casing would not hold a pressure test. Three hundred sacks of class "G" neat cement mixed at 15.8 ppg were squeezed around the shoe joint. The 13-3/8 inch casing then tested satisfactorily, and a formation pressure leak-off test of 13.0 ppg equivalent mud weight was obtained at 1606 metres.

A 12-1/4 inch hole was drilled in abrasive sandstones and siltstones to 2469 metres using conventional rotary drilling bits and assemblies and a 10% potassium chloride mud. It was then decided to drill with a stratapax bit and turbo drill, but the hole was undergauge and the turbo assembly could not get down. While reaming with a conventional assembly at 2243 metres high torque was encountered which caused a weak drillpipe tool joint to fall. Six hundred and fifty-seven metres of equipment were left in the hole. The equipment was successfully fished out, reaming completed, and the 12-1/4 inch hole was continued in shales, mudstones, and siltstones to 3548 metres using a turbo drill bottom hole assembly with stratapax and diamond bits. Despite some unavoidable experimentation with the stratapax and diamond bits which were available, turbodrilling gave at least twice the overall rate of progress than would have been obtained with the conventional bits and bottom hole assemblies.

While tripping for a new bit at 3548 metres, 82 hours were lost due to weather-related events, the anchors again slipping and needing re-setting. Upon running back in the hole, tight hole was encountered at 3358m. The hole was reamed and re-reamed back to bottom with occasional high torque and stuck pipe. The mud was conditioned, and mud weight raised from 9.9 ppg to 12.5 ppg, electric logs run and selective sidewall cores taken. The 9-5/8 inch casing was run and cemented with the casing shoe at 3519 metres. Electric logs showed the formations to be overpressured below a depth of 3050 metres.

The 8-1/2 inch bottom hole assembly was made up and run in the hole. An 8-1/2 inch hole was drilled and reamed several times to 3551 metres with great difficulty. The mud weight had to be raised from 12.5 ppg to 15.0 ppg to hold back the formation (see overpressuring part of this report). A formation leak-off test was performed over the interval 3519 to 3551 metres. Formation leak-off occurred at an equivalent mud weight of 17.0 ppg. Thereafter an 8-1/2 inch hole was drilled ahead. Turbodrilling with a diamond bit was established to give the greatest rate of progress in these overpressured siltstones and shales.

While drilling with the turbo drill below 3900 metres, increased torque was experienced and the mud weight was raised from 15.0 to 15.5 ppg. This high mud weight resulted in partial loss of circulation at 4052 metres, in a sandstone. The mud weight was reduced from 15.5 ppg back to 15.2 ppg to obtain full circulation, and drilling was continued. An increase in gas in the mud was noted. At 4101 metres circulation was again lost and was only regained after opening the turbo drill circulating valve and adding lost circulation material to the mud. The mud weight was also reduced from 15.2 ppg to 15.0 ppg. The last 100 metres of hole were drilled in sandstones and siltstones with an unstablized conventional bottom hole assembly thus eliminating the lost circulation which was due to the high pressure losses across the stratapax bit. The hole reached a total depth of 4200 metres on December 2, 1983. Electric logs were run, selective sidewall cores were taken and a velocity survey was run.

The well was plugged for abandonment.

The BOP stack and riser were pulled and recovered. Explosives were used to cut the casings 5 metres below the seabed and all subsea well-head equipment was recovered.

The anchors were pulled and the Diamond M "Epoch" departed the Bridge-water Bay No. 1 location at 1800 hours December 9, 1983.

A detailed summary of the daily operations is given in Appendix 2 and the operational summary (including the drilling curve) is included as Enclosure No. 1.

b) General Data

Well Name	:	Bridgewater Bay No. 1
Name and Address of Operator	:	Phillips Australian Oil Company 23rd floor, St. Martins Tower 44 St. George's Terrace PERTH. W.A. 6000. (G.P.O. Box 2066W PERTH. W.A. 6001.)
Co-venturer Parties' Names and Addresses	:	Gas & Fuel Exploration N.L., 151 Flinders Street, MELBOURNE, Vic. 3000 Mount Isa Mines Limited 15th floor, 160 Ann Street BRISBANE, QLD. 4000.
Exploration Permit	:	VIC/P14
District	:	Otway Basin, Victoria
Location	:	Lat. 38 degrees 32 min 25.9698 sec South Long. 141 degrees 21 min 47.9468 sec East
Elevations	:	Water depth 109 metres RKB to seabed 131 metres
Total Depth	:	4200 metres RKB
Status	:	Plugged and Abandoned. DRY 90.

c) Drilling Rig Data

Name and Address of Drilling Contractor	: Diamond "M" Marine Company 2121 Sage Road, Suite 200 P.O. Box 22738 Houston, Texas 770727 U.S.A.
Drilling Vessel	: Diamond M "Epoch" Semi-Submersible Drilling Unit Length : 88.4m (290 feet) Beam : 61.0m (200 feet) Lower Hull Beam : 10.7m (35 feet) Lower Hull Depth : 7.6m (25 feet) Lightship Dis-placement : 7754 long tons
Operating Depth	: 9,144 metres in 366 metres of water (30,000 feet in 1,200 feet of water)
Position System	: Honeywell RS-505 acoustic position and riser angle indicator
Heave Compensator	: Vetco 400-20D with 400,000 lbs capacity - 6.1m (20') stroke
Riser Tensioning	: 6ea - Western Gear 80,000 lbs - 15.2m (50') stroke.
Guide Line Tensioning	: 4 ea - Western Gear 16,000 lbs - 12.2m (40') stroke
Slip Joint	: Vetco X-52 with MR-4B connectors - 12.2m (40') stroke
Riser	: Vetco X-52 18-5/8" x 5/8" wall MR-4B connectors
Diverter	: Regan Model KFDH-3
B.O.P.	: 16-3/4" - 10,000 lbs working pressure - H2S trimmed/Vetco ball joint with MR-4B connector/C.I.W. riser connector/Two Hydril annular preventers/Two-double "U" Cameron ram preventers

B.O.P. Control System	: Koomey with acoustic back-up
Choke Manifold	: 10,000 lbs working pressure - H2S trimmed with Cameron type F gate valves/Two adjustable chokes and one remote operated Swaco Super Choke.
Pumps	: Two Oilwell 1700 PT triplex pumps with pulsation dampeners. Each driven by two GE-752 DC motors. Mud Pumps to be charged by two 6 x 8 centrifugal pumps.
Drawworks	: Oilwell E-3000 driven by two GE 752 DC motors, with Baylor 7838 electric brake and Crown-O-Matic.
Power	: Two EMD 16E-9 diesel engines, 3070 Hp. Each driving EMD 2000 KW AC generators. One EMD 16E-8 diesel engine, 2200 Hp, driving EMD 1500 KW AC generator.

Storage :

Sack storage		3,500	sacks
Bulk tanks		10,000	cu. ft.
Mud tanks		1,594	BBLS
Fuel		6,400	BBLS
Drillwater		15,842	BBLS
Potable water		755	BBLS
Mud volume active		660	BBLS
Mud volume reserve		681	BBLS
Helifuel	3 ea	5,000	litres

d) Time Analysis

Significant Times and Dates

	Hours	Date
Departed Athene No. 1 location	0000	September 5, 1983
Arrived at Bridgewater Bay No. 1 location	1030	September 9, 1983
Spud	1730	September 15, 1983
TD	1100	December 2, 1983
Depart Location	1800	December 9, 1983

Time Breakdown from transfer from Athene No. 1, till departure from location

	Hours	%
Drilling	636.5	27.71
Reaming	121.0	5.27
Cond. mud and circ.	92.0	4.01
Trips and making up BHA	503.5	21.92
Deviation Survey	10.0	0.44
BOP Preparation	20.5	0.89
BOP Run/Retrieve	26.5	1.15
BOP Testing	39.0	1.70
Logging/Velocity Survey/ Sidewall Cores	68.5	2.98
Casing	51.0	2.22
Cementing/Displacement	23.5	1.02
Waiting on cement	15.0	0.65
Leak off tests	9.5	0.41
Repairs mechanical	4.5	0.20
Fishing	79.5	3.46
Delays	42.5	1.85
Weather delays	290.0	12.63
Move and positioning	91.5	3.98
Anchoring	115.0	5.01
Other	57.5	2.50
	2297.0	100.00

Weather delays accounted for the largest percentage of time expended (12.63%) excluding drilling and making trips (27.71% and 21.92%). Permit Vic/P14 is directly exposed to the Antarctic from the south. Heavy swells and occasional gales with winds up to 65 knots and seas up to 11 metres continuously cross this part of the Southern Ocean. The weather caused delays in running and pulling anchors, delays due to the anchors slipping, delays in running the BOP stack, and delays in drilling. Rough weather caused the BOP test plug to become stuck in the wellhead and resulted in a 2 day fishing job. The weather halted the drilling of the 12-1/4 inch hole at 3548 metres for 82 hours, during which the lower part of the hole had swollen inward thus causing many hours of reaming to get back to bottom. The weather also caused damages to the BOP and riser equipment which necessitated the stack and/or riser to be pulled twice for repairs.

Overpressuring was responsible for considerable delays while the lower part of the 12-1/4 inch hole and upper part of the 8-1/2 inch hole were reamed and the mud circulated and conditioned to control the formation.

The re-cementation of the 13-3/8 inch casing shoe joint due to the mechanical failure of the cementing plug to seal took approximately 120 hours, overall, or 5.22% of the total time.

e) Drilling Performance

The 36-inch and 26-inch hole sections were drilled in limestone in accordance with program, and without problems.

The 17-1/2 inch hole section was drilled with a 14-3/4 inch bit and 17-1/2 inch underreamer simultaneously, using a single-bladed 17-1/2 inch stabilizer 90 feet above the underreamer to give pendulum stabilization and minimize hole deviation (a single-bladed 17-1/2 inch stabilizer was used to pass through the 15-1/4 inch bore of the 16-3/4 inch wellhead). The limestone formation to 820 metres drilled easily, below which hard streaks in the limestones, sandstones, mudstones, and siltstones frequently caused slow penetration and severe bit and underreamer wear. Some occasional bit balling was suspected. The 17-1/2 inch hole was extended below its programmed depth of 1219 metres to 1603 metres in order to case off some highly permeable and porous sands encountered in that interval, to improve the chances of the hole reaching total depth without setting 9-5/8 inch casing.

The 12-1/4 inch hole was drilled through the abrasive Paaratte Formation sandstones and siltstones with gauge-protected bits and a conventional stabilized drilling assembly to 2499 metres, after which depth a turbodrill with stratapax and diamond bits was run. This was chosen due to the poor progress in the lower Paaratte Formation siltstones, and the very poor progress with conventional bits that Shell had experienced in the underlying Belfast Formation shales and siltstones in the neighbouring Voluta No. 1 well. The first attempt to turbodrill, at 2469 metres had to be aborted due to the underguage 12-1/4 inch hole below 1786 metres requiring extensive reaming. During the reaming a drillpipe failure due to a high torque occurred and a fishing job ensued.

Turbodrilling from 2499 metres to 3548 metres achieved more than twice the overall rate of progress than would have been obtained with conventional drilling bits and drillcollar assemblies. This was despite some unavoidable experimentation with the different types of stratapax and diamond bits available.

At 3548 metres, hole problems due to overpressuring made it necessary to set 9-5/8 inch casing. Further progress, in 8-1/2 inch hole, was impossible until the mud weight was raised to 15.0 ppg. Thereafter turbodrilling with an 8-1/2 inch stratapax bit from 3555 metres to 3618 metres averaged a disappointing 2.5 metres per hour, and was pulled early. A conventional bit and drilling assembly then drilled from 3618 to 3628 metres, averaging only 1.4 metres per hour. The turbodrill was rerun with a diamond bit and averaged 3.23 metres per hour. A change of formation from the Belfast Formation shales and siltstones to the Waarre Formation sandstones and siltstones resulted in mud losses to the formation at 4052 metres and 4101 metres, making it impossible to continue tubodrilling. A conventional bit and drilling assembly completed the 8-1/2 inch hole to total depth of 4200 metres, averaging only 1.74 metres per hour, compared with the turbodrilling rate of 4.11 metres per hour when pulled.

It was established that in this well turbodrilling achieved at least twice the rate of progress of conventional drilling.

Table 1 contains the performance of each bit used along with the drilling parameters. Table 2 is the deviation survey. The hole was maintained at a very low angle until the 8-1/2 inch diamond bit encountered 10-to-20 degree dipping formations whilst turbodrilling between 3800 metres and 4100 metres, which increased the hole deviation to 5.25 degrees.

COMPANY Phillips Australian Oil Company | CONTRACTOR Diamond M Drilling Co. | **BIT RECORD** TABLE 1 (cont.) | COUNTY Victoria, Australia | STATE Victoria

LEASE	WELL NO	SEC	TOWNSHIP	RANGE	BLOCK	FIELD
Vic/P14	Bridgewater Bay No. 1				Vic/P14	Otway Basin

TOOL PUSHER	DRILL PIPE 5" E & S 135	DRAW WORKS Oilwell E-3000	
DAY DRILLER	TOOL JOINT MAKE SIZE 4½ TYPE IF	POWER Electric H P	UNDER SURF 30" 16 Sept., 1983
EVENING DRILLER	DRILL COLLAR NO 20 O D 7-3/4 I D 2-13/16" LENGTH 30 ft	PUMP NO 1 MAKE Oilwell MODEL A 1700 PT STROKE 12"	INT DATE
MORNING DRILLER	DRILL COLLAR NO 30 O D 6½ I D 2-13/16" LENGTH 30 ft	PUMP NO 2 MAKE Oilwell MODEL A 1700 PT STROKE 12"	T D DATE 3 Dec. 1983

BIT NO	BIT SIZE	BIT MFGR	BIT TYPE	SERIAL NO OF BIT	JET SIZE 1	JET SIZE 2	JET SIZE 3	DEPTH OUT	FTGE	HOURS RUN	ACC HOURS	FT/HR	WEIGHT 1000 LBS	ROTARY R P M	VERT DEV	PUMP PRESS	PUMPS No	PUMPS Liner	PUMPS SPM	MUD Wt	MUD Vis	DULL CODE T	DULL CODE B	DULL CODE G	REMARKS FORMATION, CIRC FLUID, ETC	DATE
15	12¼	Smith	SDGH	CK2887	14	14	14	8200	100	4.5	209.5	22.2	35/40	80	.5	2500	½	6.0	140	9.5	37	2	1	I	Reamed 5 hours	23/10/83
16	12¼	Diamont Boart	LX 27HS	7083837	22	22	22	8837	637	19.5	229.0	32.7	20/40	Turbo	.5	3200	½	6.0	168	9.6	36	Nose Flank	10% 40%		worn worn Ringed Reamed 11½ hr	25/10/83
17	12¼	Diamax	ADS II	310-20	21	21	21	9412	575	32.0	261.0	18.0	25/45	Turbo	.5	3350	½	6.0	158	9.7	37	Nose Flank	100% 60%		worn worn Ringed	27/10/83
18	12¼	Christenson	R 26 LF	1430802	22	22	22	10077	665	29.5	290.5	22.5	35	Turbo	3/4	3200	½	6.0	160	9.7	39	Nose Flank	40% 100%		worn worn Ringed Reamed ½ hr	29/10/83
19RR	12¼	Diamax	MS-5	212-10				10216	139	11.5	302.0	12.1	30/45	Turbo	3/4	3600	½	6.0	162	9.7	39	OK	for		re-run used on Hermes	30/10/83
20	12¼	D. Boart	LX 27HS	7083933	22	22	22	11639	1423	82.5	384.5	17.3	40/30	Turbo	1¼	3620	½	6.0	154	9.9	37	Nose Flank	15% 25%		worn Top row 50% worn	3/11/83
21	12¼	D. Boart	LX 27HS	7083890	22	22	22	11639	46	6.0	-	7.7	17/50	Turbo	1¼	3000	2	6.0	140	9.8	38	5 spx missing			Reamed. 4 inserts, 6 chipped, broken	7/11/83
22	12¼	Smith	SDGH	XB3191	12	12	12	11639	267	10.0	-	26.7	10	140	1¼	3200	2	6.0	135	10.5	14	1	1	1/16	Reamed	8/11/83
23	12¼	Smith	SDGH	XB3174	12	12	12	11639	229	19.5	-	11.7	5/10	140	1¼	3200	½	6.0	120	12.5	52	2	4	3/8	Reamed	10/11/83
24	12¼	Reed	FP53J	221762	14	14	14	11639	179	11.5	-	15.6	10	100	1¼	3200	2	6.0	130	12.5	55	1	1	1/16	Reamed	11/11/83
24RR	12¼	Reed	FP53J	221762	14	14	14	11639	20	0.5	-	40.0	5	120	1¼	3200	½	6.0	130	12.5	58	1	1	1/16	Reamed on condition trip	13/11/83
25	8½	Smith	FDT	CA8094	11	11	11	11639	34	8.0	-	4.3	10/15	60	1¼	3000	½	6.0	88	14.0	58	1	1	1/16	Reamed. Drilled cement & shoe	16/11/83
26	8½	Smith	FDGH	CJ4932	O	u	t	11650	11	4.0	388.5	2.75	25/30	100	-	3100	½	6.0	140	14.9	62	8	3	1/16		17/11/83
27	8½	Smith	SVH	CH1096	11	11	11	11663	13	1.5	390.0	8.7	30/35	100/80	-	3100	1	6.0	80	14.9	73	4	2	I	50% BT and bearings exposed	18/11/83
28	8½	D. Boart	LX27 HS	7083953	18	18	18	11872	209	25.5	415.5	8.2	25/30	60 Turbo	-	3600	1	6.0	82	15.0	63	OK	for		re-run 26 broken cutters	19/11/83
29	8½	Smith	F2	XA9562	11	11	11	11902	30	6.5	422.0	4.6	20/30	100/70	-	3250	1	6.0	83	15.1	63	1	1	I	Like new	20/11/83
30	8½	Diamax	MS-5	311-17	18	18	18	13306	1404	133.0	555.0	10.6	25	Turbo	-	3650	1	6.0	95	15.2	48	Nose	100%	I	worn	27/11/83
31	8½	D. Boart	LX16	7082925	18	18	18	13454	148	11	566.0	13.5	15/25	Turbo	-	3700	1	6.0	94	15.2	48	Good condition (loss circulation) Few diamonds have minor chips				30/11/83
32	8½	Smith	F2	BR 0191	O	p	e n	13780	326	57.5	623.5	5.7	40/45	65	5¼	1050	2	6.0	70	15.0	48	2	3	1/16	Slick BHA TD well	3/12/83

SMITH REPRESENTATIVE ______________________ PHONE __________

BIT RECORD

COMPANY Phillips Australian [illegible] Co[illegible]y	CONTRACTOR Diamond M [illegible]lli[illegible] Co.	COUNTY Victoria, [illegible]str[illegible]	STATE V[illegible] ria

TA[illegible] 1

LEASE	WELL NO	SEC	TOWNSHIP	RANGE	BLOCK	FIELD
Vic/P14	Bridgewater Bay No. 1				Vic/P14	Otway Basin

TOOL PUSHER	DRILL PIPE	5" E & S 135			DRAW WORKS	Oilwell E-3000		
DAY DRILLER	TOOL JOINT	MAKE	SIZE $4\frac{1}{2}$	TYPE IF	POWER	Electric	H P	UNDER SURF 30" 16 Sept. 1983
EVENING DRILLER	DRILL COLLAR	NO 20	O D 7-3/4"	I D 2-13/16" LENGTH 30 ft	PUMP NO 1	MAKE Oilwell A 1700 PT MODEL	STROKE 12"	INT DATE
MORNING DRILLER	DRILL COLLAR	NO 30	O D $6\frac{1}{2}$"	I D 2-13/16" LENGTH 30 ft	PUMP NO 2	MAKE Oilwell A 1700 PT MODEL	STROKE 12"	T D DATE 3 Dec. 1983

BIT NO	BIT SIZE	BIT MFGR	BIT TYPE	SERIAL NO OF BIT	JET SIZE 1	2	3	DEPTH OUT 431	FTGE	HOURS RUN	ACC HOURS	FT/HR	WEIGHT 1000 LBS.	ROTARY R.P.M.	VERT DEV.	PUMP PRESS	PUMPS No.	Liner	SPM	MUD Wt	Vis	DULL CODE T	B	G	REMARKS FORMATION. CIRC. FLUID, ETC	DATE
1	26	HTC	OSC 3AJ	VJ 878	22	22	22	612	181	6.5	6.5	27.9	3/5	110	1	950	$\frac{1}{2}$	6.5	220	8.5	250	Mint			Used on Athene	16/9/83
1	36	Servco	H.O.	-	22	22	22	612	181	6.5	-	27.9	3/5	110	1	950	$\frac{1}{2}$	6.5	220	8.5	250	Mint			" " "	16/9/83
1RR	26	HTC	OSC 3AJ	VJ 878	22	22	22	1655	1043	13.0	19.5	80.2	10	110	.5	2000	$\frac{1}{2}$	6.5	220	8.5	100	Mint			" " "	18/9/83
2	$14\frac{3}{4}$	Smith	DSJ	SBB 020	24	24	24	2764	1109	20.0	39.5	55.5	10/14	110	0	2300	$\frac{1}{2}$	6.5	220	9.0	35	2	2	I	Change arms underreamer	27/9/83
3	$14\frac{3}{4}$	Smith	SDT	SBF 805	24	24	24	3674	910	28.0	67.5	32.5	35	110	.5	2500	$\frac{1}{2}$	6.5	220	9.1	37	8	4	$\frac{3}{8}$	Change arms underreamer	29/9/83
4	$14\frac{3}{4}$	Smith	DSJ	747 RT	24	24	24	4969	1295	31.0	98.5	41.8	23/35	110	.5	2650	$\frac{1}{2}$	6.5	220	9.1	36	8	6	$\frac{1}{4}$	Change arms underreamer	2/10/83
5	$14\frac{3}{4}$	HTC	OSC 1GJ	894 XT	24	24	24	5260	291	11.5	110.0	25.3	25/35	110	.5	2650	$\frac{1}{2}$	6.5	220	9.1	43	6	5	$\frac{1}{8}$	Undereamer	3/10/83
6	$12\frac{1}{4}$	Smith	FDGH	XC 2406	14	14	14	5260	220	3.0	-	73.3	15/20	40	.5	2200	1	6.5	110	9.1	43	8	8	I	Drilled cement	8/10/83
Mill	12	Tri-state	Flat bottom	T.S.	O p	e	n	5260	88	9.0	-	9.8	15/20	40	.5	1500	$\frac{1}{2}$	6.5	150	9.1	45				Milled on cement	9/10/83
6RR	$12\frac{1}{4}$	Smith	FDGH	XC 2406	14	14	14	5260	129	8.5	-	15.2	15/20	60	.5	2500	$\frac{1}{2}$	6.5	140	8.9	36	6	1	I	Metal found in teeth Drilled cement	10/10/83
Mill	12	Tri-state	Flat bottom	T.S.	O p	e	n	5260	3	5.0	-	0.6	15/20	40	.5	1500	$\frac{1}{2}$	6.5	150	8.9	34		90%		Milled on packer	11/10/83
6RR	$12\frac{1}{4}$	Smith	FDGH	XC 2406	14	14	14	5260	66	4.0	-	16.5	25/30	50	.5	2550	$\frac{1}{2}$	6.5	140	8.9	34	6	7	I	6 teeth missing Drilled cement	12/10/83
7	$12\frac{1}{4}$	Smith	FDGH	XA 6970	14	14	14	5945	685	17.5	127.0	39.1	40/45	110	1	2800	$\frac{1}{2}$	6.5	140	9.4	38	8	7	$\frac{1}{4}$	Bearings showing	13/10/83
8	$12\frac{1}{4}$	Reed	HS51-J	634439	14	14	14	6929	984	22.5	150.0	43.7	40/45	110	1	2900	$\frac{1}{2}$	6.5	133	9.4	36	4	3	$\frac{1}{16}$	8 inserts missing	14/10/83
9	$12\frac{1}{4}$	Reed	HS51-J	634438	14	14	14	7300	371	15.5	165.5	23.9	40/45	110	1	2900	$\frac{1}{2}$	6.5	130	9.5	38	3	5	I		15/10/83
10	$12\frac{1}{4}$	Smith	FDGH	XC 3886	14	14	14	7689	389	14.0	179.5	27.8	40/45	80	.5	2900	$\frac{1}{2}$	6.5	130	9.5	38	6	4	$\frac{1}{4}$		16/10/83
11	$12\frac{1}{4}$	Smith	FDGH	XC 3887	14	14	14	7986	297	16.5	196.0	18.0	35/45	75	-	2900	$\frac{1}{2}$	6.5	130	9.5	38	5	3	$\frac{1}{4}$		17/10/83
12	$12\frac{1}{4}$	Smith	F2	CK 2419	14	14	14	8100	114	9.0	205.0	12.7	35/45	70	.5	2850	$\frac{1}{2}$	6.5	130	9.5	36	1	2	I		18/10/83
13	$12\frac{1}{4}$	Diamax	MS-5	212-11	15	15	15	8100	1473	25.0	-	58.9	10/20	Turbo 100	.5	1750	$\frac{1}{2}$	6.0	120	9.5	37	15% worn			Reamed tight hole segments	20/10/83
14	$12\frac{1}{4}$	Smith	SDGH	SB 2623	14	14	14	8100	170	1.0	-	170.0	0/5	140	.5	1800	$\frac{1}{2}$	6.0	120	9.5	37	1	1	I	Reaming/Drill-string parted	20/10/83
Mill	$10\frac{7}{8}$	Tri state	Skirted flat	T.S.	O p	e	n	8100	1.83	10.5	-	0.2	10/20	80/100	.5	650	1	6.0	70	95	37	-	-	-	Milled off 22" of drill string	22/10/83

SMITH REPRESENTATIVE ______________ PHONE ______________

Table 2

Bridgewater Bay No. 1

Totco Survey Summary

Depth metres RKB	Vertical Deviation Degrees
156	1.0
187	1.0
266	1.0
368	1.0
504	0.5
667	0.5
815	0.5
842	0.0
1001	0.5
1120	0.75
1277	0.5
1424	1.0
1515	0.5
1603	0.5
1812	1.0
2112	1.0
2225	0.5
2344	0.5
2434	Mis-run
2469	0.5
2499	0.5
2694	Mis-run
2869	0.75
3072	0.75
3114	0.75
3548	1.25
4200	5.25*

*The hole deviation gradually increased to 5.25 degrees. The Schlumberger dipmeter survey indicates that the increase occurred while turbodrilling between 3800 and 4100 metres and was due to drilling through dipping formations of 10 to 20 degrees.

f) Casing and Cement

The 30-inch conductor was run and cemented with the casing shoe at 182 metres. There were no problems encountered. The 20-inch conductor with a 16-3/4 inch wellhead was run and cemented with the casing shoe at 493 metres.

The 13-3/8 inch casing was set deeper than programmed, at 1594 metres instead of 1219 metres, in order to case off the very porous and permeable sands encountered. The 13-3/8 inch surface casing was run and cemented with the casing shoe at 1594 metres. When the SSR top cement plug bumped on the float collar, it failed to hold pressure. Another 14 bbls of displacement mud was pumped in an attempt to displace the plug further, thereby displacing the cement from within and around the shoe joint.

After the 13-3/8 inch seal assembly had been set the casing was tested with negative results. A 217-sack cement plug was placed from 1579 to 1488 metres and the casing was tested again with positive results.

A 12-1/4 inch slick bottom hole assembly was run in the hole. The cement plug, float collar and float shoe were drilled without encountering any cement in the shoe joint. It was concluded that during the cement displacement the cement pickup dart failed to seal in the top of the float collar therefore allowing mud to displace the cement from both the inside and outside of the shoe joint.

A casing scraper was run in and out of the hole to clean the casing. A Halliburton EZSV packer was run in the hole and set at 1576 metres on a wireline. Attempts were made to test the EZSV with negative results. A Halliburton RTTS packer was picked up, run in the hole on drillpipe and set at 1574 metres. The 13-3/8 inch casing tested with positive results but the EZSV packer still would not test. It was concluded that the EZSV was leaking through the stinger area. The RTTS was pulled out of the hole and drillpipe with a stinger was run in the hole. The stinger was stung into the EZSV and 300 sacks of class "G" neat cement mixed at 15.8 ppg were squeezed below the EZSV.

The EZSV packer and cement were drilled out to 1585 metres. The 13-3/8 inch casing was successfully tested to 2500 psi for 15 minutes.

It had not been intended to run a 9-5/8 inch casing before reaching total depth, unless hole problems made it necessary to run it as a "trouble" string. The problems of overpressured formations experienced after reaching a depth of 3548 metres made it necessary to raise the mud weight to 12.5 ppg, within 0.5 ppg of the leak-off test of 13.0 ppg obtained at the shoe of the 13-3/8 inch casing, thereby making the setting of the 9-5/8 inch casing unavoidable if the hole was to be drilled deeper.

The 9-5/8 inch intermediate casing was run and cemented with the casing shoe at 3519 metres. There were no problems encountered.

More information concerning casing and cement can be found on Table 3.

Table 3
Bridgewater Bay No. 1
Casing and Cement

Elevations RKB to MSL 23m
RKB to seabed 131m

Casing						Cement				
Date	Size	Weight	Grade & Coupling	Amount Run	Depth Set (RKB)	Cuft Slurry	Class/Type	Slurry Weight	TOC	Additives
16.9.83	30"	1" wall	Vetco Squnch	53.52m	182.0m	1725	Class G/Neat mixed with seawater	15.8 ppg	seabed	1% CaCL
17.9.83	20"	133 lb/ft	X-56 Cameron JV Type LW	359.63m	493.11m	Lead 2522	Class G/Neat mixed with drillwater	12.8 ppg	seabed	2.5% gel-water 0.5% CFR-2
						Tail 575	Class G/Neat mixed with seawater	15.8 ppg		
5.10.83	13-3/8"	72 lb/ft	N-80 Buttress	1465.45m	1594.57m	Lead 3292	Class G/Neat mixed with drillwater	12.8 ppg	341 m	2.5% gel-water & 0.4% CFR-2 & 0.2% HR-6L
						Tail 575	Class G/Neat mixed with drillwater	15.8 ppg		0.1% HR-6L
						Plug 256	Class G/Neat mixed with drillwater	15.8 ppg		Nil
						Squeeze Job 345	Class G/Neat mixed with drillwater	15.8 ppg		Nil
13.11.83	9-5/8"	47 lb/ft	N-80/L-80/ P-110 Buttress	3390.63m	3519.52m	Lead 2016	Class G/Neat mixed with drillwater	12.0 PPG	2081 m	3.7% gel - water, 0.5% CFR-2
						Tail 575	Class G/Neat mixed with drillwater	15.8 PPG		0.5% CFR-2 0.8% Halad 22A 0.1% HR-6L

g) Leak Off Test

Leak off tests were performed as per Phillips Australian Oil Company's test procedure. The results can be found in the table below (Table 4). The additional leak off test performed below the 13-3/8 inch casing shoe were due to the cementing problems encountered while cementing the 13-3/8 inch casing and the overpressuring problems encountered at 3548m. The additional tests performed below the 9-5/8 inch casing shoe were due to lost circulation problems encountered at 4101m.

Table 4
Bridgewater Bay No. 1
Leak Off Test

Date	Interval	Bbls Pumped	Leak-off Pressure (psi)	Bbls Bled Back	Und Wt. (ppg)	EMW (ppg)
25/09/83	Below 20" Shoe: 493-507m	2.5	300	1.0	8.5	12.1
8/10/83	Below 13-3/8" Shoe: 1595-1593m	9.5	1030	3.0	9.1	12.9
11/10/83	1595m-1606m	8.5	1030	4.25	9.2	13.0
8/11/83	1595m-3548m	9.0	730	5.0	10.5	13.2
16/11/83	Below 9-5/8" Shoe: 3519m-3551m	5.0	1500	3.0	14.5	17.0
26/11/73	3519-4101m (Bit at 3753m)	11.0	470	8.75	14.9	15.6
26/11/83	3519-4101m (Bit in 9-5/8" Shoe)	10.0	510	10.0	14.9	15.8

h) Drilling Fluids

The hole was spudded and the 36-inch and 26-inch holes were drilled using seawater, periodically flushing with high viscosity slugs of Aquagel flocculated with caustic soda.

The 17-1/2 inch hole was drilled with a seawater, gel, polymer mud system. The mud was prepared by blending seawater with prehydrated bentonite and treating with Drispac to maintain an API filtrate of less than 10 cc/30 min. Pills of seawater, Desco and walnut hulls along with 4 ppg of Soltex were added to alleviate suspected bit balling from 884 to 1372 metres.

The 12-1/4 inch hole was drilled with a potassium chloride - polymer mud system. The hole was drilled to 3548 metres with a KCL content of 10-12% by weight with the API filtrate maintained between 7.0 and 8.5 cc/30 min. After reaching this depth 70 hours were lost due to weather. While running in the hole after the weather abated, hole problems (high torque, swelling clays, caving hole) were encountered below 3358 metres. The following steps were taken to overcome these problems:

1. Added Drispac and Drispac Superlo to reduce API filtrate to 5 cc or less.
2. Raised KCL content to 16-17% by weight.
3. Progressively raised mud weight from 9.9 ppg to 12.5 ppg.
4. Added 4 ppb Soltex to mud.
5. Added Torque Trim.
6. Added 10% by volume of diesel oil. (Temporary step only)

Raising the mud weight and adding diesel oil seemed to be the most effective measures in stabilizing the hole to the present total depth before running electric logs. Electric logs were unable to go deeper than 3534 metres. They indicated formation overpressuring started at approximately 3050 metres, increasing with depth.

During the subsequent clean-out trip, heavy cavings in the mud returns indicated deterioration of the hole condition.

The cementation of the 9-5/8 inch casing at 3519 metres was preceded by cavings and mud losses. The KCL - polymer mud system continued to be used for the 8-1/2 inch hole. Upon drilling out of the 9-5/8 inch casing shoe, hole problems (high torque, hole packing off, swelling clay) were encountered. The mud weight was raised from 12.5 ppg to 15.0 ppg, thereby stabilizing the formation. When turbodrilling ahead was resumed, the KCL content was thereafter increased from 16% to 25-26% by weight and Drispac Superlo was added to maintain an API filtrate around 5cc. Also Desco and dilution were used to maintain the rheological mud properties at acceptable levels and Soltex was added to combat torque problems. While making a wiper trip with the turbodrill at 4041 metres, some overpulls of 140,000 lbs were experienced. Some high torques were also occasionally occurring while drilling. It was therefore decided to increase the mud weight to 15.5 ppg, but before that mud was halfway up the annulus, with the bit drilling in a sand at 4052 metres there was a loss of circulation to the formation. Mud weight was reduced to 15.2 ppg, normal circulation was regained, and drilling proceeded to 4101 metres, when circulation was again lost. The mud weight was cut back to 15.0 ppg and a 30 bbl mica pill was pumped in the hole. Full circulation was regained. (The loss of circulation was most likely due to the combination of the high mud weight and high circulation rates used to operate the turbodrill. This combination caused a high pressure loss across the turbo which was capable of fracturing the formation). The hole was drilled on to 4200 metres with a conventional drilling bit and slick drillcollars with 15.0 ppg mud without problems. The well was logged, plugged and abandoned.

Mud properties, materials and costs are given in Tables 5, 6, and 7.

Table 5

Bridgewater Bay No. 1

Mud Properties

Depth (m)	Hole Size (inches)	Weight (ppg)	Chloride (PPM)	KCL (%WT.)	OIL (%)	Water Loss (API)	Viscosity (sec)	PV	YP	PH
180	36	8.5	-	-	-	-	200+	-	-	-
256	26	8.5	-	-	-	-	200+	-	-	
504	26	8.5	-	-	-	-	200+	-	-	
842	17-1/2	9.3	12,000	-	-	13.0	35	6	6	10.0
988	17-1/2	9.2	13,000	-	-	10.0	38	10	10	10.0
1120	17-1/2	9.1	15,000	-	-	12.0	37	6	7	9.4
1188	17-1/2	9.2	15,000	-	-	12.5	36	7	7	9.9
1514	17-1/2	9.1	15,000	-	-	12.0	36	7	7	9.4
1603	17-1/2	9.1	15,000	-	-	10.0	43	7	10	9.6
1664	12-1/4	9.2	75,000	-	-	10.0	39	9	15	9.5
1832	12-1/4	9.4	73,000	-	-	9.8	38	10	14	9.5
2113	12-1/4	9.4	75,000	-	-	9.8	36	9	14	9.3
2094	12-1/4	9.4	75,000	10.0	-	9.8	36	9	14	9.3
2221	12-1/4	9.6	63,000	9.5	-	9.8	35	9	9	8.4
2344	12-1/4	9.5	59,000	7.0	-	8.0	38	12	12	9.5
2434	12-1/4	9.5	59,000	9.0	-	8.0	38	13	14	9.5
2469	12-1/4	9.5	57,500	9.0	-	8.4	36	9	10	10.0
2470	12-1/4	9.5	57,000	9.0	-	8.8	37	10	9	10.5
2499	12-1/4	9.5	56,500	10.0	-	7.4	37	10	10	10.0
2693	12-1/4	9.6	60,000	10.0	-	8.7	36	9	9	10.0
2745	12-1/4	9.6	60,000	10.0	-	7.8	36	10	11	9.5
2861	12-1/4	9.7	61,500	11.5	-	8.2	37	10	11	9.0
2979	12-1/4	9.7	60,000	11.0	-	7.8	37	12	11	9.0
3073	12-1/4	9.7	61,500	12.0	-	7.2	39	14	13	9.5
3121	12-1/4	9.7	62,000	12.0	-	6.9	39	12	11	9.5
3257	12-1/4	9.7	61,000	12.0	-	7.4	36	10	10	9.5

Table 5 (continued)

Mud Properties

Depth (m)	Hole Size (inches)	Weight (ppg)	Chloride (PPM)	KCL (%WT.)	OIL (%)	Water Loss (API)	Viscosity (sec)	PV	YP	PH
3385	12-1/4	9.8	59,500	10.0	-	8.4	36	9	9	9.5
3476	12-1/4	9.9	60,500	10.0	-	8.9	36	9	7	9.0
3550	12-1/4	9.9	60,000	10.0	-	8.6	37	10	9	9.5
3550	12-1/4	11.2	77,000	15.0	9	7.0	44	15	20	9.5
3550	12-1/4	12.5	86,000	16.0	8	4.2	61	30	26	9.0
3550	8-1/2	14.0	86,000	16.0	7	5.6	58	38	22	11.5
3551	8-1/2	14.9	87,500	14.0	6	6.2	68	47	20	10.0
3559	8-1/2	14.9	95,000	14.5	6	4.6	73	50	23	10.5
3604	8-1/2	15.0	144,000	26.0	5	5.8	63	43	20	10.0
3623	8-1/2	15.1	142,000	25.0	5	5.5	63	40	27	9.5
3655	8-1/2	15.0	144,000	26.0	4	4.8	64	41	19	10.0
3725	8-1/2	14.9	149,000	22.0	3	6.2	66	37	21	10.0
3790	8-1/2	15.0	147,000	23.0	2	7.4	65	30	15	9.5
3868	8-1/2	15.0	147,500	24.0	1	5.6	54	33	17	10.5
3937	8-1/2	15.0	146,500	25.0	1	5.6	54	32	16	10.0
4023	8-1/2	15.0	145,000	24.0	1	5.2	53	34	19	10.0
4056	8-1/2	15.2	151,000	26.0	1	5.1	48	31	14	10.0
4059	8-1/2	15.1	148,000	26.0	1	5.8	48	31	14	10.0
4101	8-1/2	14.9	134,000	25.5	1	5.8	49	33	14	10.0
4102	8-1/2	15.0	134,500	24.5	1	6.1	49	33	14	9.5
4147	8-1/2	14.9	141,000	26.0	1	4.8	54	36	18	10.0
4180	8-1/2	15.0	143,000	26.0	1	5.1	50	36	15	10.5
4200	8-1/2	15.0	143,000	26.0	1	5.0	48	33	15	10.0

Table 6

Bridgewater Bay No. 1

Mud Materials

Type	Unit	Quantity
Al. Stearate	25 kg	6
Aquagel (bulk)	100 lbs	2,430
Aquagel (sack)	100 lbs	42
Baradefoam	55 gal	6
Caustic Soda	70 kg	167
Desco	25 lbs	356
Drispac	50 lbs	435
Drispac Superlo	50 lbs	307
Lime	25 kg	6
Mica	40 lbs	30
Potassium Chloride	50 kg	6,694
Soda ash	40 kg	95
Soltex	50 lbs	454
Torque Trim II	55 gal	12
Walnut	50 lbs	47
XL Polymer	50 lbs	136
Baroid (bulk)	100 lbs	17,620
Diesel Oil	bbl	200
Mud chemicals	bbl	1,300
Reserve mud	bbl	250
Barite	bbl	1,178
Fresh water	bbl	14,238
Sea water	bbl	6,960
Total mud made	bbl	24,126

Table 7

Bridgewater Bay No. 1

Mud Cost

Interval	Hole Size	Cost A$
Seabed to 187m	36"	4,822.54
187m to 504m	26"	7,666.22
504m to 1603m	17-1/2"	51,318.39
1603m to 3548m	12-1/4"	252,470.23
3548m to 4200m	8-1/2"	204,445.52
	TOTAL:	A$520,722.90

i) Fishing

There were two occasions during the drilling of Bridgewater Bay No. 1 well when fishing operations had to be executed.

The first occasion was when the BOP test plug became stuck in the wellhead after a stack test. The string was backed off one single above the test plug and pulled out of the hole. A fishing bottom hole assembly was made up, run in the hole and engaged. Due to excessive rig heave, the overshot was backed off from the fish and pulled out of the hole. At the surface it was discovered that the string backed off at the service break in the 8-inch bumper sub, not the overshot. A new fishing bottom hole assembly was made up, run in the hole and engaged. The test plug was successfully jarred loose and pulled out of the hole. The test plug support spring of the FMC test plug was found to be broken and part of it missing. The damage probably occurred when setting the tool in rough weather.

The second occasion occurred while reaming undergauge 12-1/4 inch hole at 2243 metres. The drillstring parted at a weak tool joint leaving 657 metres of equipment in the hole. An overshot with 6-3/8" spiral grapple was run in the hole but failed to get over the fish. When the drillstring parted, the box end of the weak tool joint apparently belled out causing it to be too large for the overshot to engage. A milling bottom hole assembly was run in the hole and 22 inches of the fish were milled off. An overshot with a 5" basket grapple was run back in the hole and engaged the drillpipe. The fish was then successfully retrieved out of the hole.

During the Schlumberger logging run of 3548m, nine CST sidewall coring bullets were lost in the overgauge 12-1/4 inch hole. Some of these were subsequently encountered on bottom when attempting to drill ahead in the 8-1/2 inch hole with bit No. 26 over the interval 3548m - 3551m. The remnants of the bullet junk were recovered in a junk sub run above the next bit, No. 27, while drilling interval 3551m - 3555m. Thereafter turbodrilling with a stratapax bit was able to proceed.

j) Overpressuring

Hole Problems

Some slight overpressuring of about 10.0 ppg was expected in the Belfast Formation in the Bridgewater Bay No. 1 well similar to that of the neighbouring Voluta No. 1 well. However, the overpressuring was not detected until the weather and related events necessitated an 82 hour delay during which the 12-1/4" hole remained open without a wiper trip or conditioning trip. While running in the hole, after the weather abated, the hole was found to have closed off from 3365 to 3548m. The mud weight was increased from 9.9 ppg to 12.5 ppg and 10% diesel oil was added. The hole was cleaned to 3546m, electric logs were run, and the 9-5/8" casing was set. The electric logs confirmed the presence of overpressuring. It is suspected that some form of hydration of the clays accompanied the overpressure.

Hole problems were encountered almost immediately after drilling out of the 9-5/8 inch casing shoe with the 8-1/2 inch bottom hole assembly. The bottom hole assembly continued packing off while trying to clean out the rat hole. The mud weight was gradually raised from 12.5 ppg to 15.0 ppg thereby stabilizing the formation. This allowed the conventional slick bottom hole assembly to drill enough footage to perform a leak off test which yielded an equivalent mud weight of 17.0 ppg. The hole was continued using a turbo drill bottom hole assembly to 4042m where tight hole was encountered, leading to increasing the mud weight to 15.5 ppg. However, this high mud weight immediately led to loss of circulation at 4052m and later at 4101m. At 4052m the mud weight was reduced from 15.5 ppg to 15.2 ppg and circulation was regained (250 barrels of mud were lost). At 4101m a combination of decreasing the mud weight from 15.2 to 15.0 ppg, the opening of the circulating valve above the turbodrill, and the use of lost circulation material enabled the circulation to be regained (425 barrels of mud were lost). While pulling out of the hole, after regaining circulation, it was found that the hole would not take any fluid, nor was it flowing. It was assumed that the lost mud and/or possibly formation fluid were returning to the wellbore as the pipe was being pulled. This indicated that the hole hydraulics were almost perfectly balanced. The bit was pulled in to the 9-5/8" casing shoe and a leak off test was performed. The results yielded an equivalent mud weight of 15.8 ppg which was almost equivalent to the pore pressure. A conventional slick bottom hole assembly was run back in the hole and drilling continued to the total depth of 4200m.

Electric Logs

Even though overpressuring was suspected while reaming the 12-1/4 inch hole at 3365m (the drilling parameters, flow-line temperatures, Dcs exponent and gas shows, did not indicate overpressuring while drilling), it was not confirmed until the electric logs were run. The sonic and resistivity logs displayed a small leftward deflection at 3050m which was the top of the overpressured zone. The hole caliper showed an increasing hole size from 12-1/4 inches up to 23 inches plus from 3050 to 3530 metres. This was a very good indication of overpressuring. A semilog plot was made of the sonic travel time vs. depth (Figure 2). The points followed a straight line trend to 3050m then deviated to the right of the trend line for the remainder of the well. This deviation indicated increasing shale travel times (slower velocity) indicating overpressuring. Figure 2 also exhibits the overburden gradient, fracture gradient, pore presure gradient and mud weight vs. depth. The top of the overpressured zone can clearly be picked out on this figure.

Calculations using the following Gulf of Mexico derived equation yielded the following pressure gradients.

$$Gp = Gob - (Gob - Gpn)\ (\ Tn/\ \ To)^3$$

Gp = Formation pressure

Gob = Overburden gradient

Gpn = Normal pressure = 0.4330 psi/ft = 8.33 ppg

ΔTn = Normal travel time

ΔTo = Observed travel time

Depth	Gob		Δ Tn	Δ To	Gp	
metres	psi/ft	ppg	ms/ft	ms/ft	psi/ft	ppg
3100	0.9650	18.56	77	89	0.6209	11.94
3200	0.9655	18.57	75	87	0.6245	12.01
3300	0.9700	18.65	74	93	0.6994	13.45
3400	0.9700	18.65	72	94	0.7285	14.01
3500	0.9705	18.66	71	89	0.6978	13.42
3600	0.9750	18.75	69	88	0.7140	13.73
3700	0.9750	18.75	68	88	0.7249	13.94
3800	0.9755	18.76	67	86	0.7192	13.83
3900	0.9800	18.85	65	85	0.7358	14.15
4000	0.9800	18.85	64	83	0.7296	14.03
4100	0.9805	18.86	63	82	0.7322	14.08
4200	0.9850	18.94	62	80	0.7280	14.00

Note:

The accuracy of this information is ± 1.5 ppg due to the equation used (derived for Gulf of Mexico wells) and due to the position picked for the transit time trend line.

This calculated degree of overpressuring in the Bridgewater Bay No. 1 well, approximately 14.2 ppg (± 1.5 ppg), is much higher than that thought to be present in the Voluta well, 10 ppg.

Conclusions

- The data interpreted from the electric logs indicate overpressuring from 3050m to the well's total depth of 4200m The calculated degree of overpressuring is approximately 14.2 ppg (± 1.5 ppg). However, the hole behaviour at 4042m indicates the overpressuring to be of the order of 15.5 ppg. At 4042m increased drilling torque indicated swelling with a mud weight of 15.0 ppg. Also, from the caliper log, the over-gauge hole at 4050m indicated an insufficient mud weight to contain the formation gas. (Thirty-five percent gas was obtained with bottoms up after swabbing the hole while pulling out with the turbo drill bottom hole assembly.) At 4050m the formation was apparently very tight with minimal porosity and no permeability. When the bit encountered this section of the hole, the insufficient mud weight (15.0 ppg) allowed the gas near the wellbore to expand thereby enlarging the hole by caving. It is concluded that the overpressuring in Bridgewater Bay No. 1 was greater than 15.0 ppg, probably of the order of 15.5 ppg.

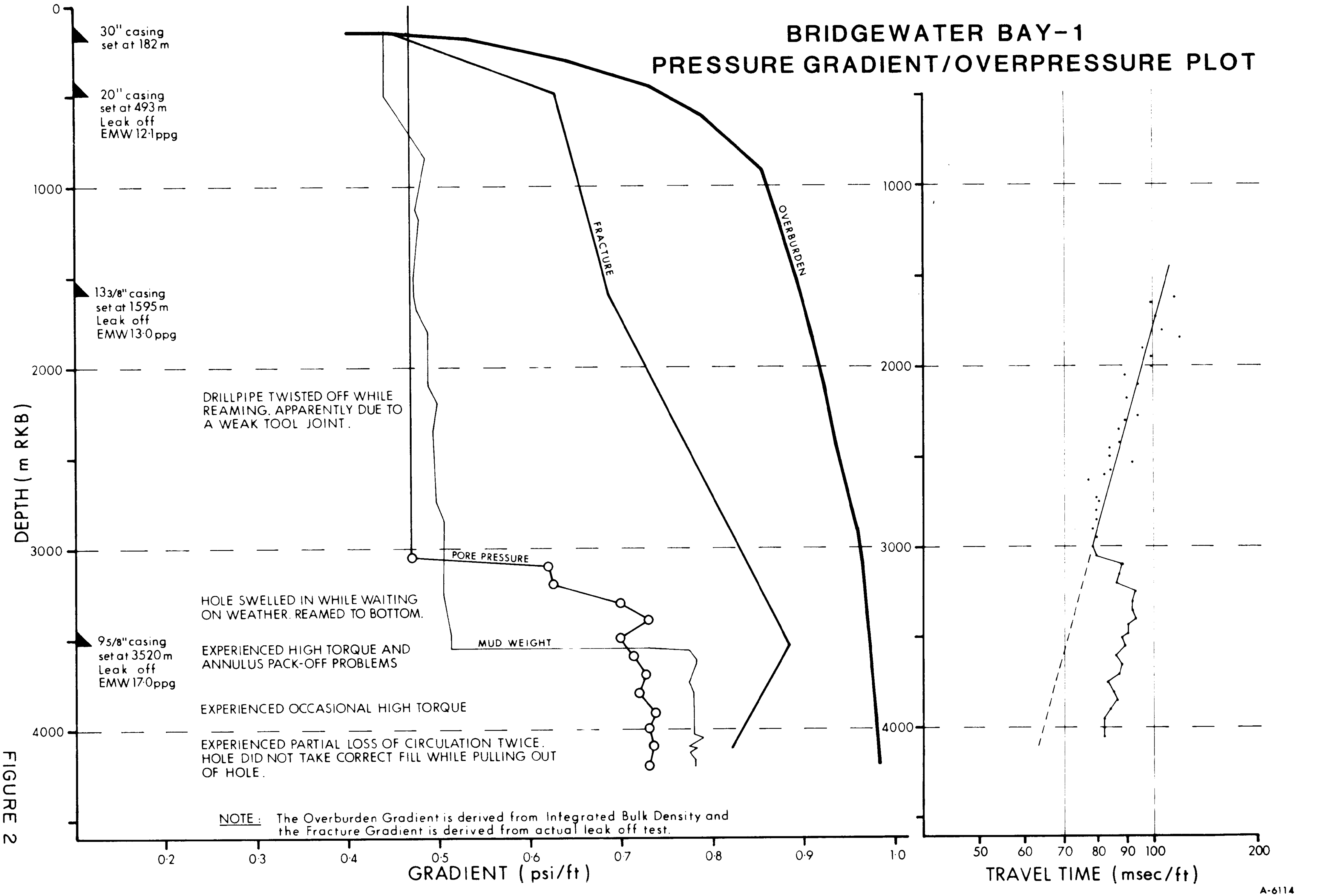

BRIDGEWATER BAY-1
PRESSURE GRADIENT/OVERPRESSURE PLOT
30" casing set at 182 m
20" casing set at 493 m
Leak off EMW 12·1 ppg
13 3/8" casing set at 1595 m
Leak off EMW 13·0 ppg
9 5/8" casing set at 3520 m
Leak off EMW 17·0 ppg
DEPTH (m RKB)
0
1000
2000
3000
4000
FRACTURE
OVERBURDEN
PORE PRESSURE
MUD WEIGHT
DRILLPIPE TWISTED OFF WHILE REAMING. APPARENTLY DUE TO A WEAK TOOL JOINT.
HOLE SWELLED IN WHILE WAITING ON WEATHER. REAMED TO BOTTOM.
EXPERIENCED HIGH TORQUE AND ANNULUS PACK-OFF PROBLEMS
EXPERIENCED OCCASIONAL HIGH TORQUE
EXPERIENCED PARTIAL LOSS OF CIRCULATION TWICE. HOLE DID NOT TAKE CORRECT FILL WHILE PULLING OUT OF HOLE.
NOTE : The Overburden Gradient is derived from Integrated Bulk Density and the Fracture Gradient is derived from actual leak off test.
0·2
0·3
0·4
0·5
0·6
0·7
0·8
0·9
1·0
GRADIENT (psi/ft)
1000
2000
3000
4000
50
60
70
80
90
100
200
TRAVEL TIME (msec/ft)
A-6114

FIGURE 2

BRIDGEWATER BAY No.1 - ABANDONMENT STATUS

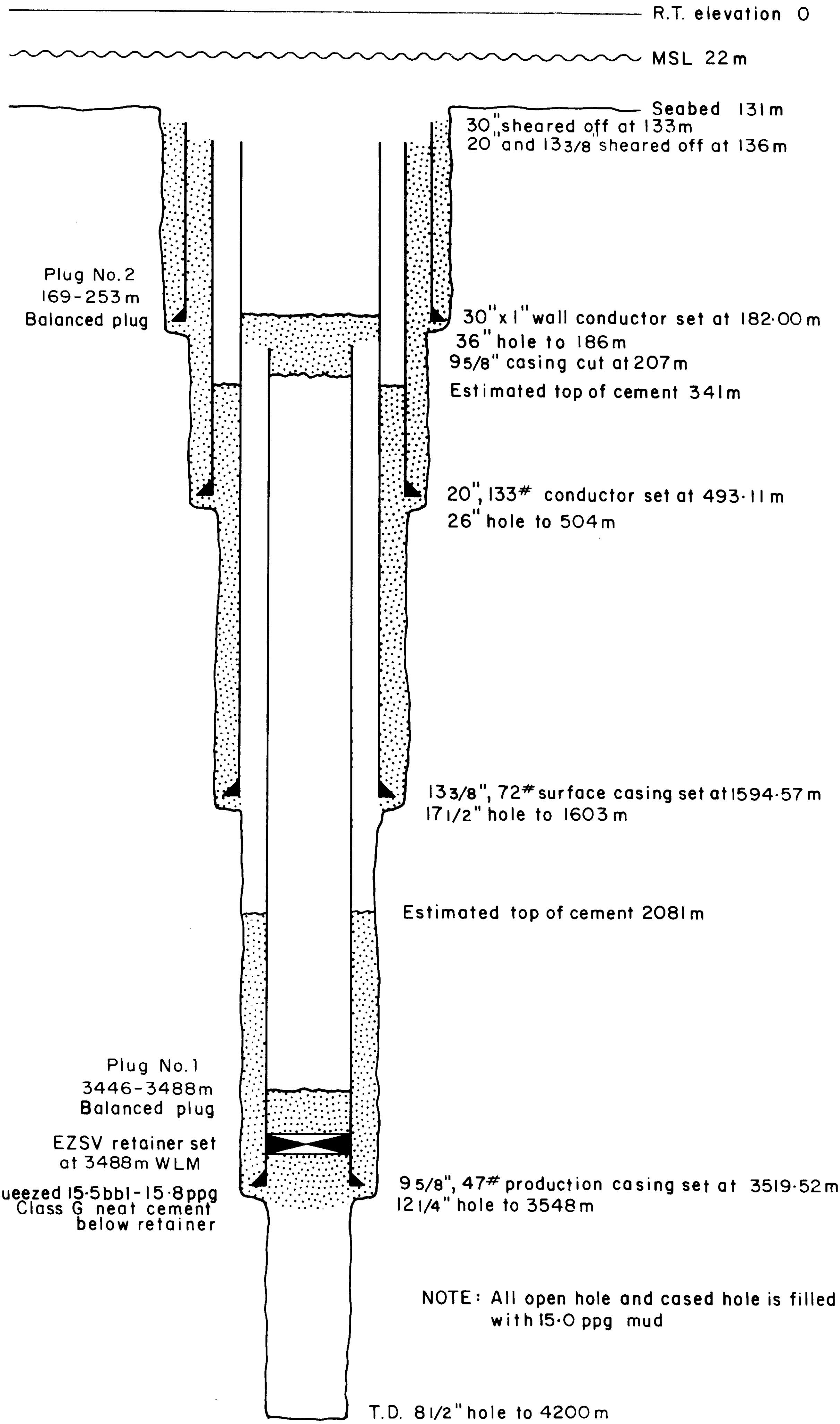


FIGURE 3

A-5968

k) Abandonment Status

Upon completion of the final logging run, Halliburton EZSV squeeze packer was run in the hole and set at 3488 metres with the wireline. Drillpipe with stinger was run in the hole and stung into the packer. Sixteen barrels of class 'G' neat cement mixed at 15.8 ppg were squeezed below the packer. Ten barrels of cement were then placed on top of the packer. Ten barrels of cement were then placed on top of the packer. (It was intended to squeeze 21 barrels of cement below the packer, but due to a displacement calculation error only 16 barrels of cement were squeezed below the packer. This left five barrels of cement in the drillpipe which was not circulated out due to another error. While circulating down the choke line to flush the drillpipe the kill line was accidently open thus only flushing the wellhead area. Thirty-two singles of drillpipe were plugged with cement). The plug was successfully tested to 2000 psi for 10 minutes.

The Servco 9-5/8 inch casing cutting tool was run in the hole and the 9-5/8 inch casing was cut at 207 metres. The Servco casing spear was run in the hole and recovered 78.5m of 9-5/8 inch casing (6 regular joints, hanger pup joint and stub).

Open end drillpipe was run in the hole to 253 metres. One hundred and sixty-three sacks of class "G" neat cement mixed at 15.8 ppg were pumped as the surface plug. The BOP stack and riser were displaced with seawater. It was noted that the hole was taking fluid during displacement. Open end drillpipe was run in the hole and tagged the cement plug at 215 metres. The cement had apparently fallen down the 9-5/8 inch by 13-3/8 inch annulus. The drillpipe was pulled out of the hole to 207 metres and another balanced plug of 109 sacks of class "G" neat cement mixed at 15.8 ppg was laid. The plug was successfully tested with 15,000 pounds weight.

The BOP stack and riser were pulled and recovered. An explosive charge was made up below the 16-3/4 inch wellhead running tool and run in the hole. Several unsuccessful attempts were made to engage the running tool. The running tool and explosive charge were pulled back out of the hole. A 50 kilogram explosive charge was made up on the rig sand line, and run in the hole to 136 metres. The rig was moved 189 - 192 metres off location and the explosive was detonated. The rig was moved back on location and a Servco 13-3/8 inch casing spear was run in the hole. The 16-3/4 inch wellhead and a 13-3/8 inch casing stub were recovered. An explosive charge was made up 3 metres below the 30-inch wellhead housing running tool, run in the hole, and detonated. (This was performed twice. The first run was a mis-fire). The 30-inch wellhead housing, floating guide base and the permanent guide frame were recovered and dismantled. The anchors were pulled and the Diamond M "Epoch" departed the Bridgewater Bay No. 1 location.

The abandonment status of Bridgewater Bay No. 1 can be seen on Figure 3.

4. GEOLOGY

a) Summary of Previous Investigations

Oil exploration in the Otway Basin began during the late 19th century when several shallow wells were drilled without encountering hydrocarbons. Exploration using modern methods began in the early 1950s and 63 wells have been drilled since 1960. In the early 1960s Frome-Broken Hill, Alliance Oil Development, and Planet Oil became the major operators, and seismic surveys were conducted followed by drilling programs. In the late 1960s to early 1970s Shell and Esso farmed into much of the onshore and offshore acreage and became the major operators, but were unsuccessful. From 1975 to 1978 exploration was dormant throughout the basin. New onshore permits were issued in 1978, and three offshore permits were awarded in Victorian waters in 1980.

No commercial quantities of hydrocarbons have yet been discovered in the Otway Basin although a sub-commercial gas field was discovered onshore at North Paaratte No. 1 in the eastern portion of the basin in 1979. To date, some 21 wells in the basin have recorded hydrocarbon shows, four of which have been located offshore (Voluta No. 1, Triton No. 1, Pecten No. 1, and Crayfish No. 1).

Exploration Permit Vic/P14 was awarded to the Phillips Group on 16 January, 1980. Structural interpretation of the Bridgewater Bay prospect was based on geophysical mapping of the "OP 80" seismic survey recorded by Geophysical Services International (GSI) in 1980. Bridgewater Bay No. 1 was the second well to be drilled in Permit Vic/P14, and followed the drilling of the Discovery Bay No. 1 in 1982. Permission to drill Bridgewater Bay No. 1 was granted by the Victorian Department of Minerals and Energy on 20 July, 1983.

b) Regional Geology

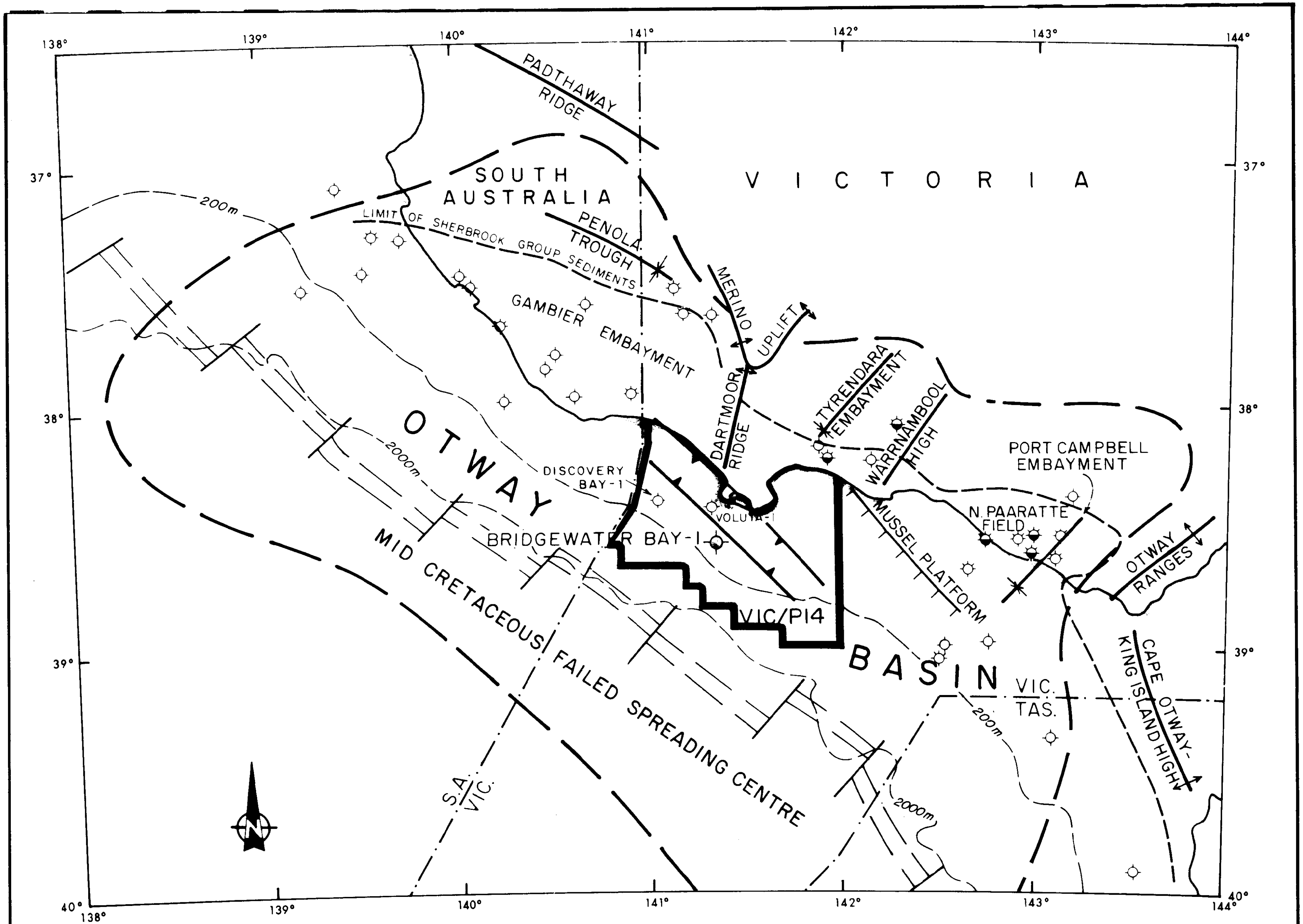
The Otway Basin is a passive continental rifted marginal basin and its development is controlled by various pre-rifting, rifting and post-rifting episodes. Actual rifting began during the uppermost Jurassic to Early Cretaceous following initial basin formation possibly related to movement along a major right lateral strike-slip fault along the basin's northern margin. The downwarp of Early Paleozoic basement rocks associated with rifting, was infilled by fluvio-lacustrine volcanogenic sediments of the Otway Group. Volcanism ceased toward the end of the Lower Cretaceous rifting episode and passive infilling of the rifted margin by non-volcanic sediments of the Sherbrook Group commenced. A Mid-Cretaceous unconformity between the Lower Cretaceous Otway Group and Upper Cretaceous Sherbrook Group sediments probably represents failed rifting between Australia and Antarctica, and also documents the opening of the Tasman Sea.

Sedimentation was predominantly from the north during Sherbrook Group deposition with a marine connection to the west. The basal transgressive Waarre Formation unit of the Sherbrook Group is in part related to the localized weathering and reworking of Otway Group sediments. The unit was deposited in a fluvial environment in the Port Campbell area and in a shallow marine environment in the Gambier Embayment. The next depositional unit formed was the basinwide Belfast Formation, marginal marine shale deposited in front of a major southward prograding system. The prograding system contemporaneously laid down the Paaratte Formation, a fluvial and marginal marine clastic sequence, followed by fluvial sandstone, shale and coal of the Curdies Formation.

A second phase of rifting, signified by a regional unconformity, commenced at the end of Upper Cretaceous time and culminated in the final separation of Australia and Antarctica. The Lower Tertiary Wangerrip Group, consisting of a basal transgressive sandstone conglomerate unit (Pebble Point Formation) overlain by a deltaic-marine sandstone, siltstone, and shale sequence (Dilwyn Formation), was deposited during this second rifting phase.

Final separation of the continents occurred during Middle to Late Eocene times, and rapid continental separation caused by direct sea floor spreading westward of this basin resulted in strong downwarping throughout the southern basinal margin. Passive Late Tertiary infilling of the marine limestone, marl, and minor sandstone of the Nirranda and Heytesbury Groups has continued until recent times.

The tectonic elements associated with the Otway Basin can be seen on Figure 4.



PHILLIPS AUSTRALIAN OIL COMPANY

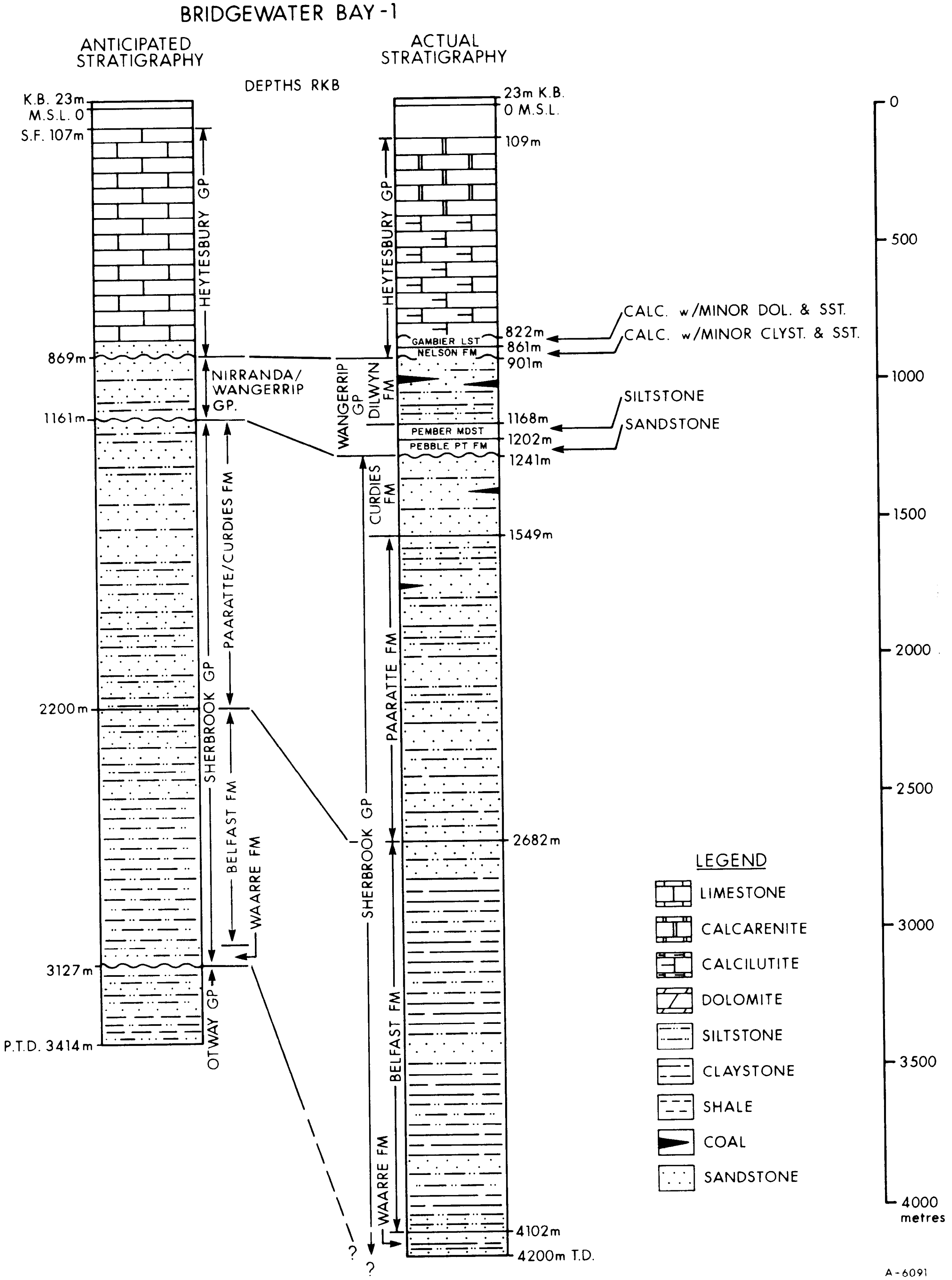
OTWAY BASIN
TECTONIC ELEMENTS

1:2500000

0 10 20 30 40 50 60 70 km

A-5342-3

FIGURE 4



BRIDGEWATER BAY-1
ANTICIPATED STRATIGRAPHY
ACTUAL STRATIGRAPHY
DEPTHS RKB
K.B. 23m
M.S.L. 0
S.F. 107m
HEYTESBURY GP
869m
NIRRANDA/ WANGERRIP GP.
1161m
PAARATTE/CURDIES FM
SHERBROOK GP
2200m
BELFAST FM
WAARRE FM
3127m
OTWAY GP
P.T.D. 3414m
23m K.B.
0 M.S.L.
109m
822m
GAMBIER LST
861m
NELSON FM
901m
WANGERRIP GP
DILWYN FM
1168m
PEMBER MDST
1202m
PEBBLE PT FM
1241m
CURDIES FM
1549m
PAARATTE FM
2682m
BELFAST FM
WAARRE FM
4102m
4200m T.D.
?
CALC. w/MINOR DOL. & SST.
CALC. w/MINOR CLYST. & SST.
SILTSTONE
SANDSTONE
LEGEND
LIMESTONE
CALCARENITE
CALCILUTITE
DOLOMITE
SILTSTONE
CLAYSTONE
SHALE
COAL
SANDSTONE
0
500
1000
1500
2000
2500
3000
3500
4000
metres
A-6091

FIGURE 5

STRATIGRAPHIC TABLE - BRIDGEWATER BAY - 1

AGE	PERIOD		EPOCH / SERIES		MILLION YEARS	GROUP	FORMATION OR FORMATION EQUIV.	LITHOLOGY	METRES (BELOW R.K.B)	THICKNESS (m)
CENOZOIC	QUATERNARY		PLEISTOCENE / HOLOCENE		1·8		NOT	SAMPLED	≥ 493	
CENOZOIC	TERTIARY	NEOGENE	PLIOCENE	LATE / EARLY	3·5 / 5		WHALERS BLUFF FM.	CLCAR & CLCLT	822	≥ 329
									822	
CENOZOIC	TERTIARY	NEOGENE	MIOCENE	LATE / MIDDLE	11 / 15	HEYTESBURY GROUP	GAMBIER LIMESTONE	CLCAR & DOL w/SST.	861	39
CENOZOIC	TERTIARY	PALEOGENE	OLIGOCENE	LATE / EARLY	23 / 33				861	
CENOZOIC	TERTIARY	PALEOGENE	EOCENE	LATE / MID	38	HEYTES GP	NELSON FORMATION	CLST w/CHT, DOL & SST	901	40
					43·5				901	
CENOZOIC	TERTIARY	PALEOGENE	EOCENE	EARLY	49·5	WANGERRIP GROUP	DILWYN FORMATION	SST w/SLTST & CLST.	1168	267
CENOZOIC	TERTIARY	PALEOGENE	PALEOCENE	LATE	55	WANGERRIP GROUP	PEMBER MUDSTONE	SLST.	1201·5	33·5
CENOZOIC	TERTIARY	PALEOGENE	PALEOCENE	MID	58	WANGERRIP GROUP	PEBBLE POINT FM.	SST.	1240·5	39
MESOZOIC	MID - LATE CRETACEOUS		MAASTRICHTIAN		65	SHERBROOK GROUP	CURDIES FORMATION	SST w/ SLTST & C	1549	308·5
MESOZOIC	MID - LATE CRETACEOUS		SANTONIAN		69	SHERBROOK GROUP	PAARATTE FORMATION	SST. & SLST w/CLST & C	2682	1133
MESOZOIC	MID - LATE CRETACEOUS		MID-EARLY TURONIAN		77	SHERBROOK GROUP	BELFAST FORMATION	SLTST. & CLST w/SST.	4102	1420
MESOZOIC	MID - LATE CRETACEOUS		CENOMANIAN		83 / 88	SHERBROOK GROUP	WAARE FORMATION	SST & CLST w/SLST.	4200	98

R.K.B. 22m ABOVE M.S.L., WATER DEPTH 109m

A-6144

FIGURE 6

Sampling commenced at 513 metres with the installation of the marine riser after setting 20-inch casing. All depths are recorded from the Rotary Kelly Bushing, 22.5 metres above Mean Sea Level.

Tertiary

Late Pliocene to Middle Pliocene: Whalers Bluff Formation Equivalent, Seafloor (?) - 822m (690.5m)

The naming of this unit has been based tenuously on foraminiferal zonation and by correlation with the time-equivalent Whalers Bluff Formation developed onshore at Portland. It consists of calcarenites and calcilutites, white to cream, greyish towards base of sequence, massive, moderately hard to hard and soft to very soft towards base, homogeneous, non-fossiliferous in upper part, dolomitic throughout, and contains sand size calcite grains throughout. Foraminifers became abundant below 587 metres and clay content increased, becoming choked and sticky towards base (almost marly). These lithologies are indicative of open shelf carbonate sedimentation.

A major hiatus separates the Middle Pliocene from the Late Miocene. Some of the Miocene section is missing at Bridgewater Bay No. 1 due to Late Miocene to Early Pliocene erosion. Likewise, the entire Miocene section is not represented by the sedimentary sequence in Discovery Bay No. 1 yet most of the Miocene is represented by limestone sediments onshore at Portland. In contrast, the Early Miocene is present in the nearby Voluta No. 1 well. This suggests that there was a great deal of erosion occurring during the Late Miocene to Early Pliocene, probably by submarine canyon cutting prior to infilling initiated during the Middle Pliocene.

Resistivity and sonic-transit time peaks at 822 metres indicate the base of the Pliocene Whalers Bluff Formation Equivalent.

Middle to Late Miocene: Gambier Limestone (Heytesbury Group), 822 - 861.3m (39.3m):

The unconformable contact between the Gambier Limestone and the Whalers Bluff Formation Equivalent is readily picked from resistivity and sonic-transit time log readings and lithologically as a change from calcilutite to interbedded calcarenite and dolomite occurs. It consists of calcarenite, white to cream and grey, massive, blocky, moderately hard to hard, with calcite and foraminifers throughout. The dolomite is green grey, hard, and appears as interbedded stringers throughout the sequence. Also present in minor amounts are chert and black, fissile shales. This section is consistent with the deposition in a mid-continental shelf environment.

A major hiatus of approximately 15 million years separates the Middle Miocene from the Middle Eocene. The entire Oligocene section is absent at the Bridgewater Bay No. 1 location. This suggests a great deal of erosion occurred at this location in post-Middle Eocene time, perhaps as part of the submarine canyon cutting suggested in the Pliocene segment.

Middle Eocene: Nelson Formation (Heytesbury Group); 861.3 - 901m (39.7m):

At 861.3 metres, distinct increases in gamma ray, resistivity log and sonic-transit time log readings along with definite lithological changes mark the top of the Middle Eocene Nelson Formation. The lithology is comprised of calcareous claystone, grey, very soft, massive, with black, hard, sugary textured dolomite, minor amounts of chert and abundant quartz sandstone, white to brown and clear, medium-to-coarse grained, subangular to rounded, and fair sorting. Also present are pyrite, mica and calcite grains with glauconite staining.

The depositional environment appears to be in an inner continental shelf environment.

A hiatus of approximately two million years exists at the base of this unit between the Middle Eocene and the underlying Late Paleocene to Early Eocene. This is characterized by a definitive but gradual decrease in the gamma ray readings, a sharp, well-defined decrease in the resistivity log, and a sharp, well-defined increase in sonic-transit time log readings. It also coincides with a strong seismic inflector at 901 metres representing the green seismic horizon (Base Tertiary

Carbonates; (Enclosure 5) mapped throughout Permit Vic/P14. This permit wide/basinwide unconformity corresponds to the final separation of the Australian and Antarctic Plates during Middle Eocene time.

Late Paleocene to Early Eocene: Dilwyn Formation (Wangerrip Group); 901 - 1168m (267m):

A very marked lithological change accompanied by sharp changes in log character separates the Dilwyn Formation from the overlying Nelson Formation. The gamma ray and resistivity curves vary consistently from high-to-low responses, indicative of the interbedded sandstone-siltstone lithologies comprising this unit.

The sandstones are lower delta plain in origin and occur in thick, massive beds separated by thinner siltstones and claystones. Coal beds one-to-two metres thick occur at the top of this section. The sandstones are quartz, white to brown and clear, medium-to-coarse grained, subangular to rounded, fair sorting with pyrite and mica present. The siltstone is cream to grey, very soft, with foraminifers and spicules common throughout and calcite cement. The claystone is dark brown, homogeneous, plastic and very sticky, very soft, non-calcareous, carbonaceous, and non-fossiliferous.

Late Paleocene: Pember Mudstone (Wangerrip Group); 1168 - 1201.5m (33.5m)

At 1168 metres, a subtle lithological change is shown by an increase in the gamma ray and resistivy curve readings as the lowermost Dilwyn Formation passes into a conformable delta front or marine siltstone and minor sandstone unit of the Pember Mudstone. The siltstone is brown to dark brown, homogeneous, soft to moderately soft, non-calcareous, argillaceous, carbonaceous and sub-fissile in part with minor sandstone interbeds, quartz, clear to white, coarse-to-very coarse grained, subangular to subrounded, moderate sphericity, well sorted, slightly argillaceous and non-carbonaceous with no apparent cement.

Middle Paleocene: Pebble Point Formation (Wangerrip Group); 1201.5 - 1240.5m (39m)

Conformably underlying the Pember Mudstone are the marine sandstones of the Pebble Point Formation at a depth of 1201.5 metres. The sandstone is quartz, clear to white and yellow to brown, with minor iron staining on the quartz grains, medium-to-coarse grained, subangular to subrounded, moderate sphericity, moderately well sorted, very minor clay/silt cement, slightly argillaceous, non-carbonaceous, with trace amounts of pyrite and glauconite.

The Pebble Point Formation is marine in origin and represents a widespread transgression throughout the Otway Basin. Sediments were deposited in a shallow marine to marginal marine environment. It is marked by a typical decrease in the gamma ray and resistivity curves and sonic-transit time log.

A marked unconformity exists between the Middle Paleocene and underlying Cretaceous sedimentary sections. This unconformity is associated with the commencement of the second phase of rifting in the Otway Basin. In comparison, the entire Paleocene section is absent in the Discovery Bay No. 1 well yet most of the Early to Late Paleocene is represented by sandstones and shales of the Pebble Point Formation onshore at Portland and in Shell Development's Voluta No. 1 well.

Cretaceous

Maastrichtian: Curdies Formation (Sherbrook Group); 1240.5 - 1549m (308.5m)

The top of the Upper Cretaceous (Maastrichtian) Curdies Formation was encountered at 1240.5 metres and is recognized by a subtle change in lithology, accompanied by increases in gamma ray, resistivity, and sonic-transit time log curves and a decrease in drilling rate when compared with the unconformably overlying Pebble Point Formation. Representing deposition within a fluvial environment, the Curdies Formation is comprised of sandstone with minor interbedded siltstone and traces of coal. The sandstone is quartz, clear to white and yellow to brown, with some iron staining, medium-to-very coarse grained, subangular to subrounded, moderately well sorted, moderate sphericity, minor clay/silt matrix, argillaceous, non-carbonaceous to carbonaceous with traces of pyrite and glauconite. The siltstone is light grey to dark brown, soft to moderately hard, non-calcareous, carbonaceous, homogeneous, argillaceous and non-fossiliferous.

The unconformity separating the Curdies Formation from the overlying Pebble Point Formation has been mapped as the pink seismic horizon throughout Permit Vic/P14 (Enclosure 5).

Santonian: Paaratte Formation (Sherbrook Group); 1549 - 2682m (1133m):

The boundary between the Paaratte Formation and the conformably overlying Curdies Formation at 1549 metres is based on variations in the gross lithologies of each unit as definitive changes in electric log character are not immediately apparent. Because both formations are time-transgressive, palynological age dating does not define the exact boundary.

The Paaratte Formation represents deposition in a fluvial to marginal marine environment and is comprised of interbedded sandstone and siltstone with claystone and minor amounts of coal. The siltstone is light grey to dark grey and dark brown, very soft to firm becoming hard toward the base of the unit, homogeneous, non-calcareous, carbonaceous, argillaceous, and non-fossiliferous. The interbedded sandstones are quartzose, clear, white and yellow to light grey, fine-to-coarse grained, subangular to rounded, moderate-to-poor sphericity, poorly-to-moderately well sorted, calcareous and pyrite cementation, with an argillaceous matrix. Coal stringers are located between 1670 - 1710 metres, 1940 - 1970 metres and coal laminations between 2490 metrs and 2640 metres. Crystalline dolomite occurs as interlaminations throughout the middle portion of the section.

The uppermost reservoir target for the Bridgewater Bay No. 1 well was a sandstone unit developed near the base of the Paaratte Formation as mapped by the brown seismic horizon. Log analysis indicates that the sandstones between 2632 metres and 2668 metres have log-derived porosities averaging 17 percent, with a high of 29 percent. Although no significant hydrocarbons were encountered, the reservoir characteristics of this interval are described in greater detail in the section on Porosity and Permeability. The basal Paaratte Formation sandstones between 2632 metres and 2668 metres have dips between 5° and 12°, with an average being 6° to the south-southwest. Sedimentary source for this lower delta plain/marginal marine unit is probably from the north.

Middle to Early Turonian: Belfast Formation (Sherbrook Group); 2682 - 4102m (1420m):

A sequence of massive siltstone and claystone with minor sandstone interbeds was encountered at 2682 metres. This interval represents the Upper Cretaceous Belfast Formation which represents the distal prograding equivalent of the overlying Paaratte Formation. The boundary between the Belfast Formation and the conformably overlying Paaratte Formation is based primarily on a sharp decrease in the resistivity curve reading and a very subtle upward shift in the sonic-transit time log. Palynological analyses at this level have been inconclusive as the microfauna are time transgressive throughout. The age dating of this unit, therefore, was tentatively assigned as Middle to Early Turonian.

The siltstone is light grey to black and occasionally white, hard to very hard, brittle, blocky to subfissile, non-calcareous, carbonaceous, homogeneous, and argillaceous. The claystone is cream, light grey to brown, very soft becoming firm in middle portion of section, massive, calcareous, argillaceous, sticky and slightly carbonaceous. The interbeds of sandstone are quartz, clear to cream and frosted, very fine-to-fine grained in the upper section becoming coarse to very coarse with depth, well sorted, low-to-high sphericity, argillaceous matrix, and uncemented. Calcite plates are in close association with the sandstone units and are clear and cream to white, fine-to-coarse grained and very platy. There are glauconite particles throughout which decrease with depth and trace amounts of coal are observed in the lowermost section.

The very fine-to-fine grained sandstone from the upper part of the Belfast Formation exhibited poor-to-fair log-derived porosities, averaging 10 percent, with a high of 19 percent. The log-derived porosities are believed to have been artificially upgraded by the clay and glauconite present within and the sandstones are, in fact, choked by the ever-present clay and silt. Log-derived porosities of zero percent have been calculated for the coarse grained sandstones in the lowermost section of the Belfast Formation.

Cenomanian: Waarre Formation (Sherbrook Group); 4102 - 4200m (98m)

The top of the Cenomanian Waarre Formation was encountered at 4102 metres and is recognized by a decrease in sonic-transit time, an increase in the resistivity log reading and a well-defined lithologic change plus a decrease in drilling rate. Ninety-eight metres of Waarre Formation sediments were drilled before the Bridgewater Bay No. 1 well was terminated at a depth of 4200 metres. It is comprised of a sequence of interbedded sandstone and claystone with minor siltstone. The sequence was deposited in a low-energy marginal-marine environment.

The sandstone is light grey to white and mottled in part, very fine-to medium grained, subangular to subrounded, poor-to-well sorted, low-to-high sphericity, argillaceous, slightly calcareous, moderately abundant carbonaceous material throughout, silica cementation, kaolinitic matrix. The claystone is light-to-medium grey and white to cream to reddish cream, soft, sticky, non-calcareous, cabonaceous specks throughout. The siltstone is black to grey and occasionally white, sucrose texture, clay matrix, slightly calcareous, argillaceous, carbonaceous, micaceous, silt-sized pyrite disseminated throughout, minor amounts of glauconite and blocky in nature.

The Waarre Formation was the primary reservoir target in the Bridgewater Bay No. 1 well. No significant hydrocarbons were encountered below 4102 metres. Reservoir characteristics for the Waarre Formation are described in the section on Porosity and Permeability. The results of a dipmeter interpretation of the lower portion of the Belfast Formation and the Waarre Formation is discussed in some detail in the Structure section of this report.

c) <u>Stratigraphy</u>

The stratigraphic section penetrated in Bridgewater Bay No. 1 extends from Recent to Late Upper Cretaceous (Cenomanian) in age. Anticipated versus actual stratigraphic sections are shown in Figure 5. Formation names, lithology and ages are shown in Figure 6.

Formation tops and ages are based upon lithological, micropaleontological, and palynological studies of sidewall cores and drill cuttings, in conjunction with wireline log characteristics and correlation with the nearby Voluta No. 1 and the Discovery Bay No. 1 wells. Ages for the Late Tertiary are based on micropaleontological data, whereas those for the Early Tertiary and Upper Cretaceous are based on palynological (spore-pollen and dinoflagellate) data.

A major unconformity exists between the Cretaceous and Tertiary sediments and is associated with the commencement of the second phase of rifting in the Otway Basin. Other major unconformities also exist where the Mid Eocene is in contact with the underlying Late Paleocene to Early Eocene. A major hiatus separates the Mid Eocene from the Mid Miocene wherein the Oligocene and the Late Eocene is absent. Another major hiatus separates the Mid-to-Late Pliocene sediments from the underlying Mid-to-Late Miocene section. Much of the Miocene section is missing at Bridgewater Bay No. 1 due to Late Miocene-to-Early Pliocene erosion. The remainder of the interval penetrated appears to be conformable with the possible exception of an angular unconformity believed to exist at the top of Mid-to-Late Cretaceous Cenomanian-aged Waarre Formation sediments.

Brief descriptions of the stratigraphic units penetrated in the Bridgewater Bay No. 1 well are presented below. Detailed lithologic descriptions of cuttings and sidewall cores are given in Appendices 3 and 4 respectively, and also on the Geologist's Litholog (Enclosure 3) and Geoservices Mud Log (Enclosure 2). A detailed summary of final stratigraphic interpretations for Bridgewater Bay No. 1 is presented on the Well Composite Log (Enclosure 4).

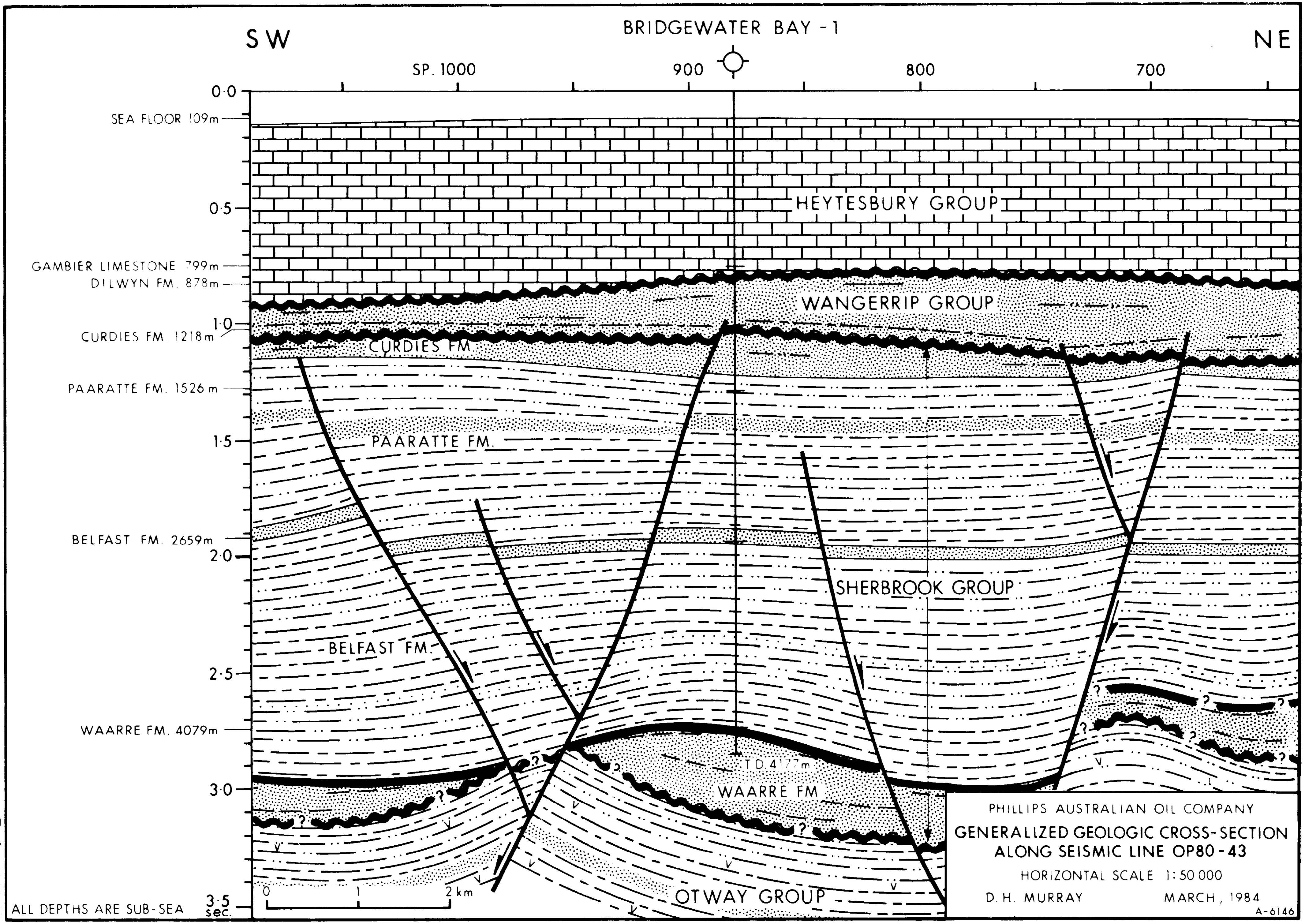

SW
BRIDGEWATER BAY - 1
NE
SP. 1000
900
800
700
0·0
SEA FLOOR 109m
0·5
HEYTESBURY GROUP
GAMBIER LIMESTONE 799m
DILWYN FM. 878m
WANGERRIP GROUP
1·0
CURDIES FM. 1218m
CURDIES FM.
PAARATTE FM. 1526 m
1·5
PAARATTE FM.
BELFAST FM. 2659m
2·0
SHERBROOK GROUP
BELFAST FM.
2·5
WAARRE FM. 4079m
T.D. 4177m
3·0
WAARRE FM.
OTWAY GROUP
3·5 sec.
0
1
2 km
ALL DEPTHS ARE SUB-SEA
PHILLIPS AUSTRALIAN OIL COMPANY
GENERALIZED GEOLOGIC CROSS-SECTION ALONG SEISMIC LINE OP80-43
HORIZONTAL SCALE 1: 50 000
D. H. MURRAY
MARCH, 1984
A-6146

FIGURE 7

d) Well Correlation

A comparison of the stratigraphy in Bridgewater Bay No. 1 with the nearby Voluta No. 1 and Discovery Bay No. 1 wells is given in Table 8. Voluta No. 1 is the closest well to the Bridgewater Bay No. 1 location, being located approximately 13.5 kilometres to the northwest. The next closest offshore well is the Discovery Bay No. 1 located approximately 29 kilometres to the west-northwest.

Although the stratigraphy at Bridgewater Bay No. 1 correlates best with that of Voluta No. 1, the depths and interval thicknesses of the Discovery Bay No. 1 well are included in Table 8 for comparison.

Both the Bridgewater Bay No. 1 and the Voluta No. 1 exhibit the same gross stratigraphic intervals; however, the thicknesses vary considerably. The differences are:

a) From Voluta No. 1 to Bridgewater Bay No. 1 the relative thicknesses of post Middle Eoecene formations show thickening of the Whalers Bluff Formation Equivalent and substantial thinning of the Gambier Limestone and Nelson Formation. The transgressive nature of the post-Eocene section should be represented by thinning of the carbonates in a northwesterly direction which is the case for the Gambier Limestone and the Nelson Formation. Pliocene carbonate deposition within channels cut during the Miocene probably accounts for the localized anomalous thicknesses of the Whalers Bluff Formation Equivalent.

b) The Nirranda Group is absent at both the Bridgewater Bay No. 1 and the Voluta No. 1. However, in comparison, 93 metres of Nirranda Group sediments are present at the Discovery Bay No. 1 location.

c) The Dilwyn Formation is 460 metres thick at Voluta No. 1 while at Bridgewater Bay No. 1 it is only 267 metres thick; a difference of 193 metres. It is postulated that downfaulting contemporaneous with or prior to Dilwyn Formation deposition formed a graben-like structure in the Voluta area, which extended slightly in the direction of the Discovery Bay area, accounting for the extra sediment thickness. At Discovery Bay No. 1 the thickness is 353 metres.

d) The Pember Mudstone and the Pebble Point Formation are of approximately equal thickness at the Bridgewater Bay No. 1 and Voluta No. 1 locations. The Pember Mudstone at the Discovery Bay No. 1 location is also of approximately equal thickness; however, the Pebble Point Formation is absent. This absence is probably due to erosion, rather than to non-deposition of the formation.

e) Both the Curdies Formation and the Paaratte Formation are considerably thicker (96.5 metres and 517 metres respectively) at Bridgewater Bay No. 1 than at Voluta No. 1. This increase is related to the basinward position of Bridgewater Bay No. 1 with respect to Voluta No. 1.

f) The Belfast Formation at Voluta No. 1 is 229.5 metres thicker than its equivalent at Bridgewater Bay No. 1. This is possibly created by a slightly greater rate of subsidence in the Voluta "graben" during Turonian time.

g) The top Waarre Formation was intersected in a structurally higher position at Voluta No. 1 as opposed to Bridgewater Bay No. 1, namely 3779.5 metres compared with 4079 metres. It should be pointed out that the Voluta No. 1 well experienced borehole difficulties while drilling the Belfast Formation. The hole was lost at a depth of 3779 metres. Drilling continued and the lithology of the well did change below 3779.5 metres. However, the gross character of the ROP curve did not change. Without benefit of all post-drilling analytical techniques, it becomes questionable as to whether the Waarre Formation was penetrated prior to total depth of the well at 3973 metres. The above correlation comment is therefore tentative at best.

Table 8

Correlation with Voluta No. 1 and Discovery Bay No. 1

Wells					
Bridgewater Bay-1		Voluta-1		Discovery Bay-1	
Depth*	Interval Thickness	Depth*	Interval Thickness	Depth*	Interval Thickness
Whalers Bluff Formation Equivalent Seafloor					
109m	690m	No data	No data	< 407m	>234m
Gambier Limestone					
799m	39m	<260m	> 436m	641m	101m
Nelson Formation					
838m	40m	696m	86m	742m	22m
Nirranda Group					
Absent	0m	Absent	0m	764m	93m
Dilwyn Formation					
878m	267m	782m	460m	857m	353m
Pember Mudstone					
1145m	33.5m	1242m	27m	1210m	46m
Pebble Point Formation					
1178.5m	39m	1269m	33m	Absent	0m
Curdies Formation					
1217.5m	308.5m	1302m	212m	1256m	267m
Paaratte Formation					
1526m	1133m	1514m	616m	1523m	1230m+
Belfast Formation					
2659m	1420m	2130m	1649.5m	Not penetrated	
Waarre Formation					
4079m	98m+	3779.5m	193.5m	Not penetrated	
Total Depth					
4177m		3973m		2753m	

*Subsea Depth to Formation Tops

e) Seismic Marker Identification

A well velocity survey was conducted at Bridgewater Bay No. 1 on completion of drilling (Addendum 3). From the well velocity log, the main seismic reflectors mapped within Permit Vic/P14 have been related to the stratigraphy of Bridgewater Bay No. 1 as shown below, and in Enclosures 4 and 5.

Seismic Event	Two-Way Time (secs)	Depth	Stratigraphy
Green	0.788	901m (-878m)	Base Tertiary Carbonates - Top Wangerrip Group
Pink	1.038	1241m (-1218m)	Base Pebble Point Formation - Top Sherbrook Group (Curdies Formation)
Brown	1.802	2367m (-2344m)	Intra-Sherbrook Formation
Orange (?)	2.792	4102m (-4079m)	Top Waarre Formation
Blue	3.080	4928m -4905m	Top Otway Group?

The depths to the green, pink, brown, and orange seismic mapping horizons are greater than those predicted prior to drilling. The pre-drill depths of the green and pink mapping horizons were respectively 32 metres and 80 metres shallower than predicted since the initial time--to-depth conversion velocities were too slow. The pre-drill depths of the brown and orange mapping horizons were respectively 1268 metres and approximately 1800 metres shallower than predicted due to miscorrelations across faulted zones between the nearby Discovery Bay No. 1 and Voluta No. 1 wells.

Based on post-drilling data from the Bridgewater Bay No. 1 well, the orange seismic horizon mapped elsewhere in Permit Vic/P14 as the Top Otway Group? appears to correlate with the top of the Waarre Formation. A reflection some 288 milliseconds below the Top Waarre Formation horizon is tentatively correlated with the Top Otway Group, and has been denoted as the blue seismic horizon. If this correlation is correct, the thickness of the Waarre Formation at the Bridgewater Bay No. 1 location is approximately 826 metres.

f) Structure

The Bridgewater Bay No. 1 well was drilled on a seismically-defined structural anomaly located in the central portion of Permit Vic/P14. It was comprised of a faulted anticlinal structure mapped as the orange seismic horizon which was correlated with the top of the Otway Group (Figure 9). In addition, a significant faulted-anticlinal closure was developed at the Near-Top Belfast Formation level (Figure 8), as mapped by the brown seismic horizon.

The brown seismic horizon was correlated from the Voluta No. 1, where it tied to an interbedded sandstone and siltstone section developed near the top of the Belfast Formation. The basal Paaratte Formation/ Top Belfast Formation contact was intersected 482 metres lower than predicted. Miscorrelation across faults between nearby Voluta No. 1 accounts for the discrepancy in anticipated versus actual depth to the brown seismic horizon (Figure 10).

With the lack of any direct well tie, mapping of the Top Otway unconformity/Waarre Formation was based broadly on an obvious deep unconformity horizon on seismic data in the western and eastern portions of Permit Vic/P14. Mapping within the central portion of the permit was more difficult, there being a choice of mapping either a shallower or deeper horizon as the top Otway unconformity. The shallower of the two horizons was mapped and tentatively correlated with the top of the Otway Group (Figure 9). The depth to this horizon at Bridgewater Bay No. 1 was estimated to be 3127 meters. It was inferred that Waarre Formation sediments would unconformably overlie this horizon. The depth to the top of the Waarre Formation was arbitrarily estimated to be approximately 3000 meters.

The results of the Bridgewater Bay No. 1 proves that the seismic interpretation within the central portion of Permit Vic/P14 is in error, the horizon mapped as the top of the Otway Group falling within the upper portion of the Belfast Formation. There is strong evidence to suggest that this horizon is related to the top of the overpressure which was encountered at approximately 3050 meters in the well. The strong seismic reflection at 2.191 seconds gives the appearance of an unconformity due possibly to the existence of mud diapirism in the area (Figures 10 and 11).

Mapping of a deeper unconformity horizon now correlated with the top of the Waarre Formation, as identified in the Bridgewater Bay No. 1 well, indicates that the structural closure mapped on the shallower horizons does not persist with depth (Figure 12). Although closure does exist on this deeper horizon the well falls approximately 35 metres downdip from the culmination.

The Bridgewater Bay No. 1 has shown that angular unconformities are developed at both the top of the Waarre Formation and the top of the Otway Group (base of Waarre Formation). In a regional sense the orange seismic mapping horizon, with the exception of the uncorrelated mapped central area appears to correlate with the top of the Waarre Formation. Although the deeper angular unconformity was not positively tied to the top Otway unconformity on the Bridgewater Bay No. 1, it is reasonable to assume that it represents the top of the Otway Group/Base of Waarre Formation.

These very critical seismic identifications will allow confident remapping of these important horizons within Permit Vic/P14.

Dipmeter results also confirm the angular relationship existing at the top of the Waarre Formation. Beds overlying the Waarre Formation tend to dip in a northerly direction while at the initial contact of the Waarre Formation the beds change decidedly to a northwesterly orientation.

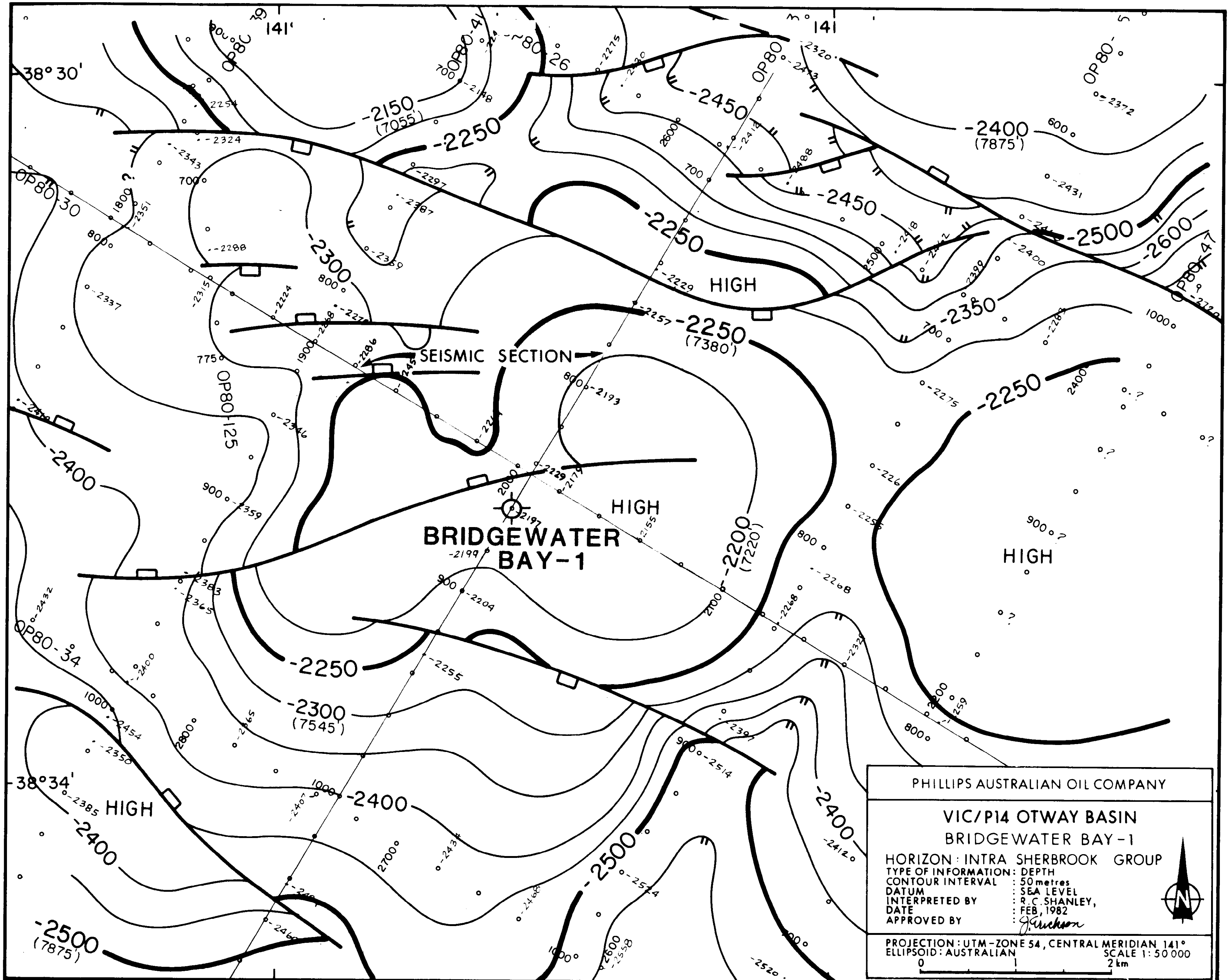

PHILLIPS AUSTRALIAN OIL COMPANY
VIC/P14 OTWAY BASIN
BRIDGEWATER BAY-1
HORIZON: INTRA SHERBROOK GROUP
TYPE OF INFORMATION: DEPTH
CONTOUR INTERVAL : 50 metres
DATUM : SEA LEVEL
INTERPRETED BY : R.C. SHANLEY,
DATE : FEB, 1982
APPROVED BY
PROJECTION: UTM-ZONE 54, CENTRAL MERIDIAN 141°
ELLIPSOID: AUSTRALIAN
SCALE 1:50 000
0
1
2 km
N
BRIDGEWATER BAY-1
SEISMIC SECTION
HIGH
HIGH
HIGH
HIGH
HIGH
38° 30'
38°34'
141'
141
-2150 (7055')
-2250 (7380')
-2200 (7220')
-2300 (7545')
-2400 (7875')
-2500 (7875')
-2250
-2300
-2350
-2400
-2450
-2500
-2600
OP80-30
OP80-34
OP80-125
OP80-47

FIGURE 8

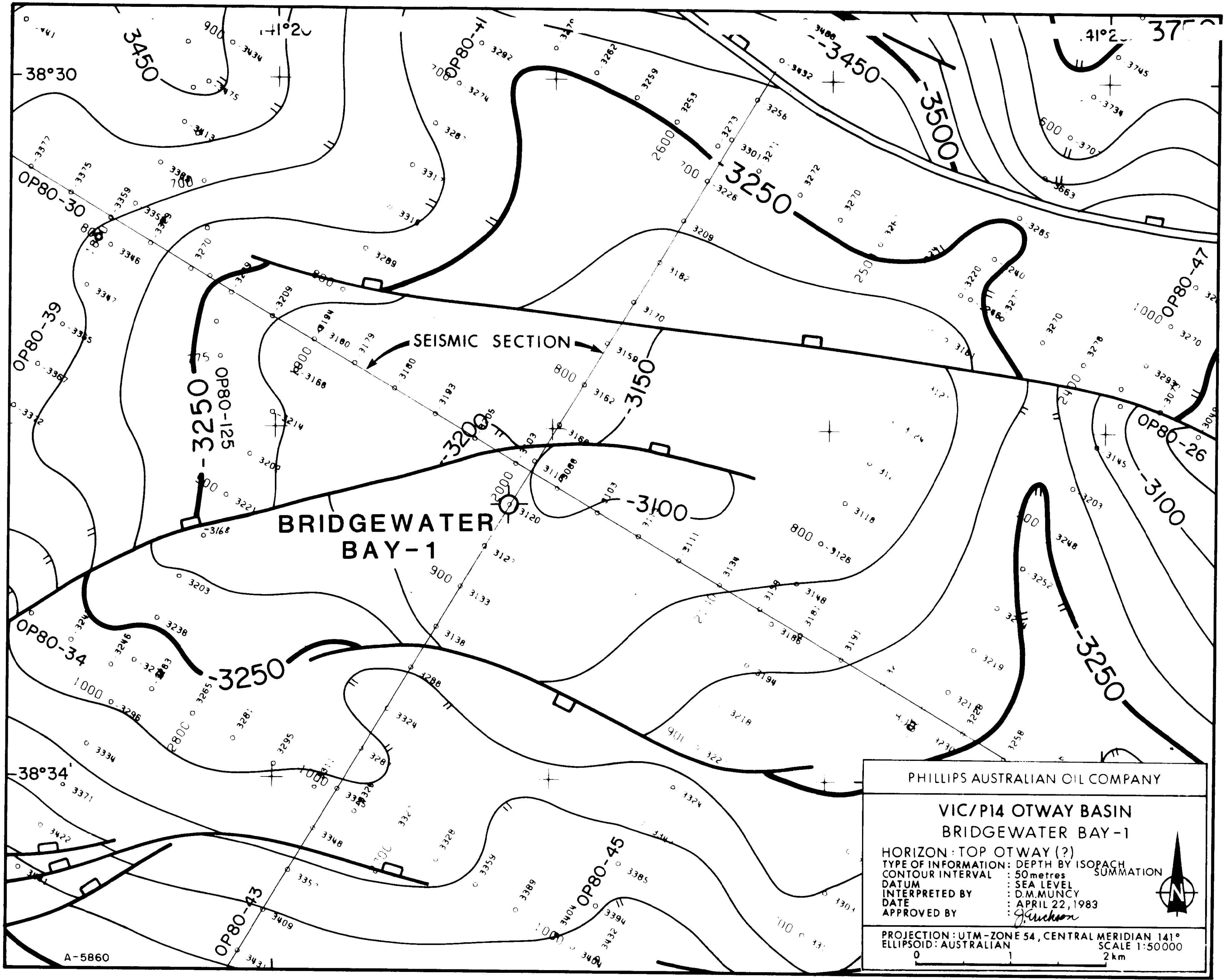
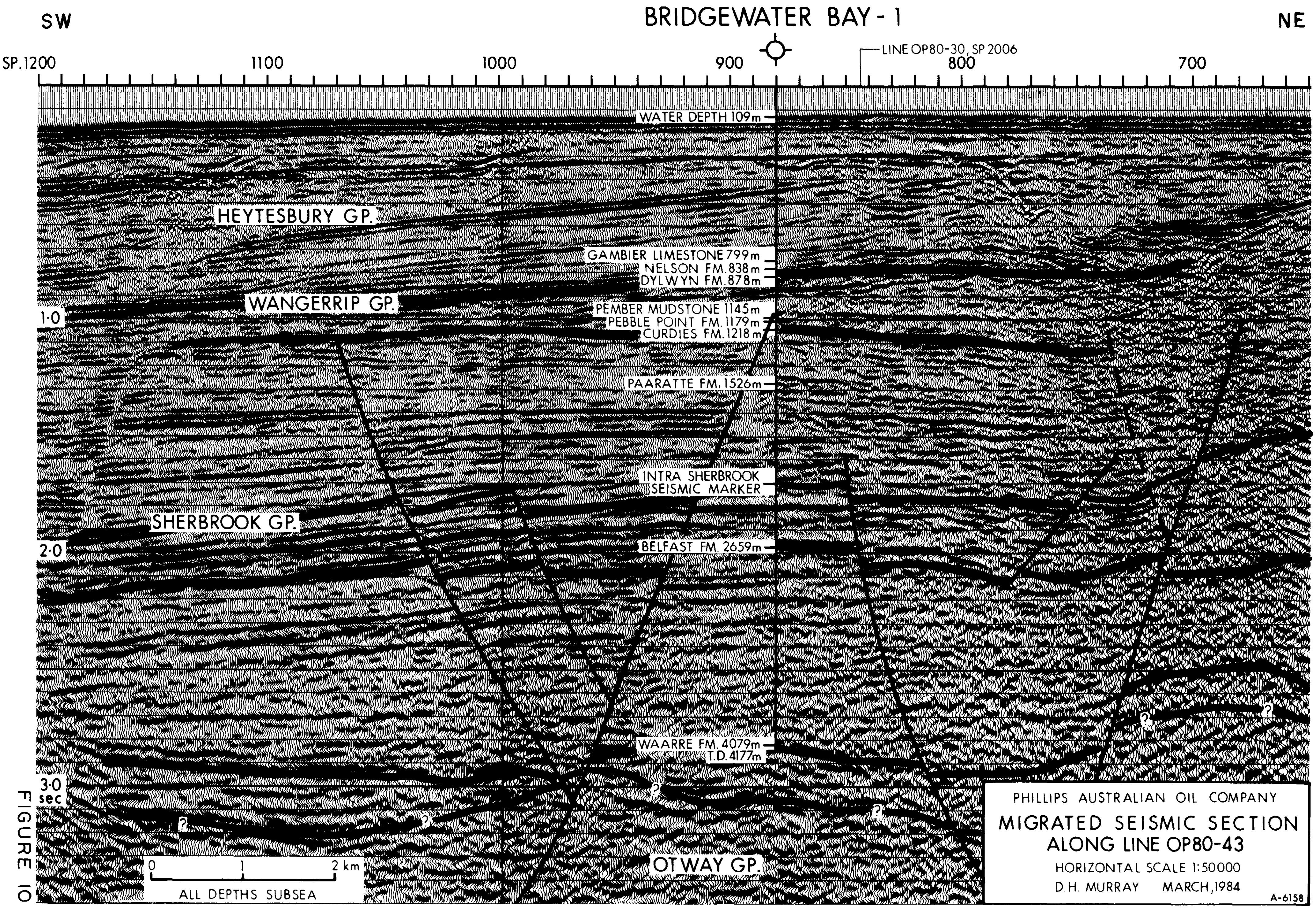
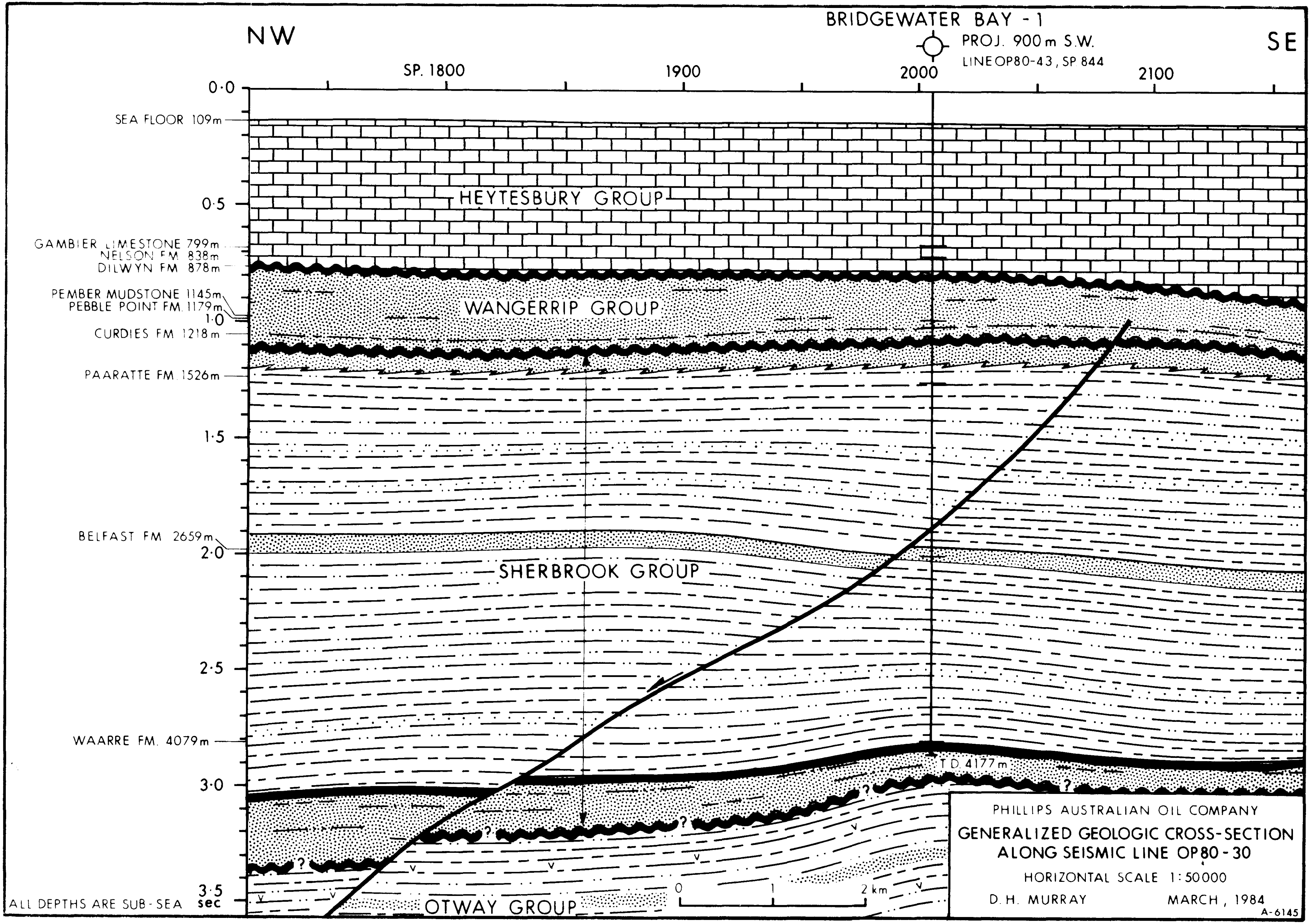

PHILLIPS AUSTRALIAN OIL COMPANY
VIC/P14 OTWAY BASIN
BRIDGEWATER BAY-1
HORIZON : TOP OTWAY (?)
TYPE OF INFORMATION : DEPTH BY ISOPACH SUMMATION
CONTOUR INTERVAL : 50 metres
DATUM : SEA LEVEL
INTERPRETED BY : D.M.MUNCY
DATE : APRIL 22, 1983
APPROVED BY
PROJECTION : UTM-ZONE 54, CENTRAL MERIDIAN 141°
ELLIPSOID : AUSTRALIAN
SCALE 1:50000
0
1
2 km
N
BRIDGEWATER BAY-1
SEISMIC SECTION
OP80-30
OP80-39
OP80-34
OP80-125
OP80-41
OP80-47
OP80-26
OP80-45
OP80-43
38°30
38°34'
-3250
-3200
-3150
-3100
-3450
-3500
3450
A-5860

FIGURE 9



BRIDGEWATER BAY - 1
SW
NE
LINE OP80-30, SP 2006
SP.1200
1100
1000
900
800
700
WATER DEPTH 109m
HEYTESBURY GP.
GAMBIER LIMESTONE 799m
NELSON FM. 838m
DYLWYN FM. 878m
WANGERRIP GP.
PEMBER MUDSTONE 1145m
PEBBLE POINT FM. 1179m
CURDIES FM. 1218m
1·0
PAARATTE FM. 1526m
INTRA SHERBROOK
SEISMIC MARKER
SHERBROOK GP.
2·0
BELFAST FM. 2659m
?
WAARRE FM. 4079m
T.D. 4177m
3·0
sec
OTWAY GP.
0
1
2 km
ALL DEPTHS SUBSEA
PHILLIPS AUSTRALIAN OIL COMPANY
MIGRATED SEISMIC SECTION
ALONG LINE OP80-43
HORIZONTAL SCALE 1:50000
D.H. MURRAY MARCH, 1984
A-6158

FIGURE 10


NW
BRIDGEWATER BAY - 1
PROJ. 900 m S.W.
LINE OP80-43, SP 844
SE
SP. 1800
1900
2000
2100
0·0
SEA FLOOR 109m
HEYTESBURY GROUP
0·5
GAMBIER LIMESTONE 799m
NELSON FM 838m
DILWYN FM 878m
PEMBER MUDSTONE 1145m
PEBBLE POINT FM 1179m
WANGERRIP GROUP
1·0
CURDIES FM 1218m
PAARATTE FM 1526m
1·5
BELFAST FM 2659m
2·0
SHERBROOK GROUP
2·5
WAARRE FM. 4079m
T.D. 4177m
3·0
3·5
sec
ALL DEPTHS ARE SUB-SEA
OTWAY GROUP
0
1
2 km
PHILLIPS AUSTRALIAN OIL COMPANY
GENERALIZED GEOLOGIC CROSS-SECTION ALONG SEISMIC LINE OP80-30
HORIZONTAL SCALE 1:50000
D. H. MURRAY
MARCH, 1984
A-6145
FIGURE 11

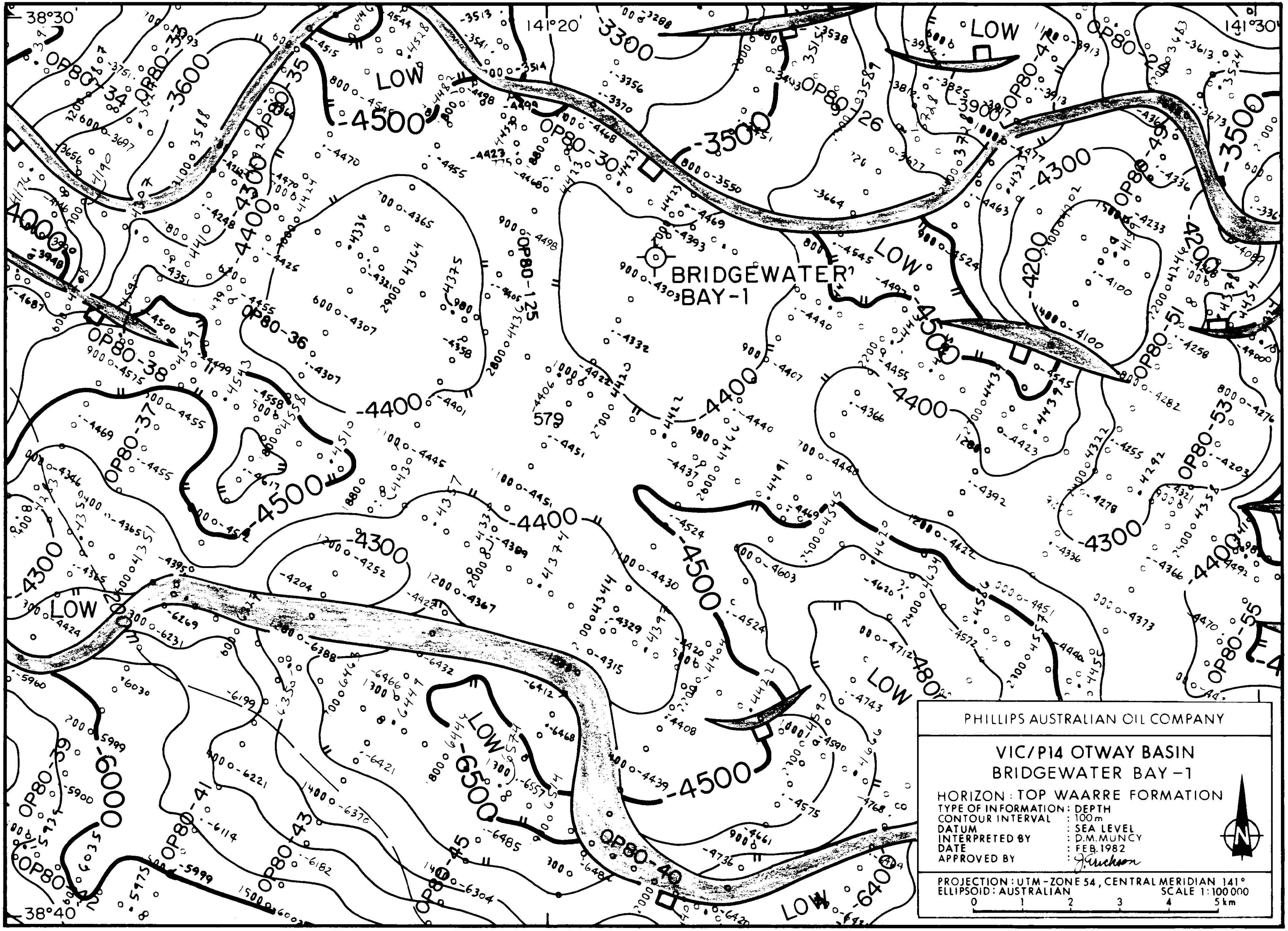


FIGURE 12

A-6189

g) Relevance to the Occurrence of Hydrocarbons

Hydrocarbon Indicators

A continuous record of gas levels was maintained by Geoservices after drilling out of the 20-inch casing shoe at 493.11 metres in Bridgewater Bay No. 1 (Addendum 2 , Enclosure 2). Total gas determinations and chromatographic analyses were conducted using a Geoservices gas chromatograph and a Flame Ionization Detector (FID). No hydrocarbon indications were noted from cuttings or sidewall cores examined. However, the extreme sensitivity of the Flame Ionization Detector allowed for the recording of trace amounts of C_2 and C_3, which otherwise would have gone undetected using the conventional chromatograph.

From the first sample returns at 513 metres to a depth of 2500 metres, only trace amounts of C_1 gas were recorded. The C_1 content ranged from a trace amount to a maximum of 4 percent between 2500 metres and 3480 metres with trace amounts of C_2 and C_3 present. In the Belfast Formation between 3480 metres and 4050 metres, C_1 ranged from trace amounts to a maximum of 0.12 percent with trace amounts of C_2 and C_3 being logged in only a few of the sample intervals. From 4050 metres to 4053 metres a C_1 maximum of 13 percent was recorded, and after circulating at 4052 metres, 0.12 percent C_2 was also detected. This C_1 peak was related to overpressure/lost circulation problems which were encountered at this zone. Trace amounts of C_1 were recorded from 4055 metres to the total depth of the well at 4200 metres.

Porosity and Permeability

Potential reservoir sections in Bridgewater Bay No. 1 comprise the Lower Tertiary Dilwyn and Pebble Point Formations and the Mid to Late Cretaceous Curdies, Paaratte, and Waarre Formations.

The Dilwyn Formation extends from 901 metres to 1168 metres and is comprised of lower delta plain sandstones with interbedded claystone and siltstone. Coal beds ranging in thicknesses of one-to-two metres occur in the top portion of this section. Sandstone beds range from two-to-nine metres in thickness with reservoir quality deteriorating with depth. In the uppermost 49 metres of the Dilwyn Formation the sandstones are quartzose, fine-to-medium grained, with occasional coarse grains, fair-to-well sorted, uncemented, with argillaceous matrix and fair visual porosity. In the lower 218 metres the sandstone grain size decreases to very fine-to-fine grained with the argillaceous matrix content increasing appreciably. Visual porosity is rated as very poor to poor in both sidewall cores and cuttings.

As a result of not running neutron-density logs through the Dilwyn Formation, porosity determinations were calculated using the sonic log and through visual estimates using sidewall cores and cuttings. Sonic log-derived porosities yielded unrealistically high values due to the undercompacted nature of the sediments. The Ro-method of correcting sonic log-derived porosities for lack of compaction was used for the upper 49 metres of the Dilwyn Formation sandstones. Corrected porosities of less than 5 percent were obtained and confirmed that the lower delta plain sandstones of the Dilwyn Formation at the Bridgewater Bay No. 1 well cannot be considered a potential reservoir.

The Pebble Point Formation extending from 1201.5 metres to 1240.5 metres is of shallow marine origin. The section is comprised of a massive, quartzose sandstone, medium-to-very coarse grained, subangular to subrounded, with poor sorting, moderate sphericity, slightly argillaceous and good visual porosity. Porosities were calculated from the sonic log as again, neutron-density logs were not run over the section. Sonic log-derived porosities are usually optimistic and this is supported in porosities of the Pebble Point Formation ranging from a low of 26 percent to a high of 44 percent (Figure 13). Even allowing for this optimistic derivation, the Pebble Point Formation at the Bridgewater Bay No. 1 location can be rated as having excellent reservoir potential especially considering the overlying Pember Mudstone section (1168 metres to 1201.5 metres) consisting of siltstone which provides a sealing mechanism.

The Curdies Formation was encountered between 1240.5 metres and 1549 metres. The fluvial section is dominated by sandstone with minor interbedded siltstones and occasional trace amounts of coal. Two types of sandstone are found in the Curdies Formation at the Bridgewater Bay No. 1 well: firstly, quartzose, fine-to-medium grained, subangular to subrounded, moderate sphericity, moderately well sorted with minor argillaceous matrix and secondly, quartzose, coarse-to-very coarse grained, round to well rounded, high sphericity, well sorted and slightly argillaceous. Individual sandstone beds average 8 metres in thickness. As with the Dilwyn and Pebble Point Formations, neutron-density logs were not run through the Curdies Formation. Sonic log-derived porosities ranged from 28.8 percent to 31.5 percent (Figure 13); considered unrealistically high due to the undercompacted nature of the sediments, the Curdies Formation would be an excellent reservoir section were it not overlain by the Pebble Point Formation sandstones and is not sealed.

The Paaratte Formation, encountered between 1549 metres and 2682 metres, is comprised of interbedded sandstone and siltstone with claystone and minor coal. The formation represents deposition in a fluvial to marginal marine environment. The sands between 1549 metres and 2632 metres range in thickness from one metre to 50 metres with an average of 5 metres and are quartzose, very fine-to-very coarse grained, glauconitic in the lower section and show fair-to-moderate visual porosity. A sandstone/minor siltstone/claystone interval which was penetrated between 2632 metres and 2682 metres was one of the drilling objectives of the Bridgewater Bay No. 1 well. The sandstone in this interval is quartzose, fine-to-very coarse grained, dominantly medium-to-coarse grained in the upper section, decreasing in grain size down-hole, with moderate sphericity, poor sorting, glauconite and increasing clay and silt content with depth.

The CPI log which was run throughout the Paaratte Formation indicates a porosity high of 29 percent with the average being 17 percent from the reservoir quality sands between 2632 metres and 2668 metres (Figure 13).

The Waarre Formation was penetrated between 4102 metres and 4200 metres (Total Depth) and is comprised of interbedded sandstone and claystone with minor siltstone. The Waarre Formation sequence was deposited in a transgressive shallow marine environment. The sandstone is white to light grey, very fine-to-fine grained, angular to subangular, with fair sorting, low-to-moderate sphericity, very clayey, very silty, siliceous cement, carbonaceous, with very poor-to-no visual porosity. The Waarre Formation was the principal drilling objective of the Bridgewater Bay No. 1 well. The CPI log indicates log-derived porosities of less than 2 percent throughout the section. Although the complete Waarre Formation was not penetrated, it must generally be regarded as having very poor reservoir quality in this portion of the basin.

Source Rock Potential

The hydrocarbon source rock potential of the sedimentary section encountered in Bridgewater Bay No. 1 was evaluated using geochemical analysis, palynological and vitrinite reflectance data, incorporated with borehole temperature measurements.

Organic geochemical analyses were performed by Analabs on thirty-one 50-metre composite drill cuttings samples taken over the interval 2700 - 4200 metres. The samples were analysed for Total Organic Carbon (TOC) content and by gas chromotography and pyrolysis (Appendix 7). Additional TOC determinations and pyrolysis, vitrinite reflectance, kerogen and spore coloration studies were also performed on thirteen sidewall cores by the Exploration Projects Section of Phillips Petroleum Company (Appendix 8).

Light hydrocarbons (C_1 and C_7) gas chromatography (headspace analysis; Appendix 7) was also performed by Analabs on cuttings samples over the interval 1130 - 4200 metres. These results indicate that sands within the interval are lean in gas and condensate, and consequently are considered to be non-prospective for any significant quantitites of indigenously-generated hydrocarbons.

Vitrinite reflectance measurements were performed on four cuttings samples at 2800 metres, 3200 metres, 3600 metres and 4200 metres. However, only two samples, those at 2800 metres and 3200 metres, contained measurable vitrinite. Both of these samples gave marginally mature reflectances (0.55% Ro and 0.53% Ro) placing these rocks in the initial stages of petroleum generation.

Tmax-pyrolysis temperatures were obtained from the thirty-one cuttings samples. The temperatures in the primary zone of interest were found to be contaminated by a petroleum-based mud additive and were therefore interpreted as being unreliable below 3600 metres. The temperatures were found to vary greatly in the overlying uncontaminated section and were found to be devoid of any recognizable maturity trend. Computer-generated results illustrate very erratic S_2 peaks, for Tmax analysis, which are interpreted to be due to the poor quality organic matter and reworked inertinite present in those samples.

The samples in the uncontaminated section contained good amounts of organic matter (>1.0 percent TOC) but the quality appeared to be low due to the overall low hydrogen index values. This resulted in the potential yields being lower, giving those sediments an overall poor hydrocarbon source character. However, the samples at 2700 metres, 2945 metres, and 3050 metres, have moderate hydrogen index values, with marginal-to-moderate potential yields.

The overall summary presented by Analabs' analysis indicates the sedimentary section penetrated in the Bridgewater Bay No. 1 well to have experienced a low degree of thermal maturation. This is based on the marginally mature Ro values obtained at 2800 metres and 3200 metres. The sediments below 3200 metres are not considered by Analabs to have obtained levels much higher than marginally to moderately mature. This would then place them within the top to middle portions of the oil window. This conclusion is not confirmed by maturation results obtained independently by Phillips Petroleum Company (Figure 14), and appear to be invalid. Pyrolysis analysis performed by Phillips

Petroleum Company on thirteen sidewall cores taken from the interval 934 metres to 4175 metres indicates no significant liquid hydrocarbon source rock potential exists at present maturity levels in the Bridgewater Bay No. 1 well to total depth.

Gas potential is indicated in the section below approximately 3800 metres in which the vitrinite reflectance values are greater than one percent (Figure 14). Seven of the thirteen samples are dominated by a liquid prone amorphous kerogen type, but the lack of fluorescence in the blue light range along with the low hydrogen index values indicate poor liquid potential. It is theorized that an oxidizing depositional environment lowered the kerogen's oil potential.

Total Organic Carbon (TOC) values are rich in nine of the thirteen samples. The remaining TOC values are rated as fair for the four deepest samples from 3295 metres to 4175 metres. This lower TOC zone coincides with maturity levels which are optimum for liquid hydrocarbon generation or are approaching the thermal dry gas range.

A very high S_1 pyrolysis peak in a sidewall core extracted from 2733 metres suggests an oil reservoir, migration pathway, or contamination. The latter suggestion would be the most feasible as Soltex, a petroleum based additive, was first introduced to the mud system at 884 metres in order to help alleviate suspected bit balling. The Soltex, although not added continuously, was introduced at least once more and residual amounts would have remained in the system throughout drilling. The production index (S_1/S_1+S_2) and the thermal extraction index (S_1 x 100)/TOC generally indicate both increasing maturity and generation with increasing depth. These data are found to be consistent with the TAI (spore color) and vitrinite reflectance maturity information. The hydrogen index values are low for all thirteen sidewall core samples and again are consistent with the visual observations in which a combination of non-fluorescent, probably oxidized amorphous algal kerogen and land derived gas-prone kerogens, indicate a low potential for liquid hydrocarbons.

Although Analabs would be considered to have a high level of expertise Australia wide and specifically in the Otway Basin, they were provided with sample cuttings which in all liklihood had been contaminated by sloughing. This contamination material would have been the result of the drilling difficulties encountered in the overpressure zone beginning at 3050 metres. Phillips Petroleum Company, on the other hand, were provided with sidewall cores taken from 934 metres to 4175 metres. These sidewall cores would be the most representative samples of the formation at the sample points. Therefore, the resulting analytical data would be the most valid.

The present day geothermal gradient at Bridgewater Bay No. 1 is 2.87°C/100 metres as calculated from the bottom hole temperature at each logging run extrapolated to static equilibrium temperature (Figure 15).

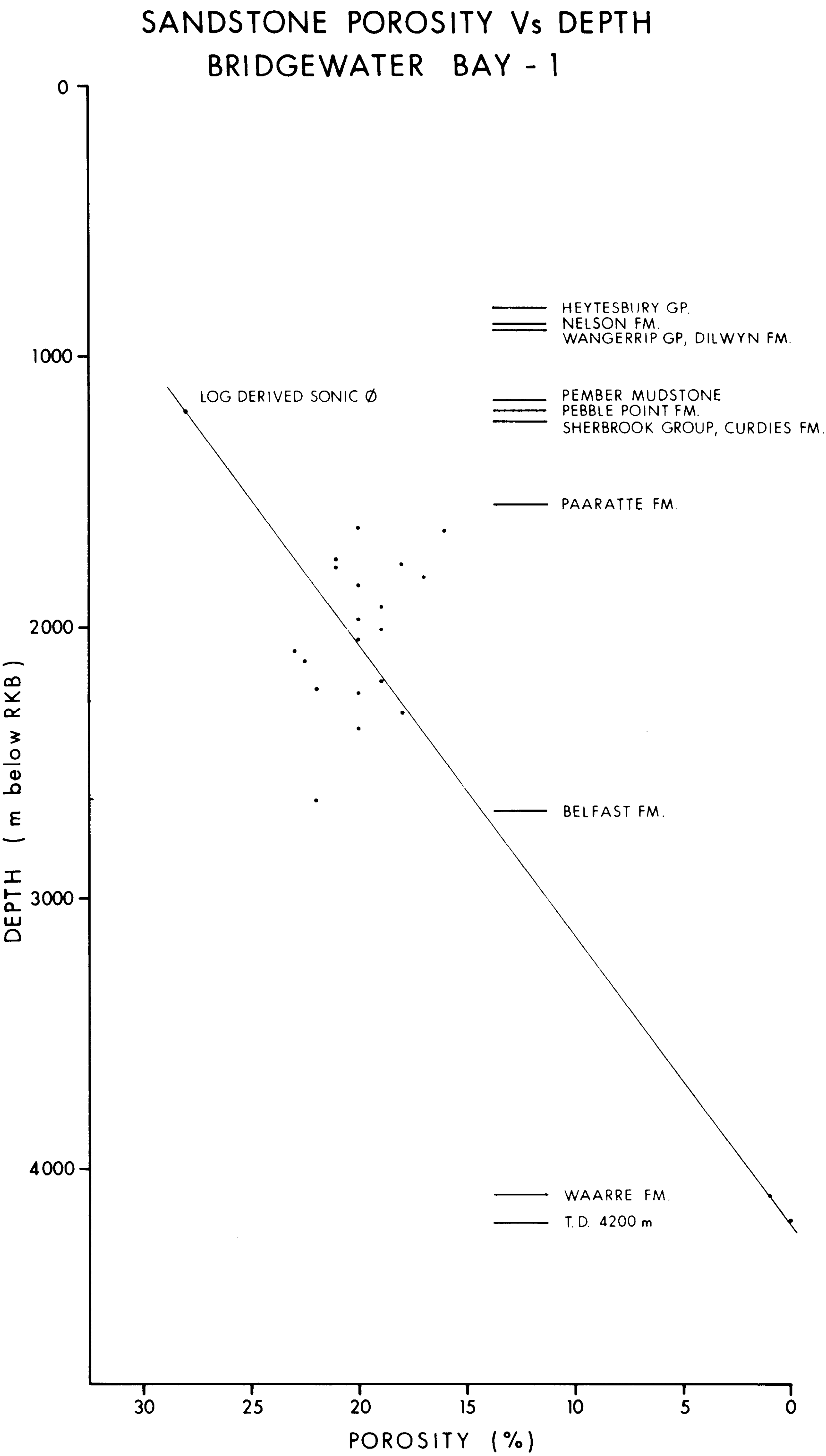


FIGURE 13
A-6150

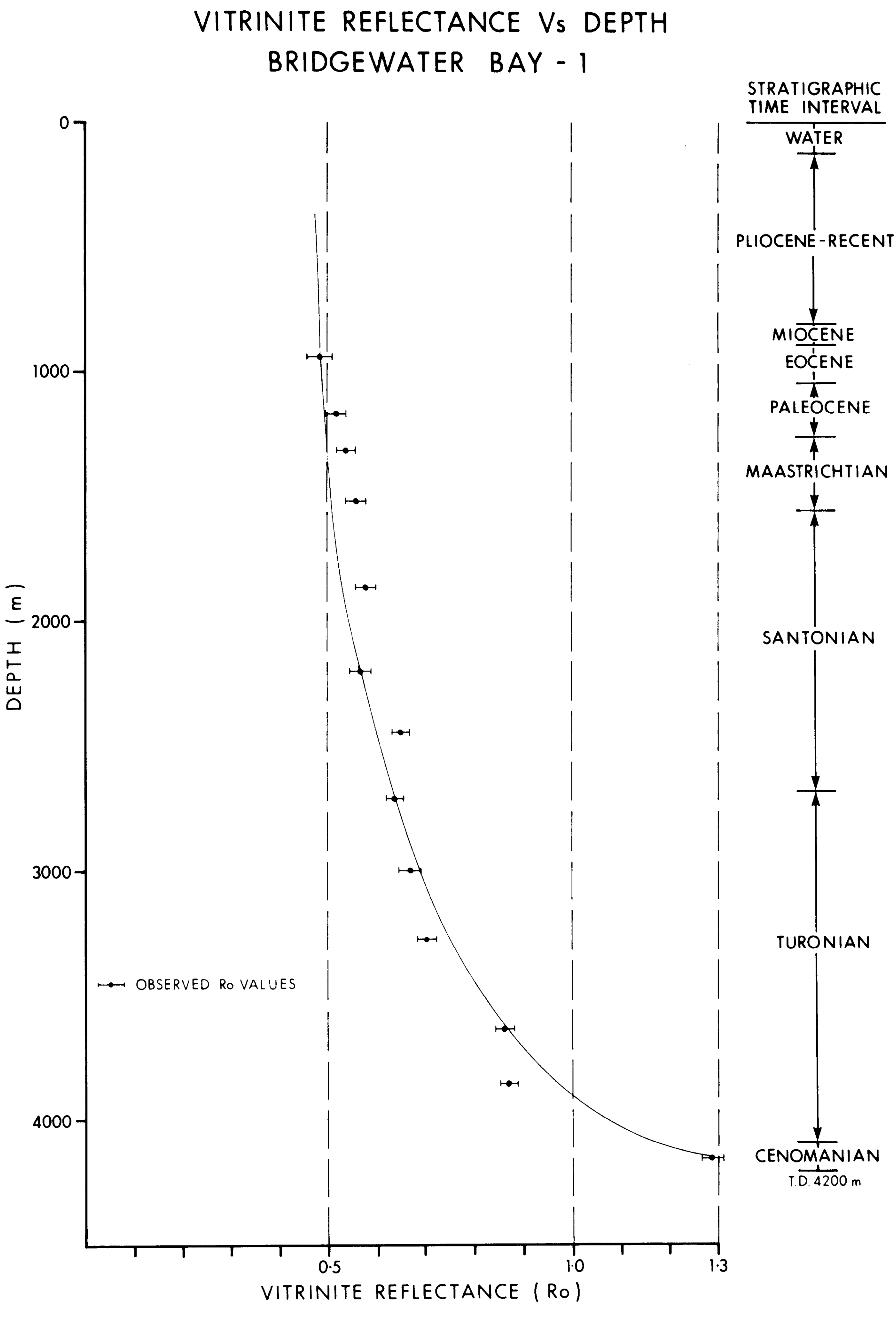


FIGURE 14

A-6151

TEMPERATURE Vs DEPTH
BRIDGEWATER BAY - 1

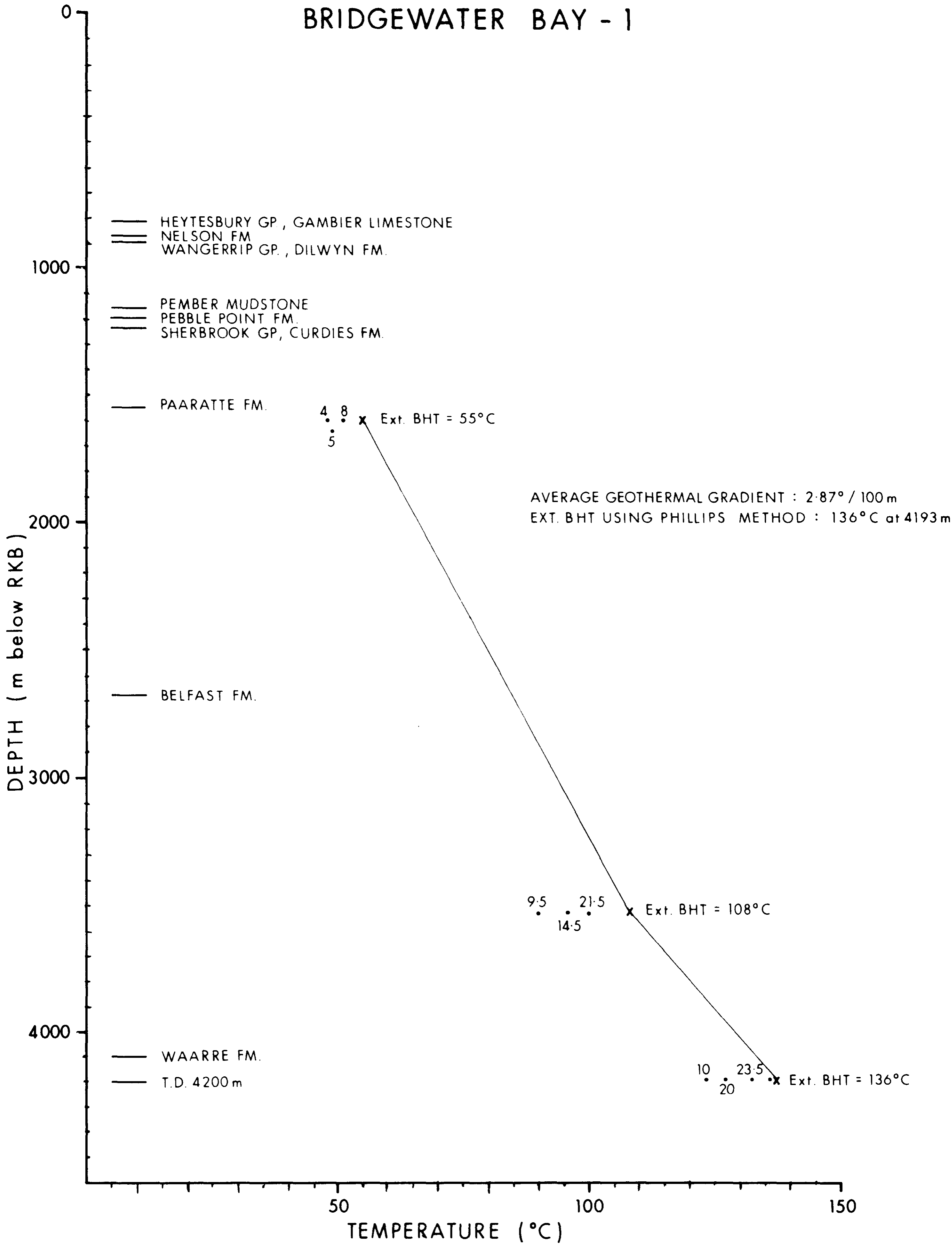


FIGURE 15
A-6149

Summary of Hydrocarbon Significance

1. The lack of significant accumulations of hydrocarbons at Bridgewater Bay No. 1 can be attributed to the following parameters:

a) The Bridgewater Bay No. 1 well penetrated the basal Paaratte Formation/Top Belfast Formation contact 482 metres lower than anticipated. The mapped faulted anticlinal closure is considered to be valid because of the conformability of the mid-Sherbrook sediments. However, the lack of hydrocarbon shows indicates either that the bounding fault does not seal or that hydrocarbons have not migrated into the structure. The latter consideration is favoured because of the demonstrated poor source potential of the underlying Belfast Formation.

   Minor sandstone beds were developed at the top of the Belfast Formation. However, they were only one to three metres thick and due to a very silty and clay choked matrix displayed very poor porosity development.

b) In excess of 100 metres of vertical closure was predicted for a faulted anticlinal structure developed at the Waarre Formation level. Because of seismic miscorrelation, the sandstones of the Waarre Formation were penetrated some 1100 metres lower than anticipated and were found to have log-derived porosities of less than two percent with very possibly nil permeability. Although there was no structural closure developed at the deeper level, the poor reservoir quality would have prohibited the trapping of significant hydrocarbons.

c) Excellent reservoir sections exist within the Pebble Point, Curdies and basal Paaratte Formations. The 39 metres of the Pebble Point Formation contain log-derived sonic porosities of between 26 percent and 44 percent and the overlying Pember Mudstone provides an excellent seal for any structural development. The sandstones of the Curdies Formation display fair-to-excellent visual porosity but lack top and intra-formational sealing mechanisms. Good quality reservoir sections are also developed within the sandstones of the Paaratte Formation, the average porosity of selected sand units being 17 percent. Log-derived porosities in the sandstones of the basal Paaratte Formation were between 10 percent and 22 percent.

d) Good quality source rocks were not penetrated at Bridgewater Bay No. 1. TOC values varied from fair-to-excellent and the majority of the samples analyzed were dominated by liquid-prone amorphous kerogen. However, the combination of low hydrogen index and lack of fluorescence indicates poor liquid hydrocarbon potential through oxidation. Thermal maturity, however, was attained below approximately 3295 metres on the basis of vitrinite reflection analysis of sidewall core material.

2. In that thermal maturity was attained below approximately 3295 metres, and a majority of samples analyzed were dominated by liquid-prone amorphous kerogen, it has been concluded that anerobic conditions which would enhance the source rock potential of the Belfast Formation could be developed in a more basinward position. The potential of Upper Sherbrook and Lower Tertiary plays may therefore be enhanced basinward of the Bridgewater Bay No. 1 location.

3. Conversely to item 4 above, Waarre Formation plays are more prospective in a landward direction, where higher energy conditions would have winnowed out the finer material and where shallower buried depths would have lessened the effects of sediment compaction. The thermal maturity of Otway Group source rocks would also be less with shallower buried depths landward.

h) Contributions to Geological Knowledge

1. The existence of a major basinwide unconformity between Cretaceous and Tertiary sediments confirms the premise that this event is associated with the commencement of the second phase of rifting in the Otway Basin.

2. A major unconformity was confirmed to exist during Early-to-Mid Eocene time. This, too, is related to a basinwide unconformity, representing final separation of Antarctica from Australia.

3. The absence of Late Eocene through Oligocene sediments indicates that the western shoulder of the rift was uplifted and exposed to erosion while the early phase of separation was in progress.

4. The Pebble Point Formation, present in both the Bridgewater Bay No. 1 and Voluta No. 1 wells, of approximately the same thickness and encountered at about the same drill depth, was absent in the Discovery Bay No. 1. This is possibly due to the existence of a structural high in the Discovery Bay area during Early Tertiary time.

5. The Paaratte Formation, encountered at approximately the same depth and having approximately equal thicknesses in Bridgewater Bay No. 1 and Discovery Bay No. 1 wells is of the order of half as thick at the Voluta No. 1 location. This may be related to the fact that the Discovery Bay and Bridgewater Bay areas are located basinward of the Voluta area. This is supported by the higher net sand content in the Voluta section.

6. The Bridgewater Bay No. 1 has confirmed the development of the Waarre Formation in the Vic/P14 portion of the Otway Basin. Although not fully penetrated in the well, it is possible that the Waarre Formation may be in the order of 800 metres thick in the Bridgewater Bay area. This would be the greatest thickness of the Waarre Formation yet identified in the Otway Basin.

7. The Paaratte Formation, encountered at approximately the same depth and having approximate thicknesses in the Bridgewater Bay No. 1 and Discovery Bay No. 1 wells is of the order of hals as thick at the Voluta No. 1 location. This supports the tectonics of the Otway Basin and the existence of the Voluta High.

8. The Bridgewater Bay No. 1 well is the only well in the offshore Otway Basin to confirm penetration of the Waarre Formation.

APPENDIX NO. 1

GOVERNMENT APPROVALS

DEPARTMENT OF MINERALS AND ENERGY

PRINCES GATE EAST 151 FLINDERS STREET MELBOURNE, VIC. 3000

TELEPHONE (03) 653 9200 TELEX MINERG AA 36595

Our Ref. KW/ML
Your Ref.
Contact
Ext. 334

20 July 1983

Mr O J Koop
General Manager
Phillips Australian Oil Company
23rd Floor
City Centre Tower
44 St George's Terrace
PERTH WA 6001

Dear Sir

DRILLING PROGRAMME - BRIDGEWATER BAY-1

You are advised that under Clause 3 of the Direction as to Drilling Operations, Designated Authority approval has been granted to your request to drill the new field wildcat Bridgewater Bay-1 in VIC/P14 using the semi-submersible drilling vessel "Diamond M Epoch". This approval is subject to the following conditions -

1 A preliminary abandonment programme shall be submitted to the Designated Authority at least one week prior to the submission of the detailed (post final logs) abandonment programme.

2 Where cuttings are recovered, dried cuttings submitted to the Designated Authority shall each be of a minimum of 100 grams in weight.

3 Phillips Australian Oil Company keeps the Australian Coastal Surveillance Centre, Canberra, informed of the movements of the drilling vessel.

Yours faithfully

J L LePage
DIRECTOR
OIL & GAS DIVISION

APPENDIX NO. 2

DAILY DRILLING SUMMARY

Date	Total Depth (RKB) Metres	Work Performed
16th Sept., 1983	187m	Re-ran Nos. 2 & 4 anchor warps. Installed a third piggyback anchor on No. 4 anchor warp. Pulled in on all anchors until all windlasses stalled or near-stalled. (The tension gauges were out of calibration). Storm tested anchors for two hours. Slacked off anchors to working tension. Ran temporary guide base and set same on seabed. RKB to seabed 131m. Water depth 109m. Ran in hole with 36 inch bottom hole assembly. Spudded well at 1730 hours, 15 September, and drilled from seabed to 187m. Spotted a 450 barrel high viscosity mud pill and pulled out of hole. Rigged up and ran 4 joints of 1 inch wall 30 inch casing with 30 inch wellhead and permanent guide base.
17th Sept., 1983	381m	Landed 30 inch casing with shoe at 182m. Cemented casing with 1500 sacks of class "G" neat cement mixed at 15.8 ppg. Made up 26 inch bottom hole assembly and ran in hole. Tagged cement at 180m. Drilled a 26 inch hole from 180m to 381m .
18th Sept., 1983	504m	Drilled a 26 inch hole from 381m to 504m. Spotted an 850 barrel high viscosity mud pill and pulled out of hole. Rigged up and ran 28 joints of X-56, 133 lbs/ft, 20 inch casing with shoe joint, cross over joint and 16-3/4 inch wellhead. Landed casing with shoe at 493m and wellhead at 128m. Ran in hole with cementing stinger and stung into the float collar. Cemented casing with 1300 sacks of Class "G" neat cement mixed with 2.5% prehydrated gel and 0.5% CFR-2 at 12.8 ppg (lead) and 500 sacks of class "G" neat cement mixed at 15.8 ppg (tail).

Date	Total Depth (RKB) Metres	Work Performed
19 Sept., 1983	504m	Laid down 26 inch bottom hole assembly and made up 17-1/2 inch bottom hole assembly. Waited on weather for 20 hours to run the blow-out preventor stack.
20 Sept., 1983	504m	Waited on weather.
21 Sept., 1983	504m	Waited on weather. At 1230 hrs the No. 2 anchor warp slipped and the rig moved 6-8m off location. Pulled in 30m of chain on the No. 2 windlass but the anchors still slipped. Slacked off tension on the stern anchors to relieve tension on the bow anchors.
22 Sept., 1983	504m	Waited on weather to re-run No. 2 anchor warp and add on additional piggyback anchor.
23 Sept., 1983	504m	Waited on weather for 20 hours. Started re-running the No. 2 anchor warp.
24 Sept., 1983	504m	M/V "Maersk Helper" recovered the No. 2 buoy and second piggyback anchor on the No. 2 anchor warp. Found that the 450 foot pendant wire between the first and second piggyback anchor had parted. M/V "Maersk Handler" set a third piggyback anchor on the No. 3 anchor warp. Waited on weather for 17 hours.
25 Sept., 1983	504m	Waited on weather for two hours. M/V "Maersk Helper" re-ran the No. 2 anchor warp and installed three piggyback anchors. Storm tested all anchors to 300,000 lbs and then slacked off to working tensions. Assembled and ran the BOP stack. Changed out a leaking kill hose.
26 Sept., 1983	585m	Could not land the BOPs because the kill hose was too short. Changed out kill hose with the

Date	Total Depth (RKB) Metres	Work Performed
26 Sept., 1983 (continued)	585m	spare rotary hose. Landed BOPs and tested to PAOC's specifications. Ran in hole with a 17-1/2 inch bottom hole assembly and tagged cement at 488m Drilled and under-reamed cement, float collar, shoe and formation to 507m. Conducted leak-off test. EMW - 12.06 ppg. Drilled and under-reamed to 585m.
27 Sept., 1983	856m	Drilled and under-reamed to 842m. Tripped for bit and cutter change. Drilled and under-reamed to 856m.
28 Sept., 1983	1065m	Drilled and under-reamed to 1065m.
29 Sept., 1983	1120m	Drilled and under-reamed 17-1/2 inch hole from 1065m to 1120m. Observed a small flow below the connector to the wellhead, possibly a leak between the blowout preventor stack and the wellhead, or alternatively perhaps coming from between the 30 inch and 20 inch strings. Pulled out of hole. Ran test plug into wellhead. Pressure-tested BOP stack - okay. Test plug stuck in wellhead, and would not come free.
30 Sept., 1983	1120m	Backed off drillpipe 1 single above test plug with Schlumberger string shot. Ran fishing string and screwed into fish. Unable to operate jars due to vessel heave in rough weather. Attempted mechanical back-off of fishing string. Jars unscrewed at service connection. Made up new fishing string with overshot. Waited for weather to abate. Engaged fish and jarred test plug free from wellhead.

Date	Total Depth (RKB) Metres	Work Performed
1st Oct., 1983	1295m	Recovered fish. Drilled and under-reamed 17-1/2 inch hole from 1120 to 1295m.
2nd Oct., 1983	1514m	Drilled and under-reamed from 1295 to 1514m. Trip for new bit and cutters.
3rd Oct., 1983	1603m	Drilled and under-reamed from 1514 to 1603m. Pulled out of hole. Schlumberger commenced running electric logs.
4th Oct., 1983	1603m	Schlumberger completed running electric logs. Made clean-out trip. Commenced running 13-3/8 inch casing.
5th Oct., 1983	1603m	Ran 13-3/8 inch casing to 1594m. After cementing casing, cementing plugs leaked pressure through shoe joint.
6th Oct., 1983	1603m	Set 13-3/8 inch casing seal assembly. Pressure-tested blowout preventors. All okay, except 13-3/8 inch casing leaked when pressured against closed shear rams. Ran in hole with open-ended drillpipe and laid cement above cement plugs 1579 to 1488m
7th Oct., 1983	1603m	Pressure tested 13-3/8 inch casing above cement plug; tested okay. Continued running in hole with 12-1/4 inch drilling assembly. Detected leak in choke line connector at riser ball joint. Pulled drilling assembly. Pulled BOP stack and repaired connector.
8th Oct., 1983	1603m	Ran and tested BOP stack. Ran in hole with drilling assembly and tagged cement plug at 1515m. Drilled cement, float collar and

Date	Total Depth (RKB) Metres	Work Performed
8th Oct., 1983	1603m	float shoe to 1594m Washed hole to 1597m. Conducted leak- off and injection tests. Made trip to change drilling assembly for casing scraper assembly.
9th Oct., 1983	1603m	Circulated mud and worked casing scraper. Pulled casing scraper assembly. Rigged up, ran and set EZ-SV packer at 1576m. Pressure tested casing and EZ-SV packer; casing would not hold pressure. Rigged up and ran a RTTS packer to 1574m. Pressure tested casing above RTTS packer; tested okay. Pressure tested casing below RTTS and EZ-SV packer; would not hold pressure. Retrieved RTTS packer. Ran in hole with cementing stinger and squeezed a 300 sack slurry of 15.8 ppg. Class "G" cement through EZ-SV packer.
10th Oct. 1983	1603m	Pulled out cementing string and ran in hole with flat bottom mill assembly. Tagged cement at 1537m. Milled cement to 1564m at which depth metal (casing) shavings appeared on shakers. Changed milling assembly to toothed bit drilling assembly. Drilled cement to 1576m.
11th Oct., 1983	1603m	Drilled on EZ-SV packer; could not make hole. Pulled assembly and found junk wedged in bit. Changed drilling assembly to milling assembly. Ran in hole to 1576m and pressure tested casing; tested okay. Milled through EZ-SV packer. Changed out milling assembly to drilling assembly. Drilled cement to 1585m and pressure tested casing; tested okay.
12th Oct., 1983	1725m (5659 ft)	Drilled cement to 1597m (5239 ft), circulated mud and conducted leak-off tests;

Date	Total Depth (RKB) Metres	Work Performed
12th Oct., 1983 (cont.)	1725m	fractured at 13.3 ppg equivalent mud weight. Tripped to change bottom hole assembly. Ran in hole, displaced to potassium chloride mud and drilled cement to 1603m. Drilled formation to 1606m and conducted leak-off test. Formation fractured at equivalent mud weight of 13.0 ppg. Drilled 12-1/4 inch hole to 1679m and circulated bottoms up for geological analysis. Drilled to 1725m.
13th Oct., 1983	1942m	Drilled 12-1/4 inch hole to 1812m. Penetration rate decreased to 16 min/metre. Tripped to change from Smith FDGH bit to Reed HS51 bit. Drilled to 1942m
14th Oct., 1983	2112m	Drilled to 2112m. Overshot slickline parted while attempting to recover survey instrument. Pulled out to recover fish. Tested BOP and well control equipment.
15th Oct., 1983	2225m	Ran in hole with new Reed HS51 bit. Washed and reamed to 2112m. Drilled to 2225m. Penetration rate decreased to 39 min/metre. Pulled out of hole for bit change.
16th Oct., 1983	2344m	Ran in hole with new Smith FDGH bit. Washed and reamed to 2225m. Drilled to 2344m. Penetration rate decreased to 28 min/metre. Tripped to change to new Smith FDGH bit.
17th Oct., 1983	2434m	Washed and reamed to 2344m. Drilled to 2434m. Penetration rate decreased to 39 min/metre. Tripped to change from Smith FDGH bit to Smith F2 bit.
18th Oct., 1983	2469m	Washed and reamed tight spots te 2434m. Drilled to 2469m.

Date	Total Depth (RKB) Metres	Work Performed
18th Oct., 1983	2469m	Pulled out of hole to change over to Turbo drilling equipment. Ran in hole with turbo drill and Diamant Boart MS5 bit. Reamed tight spots to 1796m.
19th Oct., 1983	2469m	Reamed tight spots to 1808m. Made short trip. Reamed tight spots to 2234m. Made short trip. Continued reaming tight spots.
20th Oct., 1983	2469m	Reamed tight spots to 2335m with Turbo drill and then made trip to change over to conventional BHA. Ran in hole with Smith SDGH bit and reamed tight spots to 2243m. Lost 110,000 lbs string weight and pulled out of hole to discover that drill string had parted leaving 657m of equipment in hole. Made up fishing tools.
21st Oct., 1983	2469m	Ran in hole with overshot. Failed to engage fish. Pulled out. Ran in hole with mill. Milled on fish.
22nd Oct., 1983	2469m	Milled on fish. Pulled out. Ran in hole with overshot. Engaged fish. Pulled out.
23rd Oct., 1983	2499m	Recovered fish and ran in hole with conventional BHA with new Smith FDGH bit. Washed and reamed tight spots to 2469m. Drilled to 2499m.
24th Oct., 1983	2504m	Tripped to change over to Turbo drilling assembly. Ran in hole with Diamant Boart LX27 HS bit. Washed and reamed tight spots to 2499m. Drilled to 2504m.
25th Oct., 1983	2694m	Drilled to 2694m with Turbo drill at which depth there were indications that the bit was not taking all the weight. Pulled out of hole to inspect bit and BHA.

Date	Total Depth (RKB) Metres	Work Performed
26th Oct., 1983	2770m	Completed trip to inspect BHA equipment. Diamant Boart LX27 HS bit showed wear and a ring groove was cut in the face approximately one inch in from outer circumference. Tested BOP and well control equipment. Picked up a Diamax ADS II bit and ran in hole to 2694m. Drilled to 2770m.
27th Oct., 1983	2869m	Drilled with Diamax ADS II bit from 2770m to 2869m. Pulled out of hole for bit change.
28th Oct., 1983	3022m	Picked up Christensen R26 LF bit. Ran in hole to 2647m and reamed to 2672m. Ran in hole to 2869m. Turbo drilled to 3022m.
29th Oct., 1983	3084m	Turbo drilled to 3071m. Pulled out of hole for bit change. Picked up Turbo motor section and Diamax MS5 bit. Ran in hole to 3071m. Turbo drilled 3084m.
30th Oct., 1983	3148m	Turbo drilled to 3113m. Pulled out of hole for bit change. Picked up Diamant Boart LX27 HS bit and ran in hole to 3113m. Turbo drilled to 3148m.
31st Oct., 1983	3276m	Turbo drilled to 3276m.
1st Nov., 1983	3407m	Turbo drilled to 3407m.
2nd Nov., 1983	3496m	Turbo drilled to 3412m. Made short trip to pick up Grade E drill pipe. Drilled to 3496m.
3rd Nov., 1983	3548m	Turbo drilled with a 12-1/4 inch Stratapax bit from 3497m to 3548m. Pulled out of hole laying down 118 joints of S-135 drill pipe. Ran in hole with BOP test plug.
4th Nov. 1983	3548m	Tested BOPs to PAOC's specifications. Ran in hole with Turbo

Date	Total Depth (RKB) Metres	Work Performed
4th Nov., 1983 (continued)	3548m	drill and a new Stratapax bit. Weather deteriorated. Picked up hang off tool and hung off in wellhead with bit inside the 13-3/8 inch casing shoe. Nos. 2 and 3 anchor warps slipped. Unlatched the upper riser package and waited on weather for 17 hours.
5th Nov., 1983	3548m	Waited on weather for 17-1/2 hours. Workboats started re-running the Nos. 2 and 3 anchor warps. Pulled the upper marine riser package to repair a possible leak. Found loose nuts on adaptor flange between the Hydril preventors. Repaired same.
6th Nov., 1983	3548m	Finished re-running the Nos 2 and 3 anchor warps. Re-ran the upper marine riser package. Pulled out of hole with hang-off tool. Ran in hole with test plug in drill string.
7th Nov., 1983	3548m	Tested upper marine riser package to PAOC's specifications. Recovered test plug. Ran in hole to 3366 metres (11,043 ft). Reamed to 3380m. Experienced high torque and drag with little to no progress. Pulled out of hole with Turbo drilling assembly. Picked up conventional bottom hole assembly and ran in hole with same.
8th Nov., 1983	3548m	Ran in hole to 3358m. Reamed from 3358 to 3440m. Experienced high torque and stuck pipe. Built mud weight to 10.5 ppg. Pulled out of hole to 13-3/8 inch casing shoe. Performed leak-off test. EMW of 13.2 ppg. Finished pulling out of hole. Picked up new bit and ran in hole.

Date	Total Depth (RKB) Metres	Work Performed
9th Nov., 1983	3548m	Ran in hole to 3429m. Reamed from 3429 to 3479m. Experienced high torque and stuck pipe. Pulled out of hole to 3353m to raise mud weight. Weather deteriorated. Pulled bit into 13-3/8 inch casing shoe and hung off in wellhead. Waited on weather for 10-1/2 hours.
10th Nov., 1983	3548m	Waited on weather for one hour. Ran in hole to 3467m and reamed and re-reamed interval to 3499m. Increased mud weight from 11.6 ppg to 12.5 ppg while reaming. Pulled out of hole to change bit.
11th Nov., 1983	3548m	Ran in hole with Reed FP53J bit to 3491m. Reamed interval to 3546m while adding diesel to counteract high torque problem. Circulated and conditioned hole for logging. Pulled out of hole.
12th Nov., 1983	3548m	Rigged up Schlumberger and ran GR/Sonic/DIL; LDL/CNL/GR and HDT logs from 3534m to casing shoe. Shot 51 sidewall cores.
13th Nov., 1983	3548m	Recovered 39 sidewall cores, 3 empties, 9 bullets left in hole. Ran in and conditioned hole to run casing. Reamed 3540-3546m interval. Began running 9-5/8 inch 47 PPF casing.
14th Nov., 1983	3548m	Ran 9-5/8 inch 47 PPF casing to 3519m. Cemented with an 840 sack 12 ppg lead slurry followed by a 500 sack 16.8 ppg tail slurry. Washed wellhead, set and tested seal assembly.
15th Nov., 1983	3548m	Tested BOP equipment. Laid down 12-1/4 inch BHA and made up 8-1/2 inch BHA. Waited on weather 2-1/2 hours. Ran in hole and drilled cement and shoe

Date	Total Depth (RKB) Metres	Work Performed
15th Nov., 1983	3548m	to 3519m. Attempted to clean out rat hole but experienced high torque and annulus pack-off problems. Raised mud weight to 13 ppg.
16th Nov., 1983	3549m	Reamed and re-reamed 3523-3530m interval. Experienced high torque and annulus pack-off problems. Raised mud weight to 14 ppg and re-reamed same interval; encountered same problem. Pulled out of hole to change bit and BHA. Ran in hole with slick BHA. Reamed from 3529 to 3548m. Drilled from 3548m to 3549m while raising mud weight to 14.5 ppg.
17th Nov., 1983	3551m	Drilled to 3551m and reamed 3548-3551m interval several times while raising mud weight to 14.5 ppg. Conducted a leak-off test which indicated a 17 ppg EMW leak-off. Reamed 3548-3551m interval while raising mud weight to 14.9 ppg. Pulled bit to find bit worn out and a tong die wedged in frog. Ran in hole with new bit and junk sub. Waited on weather to take on barite. Lost 6-1/2 hours to weather.
18th Nov., 1983	3558m	Drilled to 3555m and worked junk sub to prepare hole for Turbo drilling. Pulled out. Recovered pieces of Schlumberger sidewall coring bullets in junk sub. Ran 8-1/2 inch Stratapax bit and Turbo drilling assembly and then drilled to 3558m to check turbodrill. Waited on weather to take on barite. Lost seven hours to weather.
19th Nov., 1983	3612m	Drilled to 3612m with Turbo assembly. Lost 2-1/2 hours to weather.

Date	Total Depth (RKB) Metres	Work Performed
20th Nov., 1983	3628m	Drilled to 3618m with Turbo assembly. Tripped to change to conventional drilling assembly and drilled to 3628m Too slow.
21st Nov., 1983	3666m	Tripped to change to Turbo assembly and drilled to 3666m. Lost 1-1/2 hours to repairs and maintenance.
22nd Nov., 1983	3734m	Drilled to 3734m with Turbo assembly. Lost half hour to repairs.
23rd Nov., 1983	3807m	Drilled to 3807m with Turbo assembly. Lost half hour to repairs.
24th Nov., 1983	3880m	Drilled a 12-1/4 inch hole with the Turbo assembly from 3807m to 3880m with 15.0 ppg mud.
25th Nov., 1983	3951m	Drilled from 3880m to 3951m. Experienced occasional increased torque.
26th Nov., 1983	4041m	Drilled from 3951m to 4041m Experienced occasional increased torque.
27th Nov., 1983	4055m	Drilled to 4052m raising mud weight to 15.5 ppg. Started getting partial loss of circulation. Cut mud weight to 15.2 ppg and obtained full returns. Drilled to 4055m. Circulated out gas cut mud. Started pulling out of hole. Hole did not take correct fill. Ran in hole and circulated out gas cut mud. Pulled out of hole for bit change. Hole took correct fill.
28th Nov., 1983	4081m	Tested BOPs to PAOC's specifications. Picked up Diamant Boart LX-16 diamond bit and made up same on Turbo assembly. Ran in hole to 4056m. No hole problems. Drilled to 4081m.

Date	Total Depth (RKB) Metres	Work Performed
29th Nov., 1983	4101m	Drilled to 4101m. Started getting partial loss of returns. Reduced mud weight to 15.0 ppg. Obtained increased returns. Opened circulating sub on Turbo assembly and pumped a 50 bbl mica pill. Pulled out of hole to 3753m. Hole did not take correct fill. Performed leak--off test to ensure fluid passage around Turbo assembly. EMW 15.6 ppg. Pulled out of hole to 9-5/8 inch casing shoe at 3519m. Hole did not take correct fill.
30th Nov., 1983	4112m	Performed leak-off test at casing shoe to ensure fluid passage around Turbo assembly. EMW 15.8 ppg. Pulled out of hole. Hole took correct fill. Ran in hole with a Smith F2 bit. Hole took correct fill. Ran in hole with a Smith F2 bit (with no nozzles) on a slick bottom hole assembly. Tagged bottom at 4101m. Hole condition good. Drilled to 4112m.
1st Dec., 1983	4157m	Drilled from 4112 to 4185m with an 8-1/2 inch conventional unstabilized bottom hole assembly.
2nd Dec., 1983	4193m	Drilled from 4185 to 4193m.
3rd Dec., 1983	4200m	Drilled from 4193 to 4200m. Circulated. Made a short trip to the 9-5/8 inch casing shoe. Ran in hole. Circulated. Dropped Totco and measured out of hole. Totco indicated 5.25° deviation. Rigged up Schlumberger and started logging. Run No. 1 DIL /SLS/GR from 4200m to 3519m.
4th Dec., 1983	4200m	Logged. Finished run No. 1, DIL/SLS/GR, 4200 to 3519m. Run No. 2, LDL/CNL/GR, 4114m to 3580m. Run No. 3 HDT, 4183m to

Date	Total Depth (RKB) Metres	Work Performed
4th Dec., 1983 (continued)	4200m	3850m (13,724 to 12,631 ft). Re-run Run No. 2 LDL/CNL/GR, 4185m to 3900m. Run No. 4, Velocity survey, 4180m to 300m. Run No. 5, 30 selective sidewall cores.
5th Dec., 1983	3446m	Finished Run No. 5, 30 selective sidewall cores from 4175m to 3650m. Had 22 recoveries, 1 empty and 7 bullets lost in hole. Set Halliburton EZ-SV packer at 3488m. Tested same to 2000 psi. Okay. Ran in hole with EZ-SV stinger on drill pipe. Squeezed 16 barrels of class "G" neat cement mixed at 15.8 ppg below EZ-SV packer. Placed 10 barrels of class "G" neat cement on top of EZ-SV packer. Pulled 5 stands and a single of drill pipe. Reverse-circulated. Attempted to test plug down drill pipe. No success. Drill pipe plugged. Tested plug to 2000 psi down annulus for 10 minutes. Okay. Pulled out of hole laying down drill pipe. Pipe full of mud.
6th Dec., 1983	215m	Finished pulling out of hole. 32 singles were full of cement. (During reverse cirulation down the kill line, the choke line was accidentally open, therefore only allowing circulation in the wellhead area). Pulled wear bushing and seal assembly. Cut 9-5/8 inch casing at 207m and recovered same (1 stub, 6 joints and hanger pup, 78m. Ran in hole with open-ended drill pipe to 253m. Mixed and pumped 163 sacks of class "G" neat cement at 15.8 ppg. Estimated top of cement at 162m. Displaced BOP stack and riser with seawater.
7th Dec., 1983	169m	Displaced BOP stack and riser with seawater. Hole was taking

Date	Total Depth (RKB) Metres	Work Performed
7th Dec. 1983 (continued)	169m	fluid. Checked stack and riser for leak with ROV. Okay. Ran in hole with open-ended drill-pipe. Tagged cement at 215 metres. Pulled out of hole to 207 metres. Mixed and pumped 109 sacks of class "G" neat cement at 15.8 ppg. Estimated top of cement at 162 metres. Pulled out of hole. Function-tested stack. Ran in hole with 8-1/2 inch bit on drillpipe. Tagged cement at 169 metres. Set 15,000 pounds on plug. Pulled out of hole. Pulled BOP stack and riser. Ran in hole with 16-3/4 inch FMC manual wellhead running tool and ICI explosive. Could not engage running tool into wellhead. Pulled out of hole and laid down FMC running tool and ICI explosive. Anchor Report Work boats recovered the 2 piggyback anchors on the No. 5 anchor warp, the 3 piggyback anchors on the No. 4 anchor warp and the 2 piggyback anchors on the No. 6 anchor warp. Recovered 7 piggyback anchors in all.
8th Dec., 1983	169m	Lowered the ICI explosive charge on the rig sand line to 8m below the wellhead. Moved the rig 189 to 192m off location. Detonated charge. Moved rig back over location. Ran in hole with 13-3/8 inch casing spear. Retrieved 8m (26 ft) of 13-3/8 inch casing and 16-3/4 inch wellhead with 20 inch casing stub. Ran in hole with ICI explosive charge to 3m (10 ft) below FMC 30 inch manual running tool. Engaged tool. Detonated charge. Mis-fire. Pulled out

Date	Total Depth (RKB) Metres	Work Performed
8th Dec., 1983	169m	of hole and redressed charge. Ran in hole and engaged FMC tool. Detonated charge. Pulled out of hole. Recovered floating guide base, permanent guide frame and 30 inch wellhead housing with stub. Dismantled same. (Waited five hours on weather to pull anchors.)
9th Dec., 1983	P & A	Waited 2.5 hours on weather. Recovered all remaining piggy-back anchors and associated pendant wires. (Lost 10 hours due to workboats in rest period). Total of 17 piggyback anchors were recovered.
10th Dec., 1983	P & A	Pulled all main anchors. Bolstered anchor No. 7 (last anchor) at 1800 hours, 9th December, 1983. Released rig.

APPENDIX NO. 3

DETAILED CUTTINGS DESCRIPTIONS

APPENDIX NO. 3

Detailed Cuttings Descriptions

All depths quoted are below Rotary Kelly Bushing, which is 23 metres above Mean Sea Level and 132 metres above the sea bed. Drill cuttings were collected at 10 metre intervals from 504.5 metres to 1505 metres and then at 5 metre intervals from 1505 metres to the Total Depth of 4200 metres. No samples were collected while drilling top hole down to the 20" casing depth, with all returns circulating to the sea floor.

504.5-540m : Calcarenite, white to cream, blocky, massive, moderately hard to hard, sand size calcite grains, calcite cement, no fossils, with Dolomite, minor amount only, grey to black, hard.

540-587m : Calcarenite, white to cream, blocky, massive, moderately hard to hard, sand size calcite grains, calcite cement, no fossils, overall grain size decreasing and clay content increasing toward base of interval. Sample includes minor amount of Dolomite, grey to black, very hard.

587-820m : Calcilutite, white to cream and greyish, massive, silt to clay size grains, soft to very soft, clay matrix, calcite cement with Dolomite, grey to black, very hard, minor amount but throughout interval, foraminifera throughout. Samples becoming clay choked and stickier toward base of interval (almost marly).

820-843m : Calcarenite, white to cream, massive, blocky, sand size calcite grains, moderately hard to hard, calcite cement, foraminifera common throughout; Dolomite, green grey, hard, apparent stringer; Shale, black, fissile, increases toward base of interval; and chert, brown grey, very angular, splintery.

843-860m : Calcarenite, white to cream, and grey, massive, blocky, sand size grains, moderately hard to hard, calcite cement, foraminifera, Dolomite, green grey, hard, Chert, brown grey, angular, splintery, Shale, black, fissile.

860-898m : Claystone, grey, clay size material, very soft, calcite cement, abundant spicules, with Dolomite, grey to black, hard, sugary texture, Chert, brown grey, angular, sample contains glauconite stained calcite grains, very minor Shale, black, fissile.

898-905m : Claystone, grey clay size material, very soft, calcite cement, decrease in micro-organisms, with Dolomite, grey to black, hard, sugary texture, Chert, brown grey, angular, decreasing in abundance, Shale, black, fissile, also decreasing at 898m. Sandstone, quartz, white to brown and clear, medium to coarse grained, subangular to rounded, fair sorting, calcite cement, pyrite and mica present, calcite grains have glauconite staining.

905-935m : Claystone/Siltstone, cream to grey, clay/silt size material, very soft, calcite cement, foraminifera and spicules common, Dolomite, grey to black, hard, sugary texture, Sandstone, quartz, white to brown and clear, medium to coarse grained, subangular to rounded, fair sorting, calcite cement, pyrite and mica present, some calcite grains are glauconite stained. Coal, black, hard, about 40% of sample at 915m and decreases at base of interval.

935-1010m : Sandstone, quartz, white to brown and clear, medium to coarse grained, subangular to rounded, fair sorting, calcite cement, pyrite and mica present, Claystone, cream to grey, clay size material, very soft, no visible porosity.

1010-1120m : Sandstone, quartz, white to brown and clear, medium to coarse grained, subangular to rounded, fair sorting, calcite cement, pyrite and mica present. Claystone, cream to grey, clay size material, very soft, no visible porosity in sandstone.

1120-1139m : Claystone, dark brown, homogeneous, plastic, very sticky, very soft, non-calcareous, slightly carbonaceous, silty in part, non-fossiliferous, no fluorescence.

1139-1178m : Claystone, dark brown, homogeneous, plastic, very sticky, very soft, non-calcareous, carbonaceous, non-fossiliferous, no fluorescence, with interbedded Siltstone, brown to dark brown, homogeneous, soft to moderately soft, non calcareous, argillaceous, carbonaceous, non fissile, no fluorescence.

1178-1202m : Siltstone, brown to dark brown, homogenous, soft to moderately soft, non-calcareous, argillaceous, carbonaceous, sub-fissile in part, no fluorescence, with minor interbedded Sandstone, quartz, clear to white, coarse to very coarse grained, subangular to subrounded, moderate sphericity, well sorted, slightly argillaceous, no apparent cement, non carbonaceous, fair to good visual porosity, no fluorescence.

1202-1260m : Sandstone, quartz, clear white, yellow to brown, with minor iron staining on grains, medium to coarse grained, subangular to subrounded, moderate sphericity, moderately well sorted, very minor clay/silt cement, slightly argillaceous, non-carbonaceous, with traces of pyrite and rare glauconite, fair to good visual porosity, no fluorescence, with very minor Siltstone, dark grey to brown, moderately soft to soft, non-calcareous, argillaceous, homogeneous, non fossiliferous.

1260-1275m : Sandstone, quartz, clear to white, yellow to brown, with minor iron staining on grains, medium to coarse grained, subangular to subrounded, moderate sphericity, moderately well sorted, very minor clay/silt matrix, argillaceous in part, non-carbonaceous, with traces of pyrite, fair to good visual porosity, no fluorescence, with minor Siltstone, dark grey to brown, moderately hard to soft, non calcareous, argillaceous, homogeneous, non fossiliferous.

1275-1305m : Sandstone, quartz, clear to white to yellow, coarse grained, subangular to subrounded, moderate sphericity, moderately well sorted, minor clay matrix, carbonaceous in part with traces of pyrite, fair to good visual porosity, no fluorescence with minor Sandstone, quartz, clear to white, fine to medium grained, subangular to subrounded, moderate sphericity, good sorting, carbonate cement, minor clay matrix, poor visual porosity, no fluorescence.

1305-1410m : Sandstone, quartz, clear to white to yellow, coarse to very coarse grained, subangular to subrounded, moderate sphericity, moderately well sorted, minor argillaceous matrix, with trace of pyrite, fair to good visual porosity, no fluorescence, with minor interbedded Sandstone, quartz, clear to white, fine to medium grained, subangular to subrounded, moderate sphericity, good sorting, carbonate cement, minor clay matrix, poor visual porosity, no fluorescence, and minor interbedded Siltstone, brown to grey, moderately hard to moderately soft, non fossiliferous, non calcareous, homogeneous, no fluorescence.

1410-1449m : Sandstone, quartz, clear to white to yellow, coarse to very coarse grained, subangular to subrounded, moderate sphericity, moderately well sorted, minor argillaceous matrix, with common to traces of pyrite, fair to good visual porosity, no fluorescence, with minor interbedded Sandstone, quartz, white to clear, light grey, fine to medium grained, subangular to subrounded, moderate sphericity, moderate sorting, siliceous and carbonate cement, minor argillaceous matrix, traces of pyrite, poor visual porosity, no fluorescence.

1449-1514m : Sandstone, quartz, clear to white to yellow, coarse to very coarse grained, subangular to subrounded, moderate sphericity, moderately well sorted, minor argillaceous matrix, with common to traces of pyrite and glauconite, no fluorescence, with interbedded Sandstone, quartz, white to clear to light grey, fine to medium grained, subangular to subrounded, moderate sphericity, moderately well sorted, minor argillaceous matrix, no fluorescence, with interbedded Siltstone, light grey, firm to hard, carbonaceous, homogeneous, non-calcareous, slightly plastic, argillaceous, no fluorescence.

1514-1553m : Sandstone, quartz, clear to white to yellow, coarse to very coarse grained, subangular to subrounded, moderate sphericity, moderately well sorted, minor moderate sphericity, moderately well sorted, minor argillaceous matrix with common to traces of pyrite, fair to good visual porosity, no fluorescence, with interbedded Sandstone, quartz, white to clear to light grey, fine to medium grained, subangular to subrounded, moderate sphericity, moderate sorting, siliceous and carbonate and pyrite cement, minor argillaceous matrix, poor visual porosity, no fluorescence.

1553-1603m : Siltstone: light grey to dark grey, soft, homogenous, non-calcareous, non fossiliferous, carbonaceous, argillaceous, plastic, with traces of pyrite, no fluorescence, with interbedded Sandstone, quartz, coarse to very coarse grained, subangular to subrounded, moderate sphericity, moderate sorting, siliceous and carbonate and pyritic cement, minor argillaceous matrix, poor visual porosity with minor Sandstone, quartz, clear to white to yellow, fine to medium grained, subangular to subrounded, moderate sphericity, moderate sorting, siliceous and carbonate and pyritic cement, minor argillaceous matrix, poor visual porosity, no fluorescence.

1603-1644m : Siltstone, light grey to dark grey, soft, homogeneous, non-calcareous, carbonaceous, argillaceous, plastic, with interbedded Sandstone, quartz, clear to white to yellow, coarse to very coarse grained subangular to subrounded, moderate sphericity, moderately well sorted, minor argillaceous matrix with traces of pyrite, fair to good visual porosity with interbedded Sandstone, quartz, white to clear to light grey, fine grained, subangular to subrounded, moderate sphericity, moderate sorting, common calcareous cement, minor argillaceous matrix with traces of pyrite, poor visual porosity, no fluorescence.

1644-1670m : Siltstone, dark grey, argillaceous, soft, non-calcareous, carbonaceous, homogeneous with interbedded Siltstone, light grey, argillaceous, moderately hard to moderately soft, non-calcareous, carbonaceous in part, homogeneous.

1670-1710m : Siltstone, dark grey, argillaceous, soft, non-calcareous, carbonaceous, homogeneous, with interbedded Sandstone, quartz, white to light grey to clear, fine grained, subangular to subrounded, moderate sphericity, moderate sorting, common calcareous (calcite dolomite cement), minor argillaceous matrix, traces of pyrite, poor visual porosity with minor interbedded Sandstone, quartz, white to light grey, loose grains, medium to very coarse grained, angular to subrounded, poor sphericity, poorly sorted, traces of pyrite, no apparent matrix or cement with traces Coal, black, hard, blocky, fissile.

1710-1936m : Siltstone, light grey to brown, soft to firm, massive, argillaceous, non-calcareous, carbonaceous in part, with thinly interbedded Sandstone, quartz, white to light grey, very fine to medium grained, subangular to rounded, moderately well sorted, moderate sphericity, dolomitic and siliceous cement locally, minor argillaceous matrix, minor pyrite, poor visual porosity and coarse to very coarse grained Sandstone, well sorted, no cement or matrix apparent, good visual porosity, with minor Coal in upper portions of the interval.

1936-2123m : Sandstone, quartz, white to light grey, very fine to fine grained, subangular to rounded, moderately well sorted, moderate sphericity, dolomitic and siliceous cement, minor argillaceous matrix, minor pyrite, poor visual porosity with Sandstone, coarse to very coarse, well sorted, no cement or matrix apparent, good visual porosity, with interbedded Siltstone, dark grey to dark brown, massive, very soft, very argillaceous, sandy in part, non-calcareous, carbonaceous with thin Coals occurring between 1940 and 1970 metres.

2123-2175m : Sandstone, quartz, white to light grey, fine to very coarse, subangular to subrounded, poorly sorted, non-calcareous, minor clay matrix, locally dolomitic and silica cemented, pyritic, minor glauconite with minor Siltstone, dark grey, very soft, argillaceous, non-calcareous.

2175-2382m : Siltstone, dark grey, massive, soft to firm, very argillaceous, sandy in part, non-calcareous, carbonaceous, with coaly laminations, pyritic, micaceous with interbedded Sandstone, white to light grey, fine to coarse grained, poorly sorted, dolomitic and silica cemented locally, poor visual porosity, and Claystone, light grey to brown, massive, non-calcareous, silty to sandy, very soft to unconsolidated, very sticky, Dolomite stringers occur throughout the interval, beige to tan, crystalline, hard.

2382-2415m : Sandstone, white to light grey, fine to very coarse grained, subangular to subrounded, moderate sphericity, poorly sorted, locally dolomite cement, micaceous, pyritic, glauconite rare to abundant, poor visual porosity, no fluorescence.

2415-2465m : Siltstone, light to dark grey, very soft to firm, very argillaceous, sandy, micaceous, carbonaceous, non-calcareous, pyritic in part with local Dolomite, beige, crystalline, hard, and interbedded Claystone, brown to grey, very soft to unconsolidated, sticky, non-calcareous, finely micaceous, and minor thinly interbedded Sandstone, white to light grey, fine to coarse, poorly sorted, poor visual porosity.

2465-2490m : Sandstone, white to light grey, fine to coarse grained, subangular to subrounded, poorly sorted, locally calcareous, argillaceous matrix, minor local glauconite with minor interbedded Siltstone, grey, firm, slightly calcareous, sandy, glauconitic, and Claystone, brown, soft, sandy with local Dolomite, beige, crystalline, hard, sandy, glauconitic.

2490-2640 : Siltstone, light to dark grey, firm to hard, blocky, subfissile in part, slightly calcareous to dolomitic, sandy, carbonaceous with local coaly laminations, very clayey, with interbedded Claystone, brown to dark grey, massive, very soft, sticky, slightly calcareous, carbonaceous, silty, finely micaceous, and Siltstone, white to dark grey, massive, very soft to unconsolidated, very argillaceous, non-calcareous, locally kaolinitic, slightly carbonaceous, trace glauconite, with Dolomite occurring as thin interlaminations, beige to tan, hard, crystalline, sandy, with minor glauconite.

2640-2720m : Claystone, dark grey, massive, very soft, sticky, non-calcareous to slightly calcareous (Dolomitic ?), carbonaceous, with locally interbedded Sandstone, white to light grey, generally occurring as loose quartz grains in samples due to bit destroying cementation, preserved lithic chips indicate fine to very coarse grains, occasionally granular to pebbly, angular to subrounded, moderate sphericity, poorly sorted, calcareous cement, micaceous, pyrite both intragranular and dessiminated within quartz grains, locally glauconitic and Siltstone, white to dark grey, very soft to locally hard, non-calcareous, locally carbonaceous.

2720-2760m : Siltstone, black, hard, blocky to dominantly subfissile, brittle, non-calcareous, siliceous (?), argillaceous, carbonaceous and interbedded Claystone, brown, very soft, calcareous, sandy, silty, sticky.

2760-2850m : Siltstone, black, hard, brittle, commonly subfissile to occasionally blocky, non-calcareous, very argillaceous, carbonaceous, with minor interbedded Claystone, brown, very soft, calcareous, argillaceous, sticky with very minor Sandstone, quartz, grey, very fine to fine grained, calcareous cement in part, argillaceous matrix, with traces glauconite.

2850-2920m : Siltstone, grey, soft to firm, non calcareous, carbonaceous, very argillaceous in part, with rare glauconite, with interbedded Siltstone, black, hard, brittle, subfissile, non-calcareous, argillaceous, carbonaceous, homogeneous.

2920-2934m : Claystone, brown, very soft, slightly calcareous, homogeneous, non-carbonaceous, with minor interbedded Siltstone, black, hard, subfissile, non-calcareous, carbonaceous, homogeneous, argillaceous.

2934-2952m : Siltstone, black, hard, subfissile, non-calcareous, carbonaceous, homogeneous, argillaceous.

2952-3075m : Claystone, brown, very soft, massive, non-calcareous, sticky, non-carbonaceous, homogeneous, slightly argillaceous, with interbedded Siltstone, black, hard, subfissile, non-calcareous, carbonaceous, homogeneous, argillaceous, with rare glauconite, and very minor Siltstone, white to light grey, soft, massive, non-calcareous, non-carbonaceous, homogeneous, argillaceous.

3075-3113m : Siltstone, black, hard to very hard, brittle, carbonaceous, non-calcareous, argillaceous, subfissile.

3113-3410m : Claystone, light grey to grey, very soft, massive, homogeneous, sticky, argillaceous, non-calcareous, slightly carbonaceous, with microlaminations of black carbonaceous matter, and rare to trace pyrite and glauconite, with rare interbedded Siltstone, black, hard, argillaceous, carbonaceous, massive, non-calcareous, homogeneous.

3410-3485m : Claystone, light grey to grey, very soft, massive, homogenous, sticky, argillaceous, non-calcareous, slightly carbonaceous,traces of glauconite and rare pyrite, with interbedded Siltstone, dark grey, hard, blocky, argillaceous, carbonaceous in part, non-calcareous, homogeneous, massive with Siltstone, black, hard, brittle, subfissile, carbonaceous, non-calcareous, homogeneous with traces of calcareous fossiliferous material.

3485-3504m : Interbedded Siltstone and Claystone. Siltstone, two types: 1) black, hard, subfissile to blocky, homogeneous, very carbonaceous, occasional micro fossils. 2) medium grey, hard, abundant carbonaceous specks, sucrose texture, both are non-calcareous and Claystone, light to medium grey, soft, non-calcareous, occasional carbonaceous specks.

3485-3504m : Interbedded Siltstone and Claystone. Siltstone, two types: 1) black, hard, subfissile to blocky, homogeneous, very carbonaceous, occasional micro fossils. 2) medium grey, hard, abundant carbonaceous specks, sucrose texture, both are non-calcareous and Claystone, light to medium grey, soft, non-calcareous, occasional carbonaceous specks.

3504-3549m : No samples circulated to surface.

3549-3630m : Interbedded Siltstone and Claystone

Siltstone, black, very hard, well sorted, dolomite cemented (?), very carbonaceous, non-fossiliferous, minor mica, slightly argillaceous, subfissile to fissile to blocky in nature, very poor visual porosity.

Siltstone, light to medium to dark grey, firm to hard, well to moderately well sorted, non to slightly calcareous, argillaceous, carbonaceous, minor to abundant very fine grained quartz grains, minor mica, very poor visual porosity.

Claystone, light to dark grey, soft, sticky, moderate to well sorted, slightly calcareous, non-fossiliferous, carbonaceous specks in part, minor to abundant silt and very fine grained quartz grains.

Quartz Grains, clear, medium to coarse grained, moderate sorting, low to high sphericity, subangular to well rounded, uncemented.

Feldspar Grains, cream to yellow and red, firm to soft, medium to coarse grained, subangular, low sphericity, moderate sorting, partially altered to kaolinite.

3630-3800m : Siltstone, black to dark grey, hard to very hard, silt sized quartz grains, well sorted, dolomite

cement, very carbonaceous, non-fossiliferous, slightly micaceous, subfissile to blocky, very poor visual porosity.
Claystone, light to dark grey, soft, sticky, moderate to well sorted, slightly calcareous, carbonaceous specks, non-fossiliferous, minor to abundant silt and very fine grained quartz in matrix. Claystone, light grey to cream, soft to firm, well sorted, calcareous, carbonaceous specks, silt and very fine grained quartz common in matrix, Quartz Grains, clear, medium to coarse with occasional very coarse grains, well sorted, angular to well rounded, low to high sphericity, uncemented.

3800-3850m : Siltstone, black to dark grey, hard to very hard, silt sized quartz grains, well sorted, dolomite cement, very carbonaceous, non-fossiliferous, minor mica, subfissile to blocky nature, very poor visual porosity, Claystone, light grey, soft, moderate sorting, slightly calcareous, carbonaceous specks, minor to abundant silt, Quartz Grains, clear, medium to coarse with occasional very coarse quartz grains, well sorted, angular to well rounded, low to high sphericity, uncemented, Calcite Plates, white, firm to hard, medium to coarse grained.

3850-4023m : Siltstone, black to dark grey to light grey, hard to very hard, silt sized quartz grains, well sorted, dolomite cement, very carbonaceous, non-fossiliferous, minor mica disseminated very fine to silt sized pyrite, slightly argillaceous, subfissile to blocky nature, very poor visual porosity, Claystone, light grey to cream, soft, sticky, moderate sorting, slightly calcareous, carbonaceous specks, silty to very silty in part, Quartz Grains, clear to frosted to cream, medium to coarse grained, angular to well rounded, low to high sphericity, uncemented, Calcite Plates. Clear to cream to white, fine to coarse grained, platy.

4023-4052m : Siltstone, black to dark grey to light grey, hard to very hard, silt sized quartz grains, well sorted, dolomite cement, very carbonaceous, non-fossiliferous, minor mica, disseminated very fine to silt sized pyrite, slightly argillaceous, subfissile to blocky nature, very poor visual porosity, Claystone, light grey to cream, soft, sticky, moderate sorting, slightly calcareous, carbonaceous specks, silty to very silty in part.

4052-4100m : Siltstone, grey, hard to firm, silt sized quartz grains, moderately to poorly sorted, slightly calcareoeous, argillaceous, carbonaceous, very fine grained quartz particles in matrix, silt sized disseminated pyrite, micaceous, blocky nature, poor visual porosity, Siltstone, black, hard, silt sized quartz grains, well sorted, dolomite cement, very carbonaceous, blocky nature, abundant disseminated silt sized pyrite, very poor visual porosity, Claystone, light grey to cream, soft, sticky, moderate sorting, slightly calcareous, silty in part, some very fine grained quartz in matrix, Sandstone, light to dark grey, friable, very fine to fine grained quartz, poor sorting, subrounded to subangular, siliceous cement (?), argillaceous, silty, carbonaceous in part, abundant lithic fragments, micaceous, minor glauconite, occasional clear, medium grained, well to subrounded quartz grains, poor visual porosity, Coal, black, very hard, vitreous luster, conchoidal fracture.

4100-4105m : Sandstone, light grey to white and mottled, hard to firm, very fine to medium grained clear to translucent quartz grains, poor sorting, subangular to subrounded, low to moderate sphericity, slightly argillaceous, non-fossiliferous, abundant fine to medium grained black grains, poor visual porosity, Siltstone, black, hard, silt sized quartz grains, well sorted, dolomite cement, very carbonaceous, blocky nature, abundant disseminated silt sized pyrite, very poor visual porosity, Siltstone, grey, hard to firm, silt sized quartz grains, moderately to poorly sorted, slightly calcareous, argillaceous, carbonaceous, very fine grained quartz in matrix, silt sized disseminated pyrite, micaceous, blocky nature, minor glauconite, poor visual porosity, Quartz Grains, clear, coarse to very coarse grained, angular to subangular, low to moderate sphericity, uncemented.

4105-4110m : Sandstone, light grey to white, firm to hard, very fine to medium grained quartz, clear to translucent, subangular to subrounded, slightly calcareous, silty to very silty, very slightly argillaceous, abundant fine to medium black grains, poor visual porosity, no fossils, minor Claystone, white to cream to reddish cream, soft, sticky, slightly calcareous, carbonaceous specks, lithic fragments.

4110-4115m : Claystone, light grey, very silty, calcareous, sticky, soft, carbonaceous specks, Sandstone, light grey to white, firm to hard, very fine to medium grained quartz, clear to translucent, subangular to subrounded, slightly calcareous, silty to very silty, very slightly argillaceous, abundant fine to medium black grains, poor visual porosity, no fossils.

4115-4155m : Sandstone, white, salt and pepper, very fine to fine grained, subangular, well sorted, good sphericity, hard, silica cement, slightly calcareous, moderately abundant carbonaceous specks, poor visual porosity, Claystone, light to medium grey, very silty, non-calcareous, sticky, soft, carbonaceous specks, grading in part to Claystone, white to very silty, calcareous, soft, moderately abundant carbonaceous specks.

4155-4175 : Claystone, light to medium grey, very silty, non-calcareous, sticky, soft, carbonaceous specks, with minor Claystone, white, very silty, calcareous, soft, moderately abundant carbonaceous specks.

4175-4185m : Claystone, light to medium grey, very silty, non-calcareous, sticky, soft, carbonaceous specks, with minor Claystone, white, very sticky, calcareous, soft, moderately abundant carbonaceous specks, and Siltstone, light grey to white, sucrose texture, clayey matrix, slightly calcareous, soft, moderately abundant carbonaceous specks.

4185-4190m : Sandstone, white, salt and pepper, very fine to fine grained, subangular, well sorted, good sphericity, hard, silica cement, slightly calcareous, abundant clay in matrix (kaolinite ?). Occasional opaque grains, moderately abundant carbonaceous specks, poor visual porosity, with interbedded Siltstone, light grey to white, sucrose texture, clayey matrix, slightly calcareous, soft, moderately abundant carbonaceous specks.

4190-4195m : Sandstone, light grey to white, fine to medium grained, subangular to subrounded, moderately well sorted, good sphericity, hard, silica cement, slightly calcareous, abundant white clay matrix (kaolinite ?), occasional opaque grains, moderately abundant carbonaceous specks, poor visual porosity.

4195-4200m : Sandstone, light grey to white, fine to medium grained, subangular to subrounded, moderately well sorted, good sphericity, hard, silica cement, slightly calcareous, abundant white clay matrix (kaolinite ?), occasional opaque grains, moderately carbonaceous specks, poor visual porosity, with interbedded Siltstone, light grey to white, sucrose texture, clayey matrix, slightly calcareous, soft, moderately abundant carbonaceous specks.

APPENDIX NO. 4

SIDEWALL CORE DESCRIPTIONS

PHILLIPS AUSTRALIAN OIL COMPANY

SIDEWALL CORE DESCRIPTION

WELL BRIDGEWATER BAY-1 INTERVAL 550m - 1593m DATE 3/10/83 PAGE 1

SWC ATTEMPTED 30 RECEIVED 28 MISSFIRES 0 NO RECOVERY 2

RUN No. 3, Suite No. 1 GEOLOGIST M. Whibley

DEPTH in metres	LENGTH RECVD	DESCRIPTION	ODOR	STAIN	FLUORESCENCE Brightness Colour	CUT Type Colour
550	5.5cm	Calcarenite: White-light grey, massive, homogeneous, moderately hard, macro-fossils absent, with occasional coarse grained calcite plates, clear, angular-subangular, also very minor argillaceous matter disseminated throughout, poor-fair visual porosity.	-	-	-	-
635	.0cm	NO RECOVERY	-	-	-	-
650	5.5cm	Calcilutite: Light grey-cream grey, homogeneous, firm to soft, massive, slightly plastic, minor argillaceous matter throughout, with poor visual porosity.	-	-	-	-
750	4 cm	Calcilutite: Light grey-cream grey, homogeneous, massive, firm to soft, massive, slightly plastic, minor argillaceous matter throughout with poor visual porosity, with minor Calcarenite: Grey, massive, homogeneous, firm, and patchy distribution within the finer grained calcilutite.	-	-	-	-
815	5 cm	Calcilutite: Light grey-cream grey, homogeneous, massive, firm, poor visual porosity, with minor Calcarenite: Grey, massive, firm, poor-fair visual porosity.	-	-	-	-
825	5 cm	Calcarenite: White-light grey, massive, homogeneous, firm, with minor disseminated argillaceous material throughout, macro-fossils absent, poor visual porosity.	-	-	-	-
850	3.5cm	Calcarenite: White-grey, massive, homogeneous, firm to moderately hard, minor argillaceous matter throughout, and traces of calcite plates, coarse grained, subangular, poor-fair visual porosity.	-	-	-	-
887	4.5cm	Claystone: Light brown-dark brown, firm, slightly plastic, highly calcareous, sticky in part, fossiliferous, with micro lenses of Calcilutite parallel to the bedding. Lenses are up to 4mm long, comprising white-cream massive, soft, fossiliferous matter, with poor visual porosity, and occasional coarse grained calcite plates apparent.	-	-	-	-

PHILLIPS AUSTRALIAN OIL COMPANY

SIDEWALL CORE DESCRIPTION

WELL BRIDGEWATER BAY-1 INTERVAL 550m - 1593m DATE 3/10/83 PAGE 2

WC ATTEMPTED 30 RECEIVED 28 MISSFIRES 0 NO RECOVERY 2

RUN No. 3, Suite No. 1 GEOLOGIST M. Whibley

DEPTH in metres	LENGTH RECVD	DESCRIPTION	ODOR	STAIN	FLUORESCENCE Brightness Colour	CUT Type Colour
903	0 cm	No Recovery.	-	-	-	-
934	5 cm	Claystone: Dark brown, massive, homogeneous, firm to moderately hard, slightly plastic, slightly carbonaceous, non-calcareous, with fine-very fine grained pyrite disseminated throughout, and very minor Siltstone: Light brown, massive, homogeneous, highly calcareous.	-	-	-	-
965	4.5cm	Sandstone: Quartz, clear-white-brown-yellow, medium grained with occasional coarse grained grains, subangular-subrounded, moderate sphericity, fair to well sorted, with brown argillaceous matrix (silt) common, slightly calcareous also. No apparent cement. Fair visual intergranular porosity.	-	-	-	-
984	5.5cm	Sandstone: Quartz, clear-white-brown, very fine grained, subangular to rounded, moderate sphericity, well sorted, with brown argillaceous clay-silt matrix, slightly calcareous, slightly carbonaceous, no apparent cement. Also traces of coarse grained quartz grains throughout, well rounded, white, non-cemented, poor visual porosity.	-	-	-	-
1000	4.5cm	Sandstone: Quartz, clear-white-brown, fine grained, subangular to rounded, moderate sphericity, well sorted with abundant dark brown argillaceous matrix, carbonaceous, and no apparent cement. Also traces of coarse grained quartz grains, well rounded, white, non-cemented, poor visual porosity.	-	-	-	-
1054	5.5cm	Siltstone: Dark brown, homogeneous, firm to moderately hard, plastic, non-calcareous, carbonaceous with minor 1-2mm thick laminations of light grey, siltstone or very fine grained sandstone, non-calcareous. Poor visual porosity.	-	-	-	-

PHILLIPS AUSTRALIAN OIL COMPANY
SIDEWALL CORE DESCRIPTION

WELL BRIDGEWATER BAY-1 INTERVAL 550m - 1593m DATE 3/10/83 PAGE 3

SWC ATTEMPTED 30 RECEIVED 28 MISSFIRES 0 NO RECOVERY 2

RUN No. 3, Suite No. 1 GEOLOGIST M. Whibley

DEPTH in metres	LENGTH RECVD	DESCRIPTION	ODOR	STAIN	FLUORESCENCE Brightness Colour	CUT Type Colour
1108	5 cm	Siltstone: Dark brown, homogeneous, firm, plastic, non-calcareous, carbonaceous with common 1-4mm thick laminations of Sandstone: Quartz, white-light grey, very fine grained, subangular-subrounded, high sphericity, well sorted, with no apparent cement. Poor visual porosity.	-	-	-	-
1137	5 cm	Siltstone: Dark brown, homogeneous, firm, slightly plastic, non-calcareous, carbonaceous, with minor Sandstone: Quartz, white-light grey, very fine grained, subangular to subrounded, high sphericity, well sorted, no apparent cement. Poor visual porosity.	-	-	-	-
1171	6 cm	Siltstone: Dark brown, homogeneous, massive, plastic, sticky, non-calcareous, non-fissile, carbonaceous in part, poor visual porosity.	-	-	-	-
1185	5 cm	Siltstone: Dark brown, homogeneous, massive, plastic, sticky, non-calcareous, non-fissile, carbonaceous in part, poor visual porosity 'as above' SWC 1171m.	-	-	-	-
1200	5 cm	Siltstone: Dark brown, massive, homogeneous, plastic, non-calcareous, carbonaceous with occasional quartz grains, white, coarse to very coarse grained, subrounded, high sphericity, spread throughout. Poor visual porosity.	-	-	-	-
1210	4.5cm	Sandstone: Quartz, medium to very coarse grained, white-clear, yellow-brown, subangular to subrounded, moderate sphericity, poor sorting, no apparent cement, argillaceous matrix in part, non-carbonaceous, good visual intergranular porosity.	-	-	-	-
1244	4.5cm	Siltstone: Dark grey, firm, massive, homogeneous, non-calcareous, carbonaceous, argillaceous, with finely disseminated very fine grained Sandstone in part. Poor visual porosity.	-	-	-	-

PHILLIPS AUSTRALIAN OIL COMPANY
SIDEWALL CORE DESCRIPTION

WELL BRIDGEWATER BAY-1 INTERVAL 550m - 1593m DATE 3/10/83 PAGE 4

SWC ATTEMPTED 30 RECEIVED 28 MISSFIRES 0 NO RECOVERY 2

RUN No. 3, Suite No. 1 GEOLOGIST M. Whibley

DEPTH in metres	LENGTH RECVD	DESCRIPTION	ODOR	STAIN	FLUORESCENCE Brightness Colour	CUT Type Colour
1284	4 cm	Siltstone: Dark grey-black, firm, massive, homogeneous, non-calcareous, argillaceous with finely disseminated and lenses (1-2mm thick) of very fine grained Sandstone: Clear-white-light grey, subangular to subrounded, well sorted, throughout. Poor visual porosity.	-	-	-	-
1318	4.5cm	Siltstone: Light grey, firm-soft, homogeneous, slightly carbonaceous, argillaceous with interbedded Siltstone: Dark grey-dark brown, firm-soft, massive, homogeneous, argillaceous, non-calcareous. Poor visual porosity.	-	-	-	-
1373	5.5cm	Sandstone: Quartz, light grey-clear, very fine grained, subangular-subrounded, well sorted, variable sphericity, argillaceous matrix, non-calcareous, with lenses 1-2mm thick of Siltstone: Black, soft, massive, argillaceous, homogeneous, carbonaceous, non-calcareous, poor visual porosity.	-	-	-	-
1425	4.5cm	Siltstone: Black, firm-soft, homogeneous, carbonaceous, non-calcareous, argillaceous, interbedded (interlaminated) with Sandstone lenses, 1-2mm thick, quartz, light grey, very fine grained, subangular-subrounded, well sorted, argillaceous matrix, non-calcareous. Poor visual porosity.	-	-	-	-
1457	4 cm	Siltstone: Dark brown-black, firm, carbonaceous, argillaceous, non-calcareous, with interlaminated Sandstone: Quartz, light grey, very fine grained, argillaceous matrix, well sorted, subangular-subrounded, no apparent cement, poor visual porosity.	-	-	-	-
1495.5	4 cm	Sandstone: Quartz, very fine grained, subangular to subrounded, well sorted, carbonaceous, argillaceous matrix, firm, with no apparent cement. Poor visual intergranular porosity.	-	-	-	-

PHILLIPS AUSTRALIAN OIL COMPANY
SIDEWALL CORE DESCRIPTION

WELL BRIDGEWATER BAY-1 INTERVAL 550m - 1593m DATE 3/10/83 PAGE 5

SWC ATTEMPTED 30 RECEIVED 28 MISSFIRES 0 NO RECOVERY 2

RUN No. 3, Suite No. 1 GEOLOGIST M. Whibley

DEPTH in metres	LENGTH RECVD	DESCRIPTION	ODOR	STAIN	FLUORESCENCE Brightness Colour	CUT Type Colour
1522	4.5cm	Siltstone: Dark brown, massive, homogeneous, firm-moderately soft, highly carbonaceous, non-calcareous, argillaceous, with very poor inter-granular porosity.	-	-	-	-
1570	4.5cm	Siltstone: Dark brown, firm, highly carbonaceous, argillaceous, homogeneous, non-calcareous with lenses (1-4mm thick) of Sandstone: Quartz, light grey, very fine grained, sub-angular-subrounded, well sorted, no cement apparent, poor visual porosity.	-	-	-	-
1593	4 cm	Interbedded Siltstone: Black-dark brown, massive, soft, homogeneous, highly carbonaceous, non-calcareous, argillaceous with Sandstone: Quartz, clear to light grey, very fine grained, subangular-subrounded, well sorted, no cement, argillaceous, poor visual porosity. Beds or laminations are 1-5mm thick.	-	-	-	-

PHILLIPS AUSTRALIAN OIL COMPANY
SIDEWALL CORE DESCRIPTION

WELL Bridgewater Bay-1 INTERVAL 3335 - 2895m DATE 13/11/83 PAGE 1

SWC ATTEMPTED 51 RECEIVED 39 MISSFIRES 3 NO RECOVERY 9

RUN No. 2 GEOLOGIST B.E. See

DEPTH in metres	LENGTH RECVD cm	DESCRIPTION	ODOR	STAIN	FLUORESCENCE Brightness Colour	CUT Type Colour
3335		No recovery				
3295	2.5	Claystone: dark grey, homogeneous, soft, abundant glauconite mainly as pellets, prismatic calcite - probably shell fragments, non calcareous, silty.	-	-	-	-
3255	2.5	Claystone: dark grey, abundant silt, homogeneous, moderately hard, occasional carbonaceous fragments, non calcareous.				
3215	2.0	Siltstone: dark grey, very clayey, homogeneous, soft, occasional glauconite pellets, occasional carbonaceous specks, non calcareous.				
3175	2.0	Siltstone: dark grey, very clayey, homogeneous, soft, occasional glauconite pellets and carbonaceous specks, trace mica, non calcareous.				
3135		No recovery				
3095		No recovery				
3055		No recovery				
3015	2.0	Siltstone: dark grey, clay matrix, homogeneous, soft, moderately abundant glauconite pellets, occasional carbonaceous specks and fragments, trace mica, non calcareous				
2975		No recovery				
2935	2.0	Siltstone: dark grey, clay matrix, homogeneous, soft, abundant glauconite pellets, occasional carbonaceous specks, trace mica, slightly calcareous.				
2895	3.0	Claystone: dark grey, silty, homogeneous, soft, moderately abundant glauconite in silt size pellets, occasional carbonaceous specks, non calcareous.				

PHILLIPS AUSTRALIAN OIL COMPANY
SIDEWALL CORE DESCRIPTION

WELL Bridgewater Bay-1 INTERVAL 2855 - 2680 DATE 13/11/83 PAGE 2

SWC ATTEMPTED 51 RECEIVED 39 MISSFIRES 3 NO RECOVERY 9

RUN No. 2 GEOLOGIST B.E. See

DEPTH in metres	LENGTH RECVD cm	DESCRIPTION	ODOR	STAIN	FLUORESCENCE Brightness Colour	CUT Type Colour
2855	2.5	Siltstone: dark grey, clayey matrix, homogeneous, soft, trace glauconite, moderately abundant carbonaceous fragments, non calcareous.	–	–	–	–
2815	2.5	Siltstone: dark grey, clayey matrix, homogeneous, firm, moderately abundant glauconite pellets, trace carbonaceous specks, very slightly calcareous.				
2755	3.0	Siltstone: dark grey, clayey matrix, homogeneous, firm, moderately abundant glauconite pellets, trace carbonaceous specks, slightly calcareous.				
2735	2.5	Siltstone: dark grey, clay matrix, homogeneous, firm, occasional glauconite pellets, moderately abundant carbonaceous specks, trace mica, slightly calcareous.				
2720		No recovery				
2708	2.0	Sandstone: light grey-white, very fine grained, abundant clear grains, sub-angular to subrounded well sorted moderate sphericity, abundant clay & silt, occasional glauconite pellets, abundant carbonaceous specks slightly calcareous, poor visual porosity.				
2690	2.75	Sandstone: light grey-white, very fine grained, abundant clear grains, sub angular to subrounded, well sorted, moderate sphericity, abundant clay and silt, no glauconite abundant carbonaceous specks, slightly calcareous, poor visual porosity.				
2680	2.0	Siltstone: grey, clay matrix, soft, abundant carbonaceous specks with interlaminations of Sandstone: white, very fine grained, subangular to subrounded, well sorted, minor glauconite, occasional carbonaceous specks, Siltstone very calcareous in part.				

PHILLIPS AUSTRALIAN OIL COMPANY

SIDEWALL CORE DESCRIPTION

WELL Bridgewater Bay-1 INTERVAL 2650-2342 DATE 13/11/83 PAGE 3

SWC ATTEMPTED 51 RECEIVED 39 MISSFIRES 3 NO RECOVERY 9

RUN No. 2 GEOLOGIST B.E. See

DEPTH in metres	LENGTH RECVD cm	DESCRIPTION	ODOR	STAIN	FLUORESCENCE Brightness Colour	CUT Type Colour
2650	2.0	Sandstone: light grey, very fine grained, abundant clear grains, subangular, well sorted, moderate sphericity, silica cement, trace glauconite, minor carbonaceous specks non calcareous, good visual porosity.	-	-	-	-
2630		No recovery				
2590	1.5	Siltstone: dark grey to dark brown, very clayey matrix, homogeneous, moderately hard, abundant coaly-carbonaceous material, slightly calcareous.				
2555	2.0	Siltstone: dark grey to dark brown, very clayey matrix, homogeneous, firm, abundant carbonaceous specks, calcareous.				
2515		No recovery				
2480	2.0	Siltstone: dark grey to dark brown, very clayey matrix, firm, abundant carbonaceous specks, non calcareous with interlaiminations of Sandstone: white, very fine grained, subangular to subrounded, well sorted, trace glauconite, non calcareous.				
2450	2.25	Mudstone: dark brown, moderately hard, abundant silt, moderately abundant subangular to subrounded, clear quartz grains, medium to coarse size floating in matrix, abundant carbonaceous specks, trace glauconite slightly calcareous.				
2403		No recovery.				
2368		No recovery				
2342		No recovery				

PHILLIPS AUSTRALIAN OIL COMPANY
SIDEWALL CORE DESCRIPTION

WELL Bridgewater Bay-1 INTERVAL 2300-2130 DATE 13/11/83 PAGE 4

SWC ATTEMPTED 51 RECEIVED 39 MISSFIRES 3 NO RECOVERY 9

RUN No. 2 GEOLOGIST B.E. See

DEPTH in metres	LENGTH RECVD cm	DESCRIPTION	ODOR	STAIN	FLUORESCENCE Brightness Colour	CUT Type Colour
2300	2.5	Siltstone: dark grey to brown, very clayey matrix, homogeneous, soft, moderately abundant carbonaceous specks, sandy in part (very fine grained), non calcareous.	-	-	-	-
2265	2.5	Sandstone: medium grey, very fine grained, subangular to subrounded, moderate sphericity, well sorted, silica cement, trace glauconite, abundant carbonaceous specks, non calcareous, fair visual porosity.				
2235	3.0	Siltstone: dark grey to brown, very clayey matrix, firm, moderately abundant carbonaceous specks, non calcareous, with interlaminated Sandstone: white, very fine grained, subangular to subrounded, moderate sphericity, well sorted moderately abundant carbonaceous specks, trace glauconite, non calcareous.				
2215	2.75	Siltstone: dark grey, very clayey matrix, firm, moderately abundant carbonaceous specks, sandy in part (very fine grained), non calcareous				
2175	3.0	Sandstone: light grey to white, very fine grained, subangular to subrounded, moderate sphericity, well sorted, abundant silt (medium grey) in matrix, minor glauconite, abundant coaly-carbonaceous material, non calcareous, poor visual porosity.				
2130	2.75	Sandstone: dark to light grey, very fine grained, subangular to subrounded, moderate to good sphericity, well sorted, abundant dark grey silt (dirty) matrix, moderately abundant glauconite and pyrite, trace mica, minor carbonaceous specks, non calcaresous, poor visual porosity				

PHILLIPS AUSTRALIAN OIL COMPANY
SIDEWALL CORE DESCRIPTION

WELL Bridgewater Bay-1 INTERVAL 2100 - 1939m DATE 13/11/83 PAGE 5

SWC ATTEMPTED 51 RECEIVED 39 MISSFIRES 3 NO RECOVERY 9

RUN No. 2 GEOLOGIST B.E. See

DEPTH in metres	LENGTH RECVD cm	DESCRIPTION	ODOR	STAIN	FLUORESCENCE Brightness Colour	CUT Type Colour
2100	2.75	Sandstone: medium to light grey, very fine grained, subangular to subrounded, moderate to good sphericity, well sorted, abundant dark grey silt (dirty), minor glauconite and pyrite, trace mica, moderately abundant carbonaceous specks, non calcareous, poor visual porosity.	-	-	-	-
2079	2.5	Siltstone: dark grey, very clayey, firm, moderately abundant carbonaceous specks, very sandy throughout (very fine grained subrounded quartz grains floating in matrix, moderately abundant glauconite, non calcareous.				
2052	2.75	Siltstone: dark grey, very clayey, firm to moderately hard, abundant carbonaceous specks, moderately abundant glauconite, very sandy throughout - sand grains range from very fine to medium size, sub-rounded, slightly calcareous.				
2015	3.0	Sandstone: dark to medium grey, very fine to medium grained, moderate to good sphericity, subrounded, poorly sorted, very dirty silty/clayey matrix, abundant nodular glauconite and carbonaceous material, non calcareous, poor visual porosity.				
1979		No recovery				
1939	2.5	Siltstone: dark brown, very clayey matrix, firm, abundant carbonaceous specks, occasional mica flakes, interlaminated Sandstone: white, very fine grained, subangular to subround, moderate to good sphericity well sorted, minor glauconite and carbonaceous specks, non calcareous				

PHILLIPS AUSTRALIAN OIL COMPANY
SIDEWALL CORE DESCRIPTION

WELL Bridgewater Bay # 1 INTERVAL 1910 - 1720m DATE 13/11/83 PAGE 6

SWC ATTEMPTED 51 RECEIVED 39 MISSFIRES 3 NO RECOVERY 9

RUN No. 2 GEOLOGIST B.E. See

DEPTH in metres	LENGTH RECVD cm	DESCRIPTION	ODOR	STAIN	FLUORESCENCE Brightness Colour	CUT Type Colour
1910	3.0	Interlaminated Siltstone and Sandstone; Siltstone: dark brown very clayey matrix, firm abundant carbonaceous specks, occasional mica flakes; Sandstone; light grey to white, very fine grained, subangular to subround, moderate to good sphericity, well sorted, minor glauconite and carbonaceous specks, non calcareous.	-	-	-	-
1870	3.5	Claystone: dark brown, homogeneous, abundant silt, moderately hard, abundant carbonaceous specks, moderately abundant glauconite, non calcareous.				
1830	3.0	Claystone: dark brown, homogeneous, abundant silt, moderately hard, abundant carbonaceous specks, minor glauconite, non calcareous.				
1800	3.75	Claystone: medium brown, homogeneous moderately abundant silt, moderately hard, abundant carbonaceous specks, slightly calcareous.				
1773	3.5	Siltstone: Medium to dark brown, very clayey matrix, moderately hard, minor carbonaceous specks, abundant glauconite pellets, trace mica, very sandy with very fine to medium grained quartz, mostly subrounded, moderate to good sphericity, poorly sorted, slightly calcareous.				
1720	3.5	Sandstone: dark grey, very fine grained, very clayey matrix, subangular to subround, moderate sphericity, well sorted, moderately abundant carbonaceous specks, very slightly calcareous. Poor visual porosity.				

PHILLIPS AUSTRALIAN OIL COMPANY
SIDEWALL CORE DESCRIPTION

WELL Bridgewater Bay # 1 INTERVAL 1700 - 1613m DATE 13/11/83 PAGE 7

SWC ATTEMPTED 51 RECEIVED 39 MISSFIRES 3 NO RECOVERY 9

RUN No. 2 GEOLOGIST B.E. See

DEPTH in metres	LENGTH RECVD	DESCRIPTION	ODOR	STAIN	FLUORESCENCE Brightness Colour	CUT Type Colour
1700	1.75	Sandstone: medium grey, very fine grained, subangular to subround, moderate to good sphericity, well sorted, moderately abundant carbonaceous specks, trace glauconite very calcareous matrix, poor visual porosity.	-	-	-	-
1663	3.0	Sandstone: Medium grey, fine to medium grained, subangular to sub-rounded, moderate to good sphericity, most grains clear, 5% opaque, moderately well sorted, minor carbonaceous specks, trace glauconite, non calcareous, good visual porosity.				
1613	3.0	Sandstone: light grey to white, very fine grained, subangular to subrounded, moderate to good sphericity, well sorted, minor carbonaceous specks, trace glauconite, non calcareous, with interbedded Siltstone: medium brown, very clayey matrix, minor carbonaceous specks, homogeneous, non calcareous, moderately hard.				

PHILLIPS AUSTRALIAN OIL COMPANY
SIDEWALL CORE DESCRIPTION

WELL Bridgewater Bay-1 INTERVAL 3663 DATE PAGE 4

SWC ATTEMPTED 30 RECEIVED 22 MISSFIRES 0 NO RECOVERY 8

RUN No. 3 GEOLOGIST B. See

DEPTH in metres	LENGTH RECVD cm.	DESCRIPTION	ODOR	STAIN	FLUORESCENCE Brightness Colour	CUT Type Colour
3560	0.5	Claystone: Dark grey, homogeneous firm, non-calcareous, silty, sandy (very fine sand), moderately abundant carbonaceous specks.	-	-	-	-

PHILLIPS AUSTRALIAN OIL COMPANY
SIDEWALL CORE DESCRIPTION

WELL Bridgewater Bay-1 INTERVAL 4014-3600m DATE 4/12/83 PAGE 3

SWC ATTEMPTED 30 RECEIVED 22 MISSFIRES 0 NO RECOVERY 8

RUN No. 3 GEOLOGIST B. See

DEPTH in metres	LENGTH RECVD cm	DESCRIPTION	ODOR	STAIN	FLUORESCENCE Brightness Colour	CUT Type Colour
4014	1.0	Claystone: Dark grey to black, homogeneous, firm, non calcareous, silty, sand, (very fine grains) Mod. abundant carbonaceous specks.	-	-	-	-
4008	0.5	Claystone: Dark to medium grey, homogeneous, hard, very calcareous, silty, occasional carbonaceous specks.	-	-	-	-
3960	1.0	Claystone: Dark grey, homogeneous firm, non calcareous, slightly silty, occasional carbonaceous specks.	-	-	-	-
3920		No recovery				
3880		No recovery				
3840		No recovery				
3800	1.0	Claystone: Dark grey to black, homogeneous, firm, non calcareous, silty, abundant carbonaceous specks.	-	-	-	-
2760	1.0	Claystone: Dark grey, homogeneous, firm, non calcareous, silty, moderately abundant carbonaceous specks.	-	-	-	-
3720	0.5	Claystone: Dark grey, homogeneous, firm, non calcareous, silty, moderately abundant carbonaceous specks.	-	-	-	-
3680	1.0	Claystone: Dark grey, homogeneous, firm, non calcareous, silty, moderately abundant carbonaceous specks.	-	-	-	-
3640	1.0	Claystone: Dark grey, homogeneous, firm, non calcareous, silty, moderately abundant carbonaceous specks.	-	-	-	-
3600	1.0	Claystone: Dark grey, homogeneous, firm, non calcareous, silty, moderately abundant carbonaceous specks.				

PHILLIPS AUSTRALIAN OIL COMPANY

SIDEWALL CORE DESCRIPTION

WELL Bridgewater Bay-1 INTERVAL 4105-4017 DATE 4/12/83 PAGE 2

SWC ATTEMPTED 30 RECEIVED 22 MISSFIRES 0 NO RECOVERY 8

RUN No. 3 GEOLOGIST B. See

DEPTH in metres	LENGTH RECVD	DESCRIPTION	ODOR	STAIN	FLUORESCENCE Brightness Colour	CUT Type Colour
4105	0.5	Sandstone: Light to grey to white, salt & pepper, very fine to fine grained, angular to subangular, fair sorting, low to moderate sphericity, very clayey and silty, transparent to translucent grains, hard, non calcareous silica cement, salt & pepper appearance caused by carbonaceous material, no visual porosity.	-	-	-	-
4102	1.0	Claystone: Dark brown to black, homogeneous, firm, silty, occasional areas of white calcareous material, non calcareous overall, fossil fragments both siliceous and calcareous.	-	-	-	-
4098	1.0	Claystone: Dark grey to black, homogeneous, firm, non calcareous, white siliceous 1mm band runs through centre of core - probably represents deep-sea ooze, silty.				
4088		No recovery.				
4072	1.0	Claystone: Dark grey, homogeneous firm, very slightly calcareous, occasional areas of white calcareous material, very silty - borderline Siltstone, abundant carbonaceous specks.	-	-	-	-
4047	0.5	Sandstone: Dark grey, very fine grained, angular to subangular, moderately well sorted, moderate sphericity, very clayey and silty, grains mostly transparent, hard, very slightly calcareous, trace glauconite?, moderately abundant carbonaceous specks. No visual porosity.	-	-	-	-
4025		No recovery				
4017	0.5	Sandstone: Dark grey, very fine grained, angular to subround, moderately well sorted, moderate sphericity, very clayey & silty, grains mostly transparent, trace glauconite? moderately abundant carbonaceous specks. No visual porosity.	-	-	-	-

PHILLIPS AUSTRALIAN OIL COMPANY

SIDEWALL CORE DESCRIPTION

WELL Bridgewater Bay-1 INTERVAL 4175-4109m DATE 4/12/83 PAGE 1

SWC ATTEMPTED 30 RECEIVED 22 MISSFIRES 0 NO RECOVERY 8

RUN No. 3 GEOLOGIST B. See

DEPTH in metres	LENGTH RECVD cm	DESCRIPTION	ODOR	STAIN	FLUORESCENCE Brightness Colour	CUT Type Colour
4175	.75	Claystone: Light to medium grey, homogeneous, firm, non calcareous, silty; very silty in part and calcareous with abundant silt size carbonaceous specks.	-	-	-	-
4165	1.00	Siltstone: grey, sucrose texture, very clayey, firm, moderately abundant carbonaceous specks, very minor silt size mica, very slightly calcareous.	-	-	-	-
4156	0.5	Siltstone: Light to medium grey, sucrose texture, very clayey, firm, slightly calcareous, abundant carbonaceous specks scattered throughout matrix, minor carbonaceous bands (less than 1mm) with coaly material, very minor silt size mica.	-	-	-	-
4148		No recovery.				
4137	1.75	Claystone: Light to medium grey, homogeneous, firm, very slightly calcareous, silty, moderately abundant carbonaceous specks.	-	-	-	-
4130		No recovery				
4125	1.0	Sandstone: White, salt & pepper, very fine to fine grained, angular to subangular, fair sorting, fair sphericity, very clayey, very silty, very calcareous, moderately hard, salt & pepper appearance caused by grey translucent to opaque grains and by carbonaceous blotches; no visual porosity.	-	-	-	-
4115		No recovery.				
4109	0.75	Siltstone: Medium grey, sucrose texture, very clayey, firm, non calcareous, abundant carbonaceous specks, trace mica.	-	-	-	-

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APPENDIX NO. 5

MICROPALEONTOLOGICAL REPORT

FORAMINIFERAL SEQUENCE

in

BRIDGEWATER BAY # 1,

OTWAY BASIN.

for: PHILLIPS AUSTRALIAN OIL COMPANY,

February 16th, 1984.

David Taylor,
23 Ballast Point Road,
BIRCHGROVE,
NSW, 2041.

(02)810 5643

Sample Depths (m)	*AGE*	*ZONE or STAGE*	*E-log Pick*	*Paleo-environment*
550 to 815	MID PLIOCENE	Zone A-3		Mid continental shelf (≈100m)* calcarenite with canyon fills at 650 & 550m
			822	
825 to 850	MID MIOCENE	Zone C		Mid continental shelf (≈100m)* biogenic calcarenite.
			860	
887	MID/LATE EOCENE	? Zone N		Inner continental shelf (≈40m)* biogenic carbonate.
			900	
934 to 1210	EARLY TERTIARY	???		Marginal Marine qtz. sands & silts with *Pebble Point Fm.* equivalent at 1210
?1244 to 2855	LATE CRETACEOUS	???		Marginal Marine qtz. sands & silts in proximity of barrier-dune system.
2895 to 3615	MID CRETACEOUS	?Mid-early Turonian ? (refer Fig.2)		Marginal Marine.
3625 to 4165	MID CRETACEOUS	???		Marginal Marine.

= hiatus * paleobathymetric estimate

FIGURE 1: SUMMARY of BIOSTRATIGRAPHIC SEQUENCE - BRIDGEWATER BAY # 1.

David Taylor, February 16, 1984.

INTRODUCTION.

Eighty five sidewall cores were examined from BRIDGEWATER BAY # 1 between 550 and 4165m. Whilst drilling was in progress, seventeen rotary cutting samples were examined as urgent. Subsequently, eight cutting samples were examined between 2880 and 2985m in an attempt to clarify the discrepancy between the foraminiferal biostratigraphy and the palyno-stratigraphy of the mid Cretaceous sequence between 2895 and 3615m (refer Figure 2 - next page).

The following Figures accompany this report -

? MID CRETACEOUS ? - 4165 to 3625m.

Apart from contaminated cutting samples and single fragment of a *Dorothia* in the sidewall core at 3720m, no Cretaceous foraminifera were found in this interval; either in sidewall cores or cuttings.

The palynological results for this interval are inconclusive because of extremely poor preservation (see report by Helene Martin). However, many of the dinoflagellate species determined have mid Cretaceous ranges.

A dominance of quartz sand in residues at, and below, 4008m (refer Figure 5) is the only evidence for designation of the *WARRE FORMATION*. Above 4008m, and as high as 3660m, the sediment was mainly of silt grade, suggesting it represents an equivalent of the lower part of the *BELFAST MUDSTONE*.

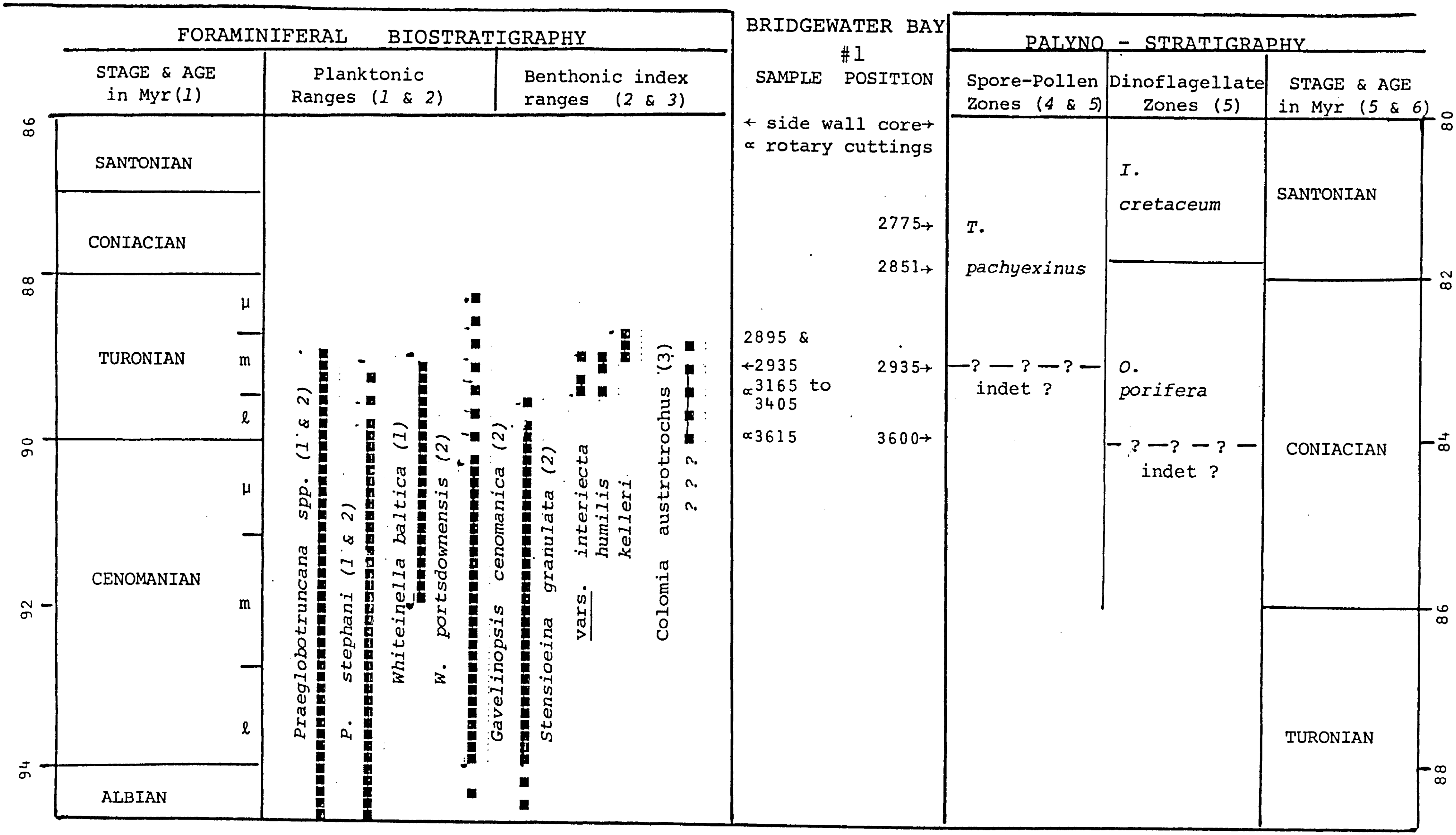

FIGURE 2: DISCREPANCIES in CRETACEOUS STAGE DETERMINATIONS for BRIDGEWATER BAY # 1.
(Compare this report with that by Helene Martin).

N.B. Differences in time scales between left and right.

References (1) *Robaszynski & Caron (1979)*
(2) *Koch (1977) & Hilterman & Koch (1962)*
(3) *Taylor (1964 & subseq. obs.)*
(4) *Dettmann & Playford (1969)*
(5) *Stacey (1982)*
(6) *Van Hinte (1976)*

David Taylor, February 9,1984.

BR WB 1 / PE900161 / P142

3.

MID CRETACEOUS - ? TURONIAN ? - 3615 to 2895m.

Over this interval there is discrepancy in the age determination arrived at by foraminiferal biostratigraphic methods and that by palyno-stratigraphy. These discrepancies are illustrated on Figure 2 (preceeding page). It should be noted that the controversy even extends to the geochronic time scale applied on each side of the diagram. The time scale, linked with with planktonic foraminiferal correlation, is that arrived at by the European Working Group of the IGCP - Mid Cretaceous Event Project (as outlined in Robaszynski & Caron, 1979). The time scale applied by Stacey (1982) was an earlier version (Van Hinte, 1976).

The base and top of this interval is marked by the presence of the aragonitic benthonic foraminifera *Colomia austrotrochus,* which Taylor (1964) selected as an indicator of his Zonule B. Also present within this interval is one specimen of *Gavelinopsis cenomanica;* another designated Zonule B indicator.

However, of greater significance in this Bridgewater Bay interval was the presence of a few specimens of planktonic foraminifera; including a *Praeglobotruncana* sp. (SWC 2935). This specimen has strong morphological affinities to *P. stephani* (*sensu* Hiltermann & Koch, 1962 and Robaszynski & Caron, 1979) and in many ways similar to *P. delrioensis delrioensis* (*sensu* Koch, 1977, refer synonymy on p.25). Planktonics were also recorded in cuttings at 3295 and 3495m, including three specimens listed on Figure 5 as *Whiteinella baltica* (*sensu* Robaszynski & Caron, 1979), but listed also on Figure 2 as *W. portsdownensis* (*sensu* Koch, 1977).

Other occurrences of significance are four specimens of calcareous benthonic forms, representing the earliest stages of the *Stenosioeina granulata* lineage group (refer Koch, 1977, Fig. 3, p.32). The Bridgewater Bay # 1 specimens are referable to the flattened, lenticular praecursor morphotypes, rather than to the plano-convex pentultimate and ultimate forms. Thus these specimens were probably referable to either *S. granulata interiecta* or *humilis*, or possibly to the intermediate morphotype *kelleri*.

Originally, Taylor (1964) placed Zonule B within the Turonian Stage by cross-correlation of the Victorian, purely benthonic faunas, with similar faunas, associated with diagnostic planktonic forms on the Western Australian margin. Of particular importance in this correlation was *Gavelinopsis cenomanica;* its prescribed range of Cenomanian to Early Turonian in North-Western Europe, as given by Hiltermann & Koch (1962), and confirmed in Koch (1977, Tab.1). Shell Development (1967), in their study of the Voluta # 1 sequence (in the vicinity of Bridgewater Bay # 1) applied Taylor's (1964) scheme for the Port Campbell Embayment. But for rather tenuous reasons, they amended the scheme by extending the range of *G. cenomanica* into the lower part of Zonule A. Shell Development (1967) designated this lower part of Zonule A (Zonule XA-2) as being possibly of Coniacian age, thus implying that *G. cenomanica* remained in the Otway Basin as a relict after its extinction in Western Australia and North Western Europe.

Age determinations by micropaleontologists were hampered by the total absence of biostratigraphically diagnostic, planktonic foraminiferal taxa. This problem of chrono-stratigraphic precision in a stage determination for Zonule B (of Taylor, 1964) seemed resolved by the recovery of four specimens of index planktonic forms. Even if the single specimen, listed as *Praeglobotruncana* aff. *stephani* is not referable to that species, it is indisputably a *Praeglobotruncana*, and thus the sidewall core at 2935m can be no younger than mid Turonian (refer Figure 2). The identification of *Whiteinella baltica* and/or *W. portsdownensis* strongly collaborates this conclusion. The presence of praecursor forms in the *Stensioeina granulata* lineage restricts the age of the interval, at least above 3170m, to the mid Turonian; refer Figure 2 and note from Figure 5 that *S. granulata* Group specimens were found only in cuttings. Indirect evidence regarding the range of *Colomia austrotrochus* is included on Figure 2 from Taylor's personal observations of the association of this species with early to mid Turonian planktonic foraminifera in samples from the West Australian Margin.

Admittedly, the evidence is sparse for a mid Turonian to possibly early Turonian age for the interval 3615 to 2895m; being dependant on four poorly preserved planktonic foraminifera, with supporting evidence from the presence of some ten calcareous benthonic specimens. Yet by plotting a composite of ranges of all species present, as on Figure 2, an impression emerges, albeit on sparse evidence, of a biostratigraphic placement within a narrow time span, approximating one million years.

This apparent biostratigraphic precision is exploded by the palynological determinations on the same samples (refer right hand column of Figure 2). Samples dated as *no younger* than mid Turonian on foraminiferal evidence are considered as *no older* than mid Coniacian or even early Santonian on the bulk of palynological evidence (refer palynology report on Bridgewater Bay # 1 by Helene Martin). As explained by Martin, preservation of the spore/pollen is poor within this interval and occurrence of diagnostic forms is sporadic, so the palyno-stratigraphy is dependant on dinoflagellates; particularly the zonal indicator *Odontochitina porifera* between 3600 and 2815m. Martin expresses reservations regarding the designation of these Cretaceous (as well as Tertiary) dinoflagellate zones in that there is no description or diagnoses of the zones by Stacey (1982) or his Esso Australia associates. A similar statement could be made regarding the sample locations used as evidence for the Cretaceous stage designations for the dinoflagellate zones. Such evidence is only valid if the particular dinoflagellate assemblage was associated with a stage diagnostic planktonic foraminiferal and/or ammonite fauna. As already explained, such samples are not available from the Otway Basin or elsewhere along the Southern Margin.

Possibly, the mid Turonian foraminifera were reworked in younger sediment, but it is also possible that the Coniacian/Santonian microflora were contaminants in mud penetrated sidewall cores. However, the discrepancies in Cretaceous Stage determinations for Bridgewater Bay # 1 cannot be dismissed by such argument; resolution is only possible by production of further evidence.

This interval between 3615 and 2895m was deposited in marginal marine conditions, as is evident by the predominance of arenaceous benthonic foraminifera (refer Figure 5). This Bridgewater Bay # 1 interval was deposited in even more marginal marine paleoenvironments than for the equivalent interval in Voluta # 1 between 3568.5 and 2800m, judging from the higher specific diversity and numerical specimen frequency in Voluta # 1 (Shell Development, 1967). Nondescript planktonic foraminifera, *Hedbergella*, occur fairly frequently (up to 20 specimens per sample) in the Voluta interval. The recovery of four diagnostic planktonics in the equivalent interval in Bridgewater Bay # 1 may be purely a chance factor in sampling, suggesting that they may be present as a "trace" throughout the Basin.

LATE CRETACEOUS - 2855 to ?1244m.

This interval has been subdivided into palynological zones (both spore/ pollen and dinoflagellates) by Helene Martin. No comment on the foraminiferal biostratigraphy is warranted because of the absence of diagnostic species, particularly planktonic ones.

The foraminiferal faunas, where present, were almost totally dominated by arenaceous species; particularly *Haplophragmoides* spp. The occurrence of these arenaceous assemblages were sporadic (refer Figures 3 & 4) and often were not present in samples from which Martin reports dinoflagellates. The inference is that the environment was marginal marine with strongly fluctuating conditions regarding salinity and pH. The presence of frosted and fractured quartz sand in many samples, suggests the depositional site was within the proximity of a barrier-dune system.

EARLY TERTIARY - 1210 to 934m.

Once again age determination is dependant on the palynology of Helene Martin. The sample at 1210m is of interest, as the limonitic stained, polymodal sand grains suggest correlation with the *Pebble Point Formation*. This assumption is confirmed by the presence of the dinoflagellate *Isabelidinium bakeri* in the sample at 1210m.

MID or LATE EOCENE - 887m (refer Figure 3).

This biogenic calcarenite was probably deposited at the top of the mid Eocene, although deposition of the unit (top on E-log - 860m) probably extended into the late Eocene. Deposition was on the inner continental shelf (≃40m in paleodepth).

MID MIOCENE - ZONE C - 850 to 825m.

An unconformity was apparent at 860m (E-logs) with the incoming of a distinctly (see Figure 3) mid Miocene planktonic assemblage at 850m. Deposition was on the mid continental shelf with paleodepth increasing to ≃100m.

MID PLIOCENE - ZONE A-3 - 815 to 550m.

Another unconformity was apparent at 822m (E-logs) with a mid Pliocene assemblage being recorded upwards from 815m (see Figure 3). As in the mid Miocene, deposition was on the mid continental shelf (≈100m) but there is some evidence of canyon cutting and filling with a numerical abundance of *Cassidulina leavigata* and *Fissurina* spp. at 650 and 550m. associated in richly bryozoal calcarenites. This apparent canyon activity could account for the mid Miocene/mid Pliocene unconformity at 825m. However, mid Pliocene canyon carbonate fills in Bridgewater Bay are not as well developed as those between 660 and 434m in Discovery Bay # 1.

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SAMPLE DEPTH in metres += sidewall cores		PLANKTONIC FORAMINIFERA																				
	EOCENE				MIOCENE							PLIOCENE									BIOSTRATIGRAPHY	
	G'theka index	*G'alia turgida*	*G'ina linaperta*	*G'ina anigporoides* (S.L.)	*Orb. universa*	*G'quad altispira*	*G'alia mayeri*	*G'alia lenguaensis*	*G'ina woodi woodi*	*G'ina nepenthes*	*G'alia miozea conoidea*	*G'alia inflata*	*G'alia panda*	*G'quad dehiscens* (S.S.)	*G'ina decoraperta*	*G'ina bulloides*	*G'oides trilobus*	*G'alia humerosa*	*G'alia crassaformis*	*G'alia conomiozea*	AGE and ZONE	Depth of basal sample in unit
550.0+					•							•			x	x		•	•			
650.0+					•					•	•	•			x	x		•	•	•	MID/LATE	
750.0+					•	•									•	•		•			PLIOCENE	
815.0+					•						•	•	•	•	x	x	•				ZONE A-3	815
825.0+					•		•		x	•	•										MID MIOCENE	
850.0+					•	•	•	•	x												ZONE C	850
887.0+	•	•	•	•																	EOCENE ? ZONE N	887
934.0+																						
965.0+																					? ? ?	
984.0+																						
1000.0+																						
1054.0+																						
1108.0+																					? ? ?	
1137.0+																						
1171.0+																						
1185.0+																						
1200.0+																					? ? ?	
1210.0+																						
1244.0+																						
1284.0+																						
1318.0+																						
1373.0+																						
1426.0+																						
1457.0+																						
1495.5+																						
1522.0+																					LATE CRETACEOUS	
1570.0+																						
1593.0+																						

SAMPLE DEPTH in metres += sidewall cores	SELECTED BENTHONIC FORAMINIFERA and OTHER FAUNA																						
	? Gavelinopsis eriksdalensis	*Hyperammina elongata*	*Haplophragmoides* spp.	*Bathysiphon angleseanensis*	*Cassidulina subglobosa*	*Ceratobulimina* sp.	NODOSARIDS	*Alabamina westraliensis*	*Euuvigerina peregina*	*Cibicides opacus*	*Anglogencrina australis*	*Rosalina bradyii*	*Loxostomum* spp.	*Anomalina macroglabra*	*Cibicides mediocris*	*Fissurina* spp.	*Cassidulina leavigata*	pyritized rods, spheres & discs	mollusca	fish remains	bryozoal frags.	echinoid spines	ostracodes
550.0+										x					•	x	x				x	•	•
650.0+										x			•			x	x				x		•
750.0+									x	x											x	x	•
815.0+									x	x	•		•	•	•						x	x	•
825.0+					•					•	•	•	•	•							x	x	
850.0+					•				•	x	•												
887.0+					x	•	x	•													x	•	
934.0+				x																			
965.0+																				•			
984.0+																							
1000.0+																							
1054.0+																							
1108.0+			D																•	•			
1137.0+																							
1171.0+																							
1185.0+																							
1200.0+			D															x	•				
1210.0+																							
1244.0+																							
1284.0+																		x					
1318.0+																		x					
1373.0+																							
1426.0+																							
1457.0+																							
1495.5+																							
1522.0+	•	•																					
1570.0+																							
1593.0+																							

SAMPLE DEPTH in metres += sidewall cores			RESIDUE GRAIN LITHOLOGY						
			MINOR ELEMENTS						MAJOR ELEMENTS
	Foraminiferal count	Planktonic %	pyrite	limonite pellets	glauconite	m-c ang. qtz.	chert	f. ang. qtz.	
550.0+	500	80						r	§§§§§§§§§§§§§§§§§§§§
650.0+	500	80						r	§§§§§§§§§§§§§§§§§§§§
750.0+	?	?						A	§§§§§§§§§§§§§§§§§§§§
815.0+	250	40				A			§§§§§§§§§§§§§§§§§§§§
825.0+	250	50				A			§§§§§§§§§§§§§§§§§§§§
850.0+	300	50				A	r		§§§§§§§§§§§§§§§§§§§§
887.0+	50	20	A						§§§§§§§§§§§§§§§§§§§§
934.0+	20	nil	A						-•- ∆∇∆∇∆∇∆∇∆∇∆∇∆∇∆∇
965.0+	NFF		A						••• ∇∆∇∆∇∆∇∆∇∆∇∆∇∆∇∆
984.0+	NFF		A						••••••••••• ∆∇∆∇∆∇∆∇
1000.0+	NFF		C						••• ∆∇∆∇∆∇∆∇∆∇∆∇∆∇∆∇
1054.0+	NFF					A			••••••••••• ∇∆∇∆∇∆∇∆
1108.0+	50	nil				A			•••••••••••••• ♦♦♦♦♦
1137.0+	NFF		C						∆∇∆∇∆∇∆∇∆∇∆∇∆∇∆∇∆∇∆∇
1171.0+	NFF		A		C				∇∆∇∆∇∆∇∆∇∆∇∆∇∆∇∆∇∆∇∆
1185.0+	NFF		C			r			•••••••••••••••••••••
1200.0+	50	nil			r				○o•○o•○o•○o• ♦♦♦♦
1210.0+	NFF			A					ϕ•ϕ•ϕ•ϕ•ϕ•ϕ•ϕ•ϕ•ϕ•ϕ•
1244.0+	NFF								•-•-•-•-•-•-•-• ♦♦♦♦
1284.0+	NFF								•○•○•○•○•○•○•○• ♦♦♦♦
1318.0+	NFF								○•○•○•○•○•○•○•○ ♦♦♦♦
1373.0+	NFF								○o•○o•○o•○o•○o•○
1426.0+	NFF								○o•○o•○o•○o•○o•○
1457.0+	NFF								••••••••••••••••••••
1495.5+	NFF								○o•○o•○o•○o• ♦♦♦♦
1522.0+	5	nil							○o•○o• ♦♦♦♦♦♦♦♦♦♦♦
1570.0+	NFF								∆∇∆∇∆∇∆∇∆∇∆∇∆∇∆∇∆∇∆∇
1593.0+	NFF		A						∇∆∇∆∇∆∇∆∇∆∇∆∇∆∇∆∇∆∇∆

§§ : biogenic calcarenite
-•- : mica,qtz.siltst.
ϕ• : limonitic c-m ang-subrd. qtz. sdst.
~~ : silt
•o○ : f.m. & c. qtz. ang-subrd.
♦♦ : pyrite
∆∇ : frosted & fractured qtz.

Distribution Symbol Key:

• = <20 specimens
x = >20 specimens
D = Dominant 60% specimens

N.F.F. = no foraminifera found
? = determination queried
~~~~~~ = hiatus

A = 1-5% grains
C = >20 grains
r = <20 grains

FIGURE 3: TERTIARY to LATE CRETACEOUS FORAMINIFERAL and SEDIMENT GRAIN DISTRIBUTION - BRIDGEWATER BAY # 1 : 550m to 1593m.

David Taylor, February 1984.

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~~~~~~

SAMPLE DEPTH in metres → = ˈlew- cor α = rotary cuttings with base interval depths	*Trochammina "subinflata"*	*Haplophragmoides* sp. A	*H.* sp. B	*H.* sp. C	*Ammobaculites* cf. *fragmentaria*	*Amplagena* sp.	*Bathysiphon* sp.	*Hyperammina elongata*	*Vulvulineria erugata*	*Ammodiscus* sp.	*Ammobaculites* sp.?	FORAM COUNT	% PLANKTONICS	% CALCAREOUS BENTHONICS	% ARENACEOUS BENTHONICS	pyrite spheres	pyrite rods	pyrite discs	*Inoceramus* prisms	pyrite	limonite-clay	carbonaceous matter	mica	m-c ang. qtz.	glauconite	MAJOR COMPONENTS
	FORAMINIFERA											STATISTICS				OTHER FAUNA				RESIDUE GRAIN LITHOLOGY — MINOR COMPONENTS						RESIDUE GRAIN LITHOLOGY — MAJOR COMPONENTS: °o: f.m. qtz. ang-subrd.; Δ∇: frosted & fractured qtz.; ~~: silt; ◆◆: pyrite; ♣♣: limonitic clay & pellet - siltst.& qtz. sdst.
13 0→												NFF	–	–	–					r						ooooooooooooooooooooooo
63.0→												NFF	–	–	–					r	C	r				Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇
00 0→												NFF	–	–	–					r	A	C	r			ooooooooooooooooooooooo
20 0→												NFF	–	–	–											Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇
73.0→												NFF	–	–	–					A						∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ
00.0→	°	D										15	–	–	100						A					o~o~o~o~o~o~o~o~o~o~o~
30 0→												NFF	–	–	–											ooooooooooooooooooooooo
70 0→	x	x	x	x	°	°	°	°				100	–	–	100	x	x			A		A		A		~~~~~~~~~~~~~~~~~~~~~~~
10.0→												NFF	–	–	–					A		A				o~o~o~o~o Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇
39 0→												NFF	–	–	–											~o~o~o Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ
15 0→												NFF	–	–	–					C	A					∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ
52.0→												NFF	–	–	–	°				C	C					o~o~o~ Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ
79.0→		°										10	–	–	100					r	C				r	~o~o~o ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇
00 0→												NFF	–	–	–											o~o~o~ Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ
30 0→									°			?	–	?	?	°				C						~o~o~o ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇
75.0→												NFF	–	–	–											o~o~o~o~o~o~o~o~o~o~o~
15 0→												NFF	–	–	–			°		A						Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇
35 0→												NFF	–	–	–	°	°					r				~o~o~o~o~o~o~o~o~o~o ◆◆◆
65.0→												NFF	–	–	–					C						Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇ ♣
00.0→												NFF	–	–	–					r						o~o~o~ Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ
50 0→												NFF	–	–	–										r	oOoOoOoOoOoOoOoOoOoOo ♣♣
80 0→												NFF	–	–	–					r						OoOoOoOoOoOoOoOoOoOoOoOo
55.0→												NFF	–	–	–				°	C						∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ
90 0→	°										°	15	–	–	100					C		C				~o~o~o ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇
50 0→												NFF	–	–	–					A						o~o~o~ Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ
80.0→												NFF	–	–	–							A	A			~o~o~o~o~o ∇Δ∇Δ∇Δ∇Δ∇
90.0→												NFF	–	–	–							C	C			o~o~o~o~o~ Δ∇Δ∇Δ∇Δ∇Δ
08. →												NFF	–	–	–							A	r			~o~o~o Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ
35. →			°									5	–	–	100										r	Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇Δ∇
75.0→												NFF	–	–	–					C		C				~o~o~o~o~o~o~o~o~o~o~o
15.0→				°								5	–	–	100					C		C	r			o~ooooooooooooooooooooo
50. α				°								5	–	–	100							A				~o≈o~o~o~o~o~o~o~o~o~o
55.0→				°			°				°	10	–	–	100					C		C	C		r	ooooooooooooooooooooooo
60.0α				°							°	5	–	–	100											o~o~o~o~o~o~o~o~o~o~o~

FIGURE 4: LATE CRETACEOUS FORAMINIFERAL and SEDIMENT GRAIN DISTRIBUTION - BRIDGEWATER BAY # 1 : 1613m to 2860m.
Refer Figure 3 for Distribution Symbols.

Da id Taylor, February 1984.

FORAMINIFERA — OTHER FAUNA — RESIDUE GRAIN LITHOLOGY

SAMPLE DEPTH in Metres
+ = sidewall cores
α = rotary cuttings with base interval depth.

MAJOR COMPONENTS:
•o◯ : f. m. c. qtz. ang. subrd.
~ : silt
♦ : pyrite
ΔV : frosted & fractured qtz.
⊔ : dk. gy. carbonaceous mudstone

SAMPLE DEPTH in Metres	PLANKTONIC: Praeglobotruncana aff. stephani*	Hedbergella sp.?	Whiteinella baltica*	CALCAREOUS BENTHONIC: Colomia austrotrochus*	Praebulimina sp.?	Gyroidina nitida	Stensioeina granulata Gp.*	Gavelinopsis cenomanica	Hanzawaia californica	Allomorphina pyriformis	Saracenaria cf. triangularis	Globulina lacrima	Palaimorphina heliciformis
2890.0α													
2895.0+				•	•								
2930 & 35α													
2935.0+	•					•							
2960 & 85α													
3015.0+													
3165 & 70α							•	•	•	•	•		
3175.0+		•											
3215.0+													
3255.0+													
3295.0α			•									•	
3295.0+													
3405.0α		•	•				•						
3495.0α												•	
3541.0α													
3560.0+													
3600.0+													
3615.0α				•									
3625.6α													
3660.0α													
3680.0+													
3720.0+													
3730.0α													
3760.0+													
3800.0+													
3805.0α													
3936.5α													
4008.0+													
4014.0+													
4017.0+													
4047.0+													
4072.0+													
4075.0α													
4090.0α													
4098.0+													
4102.0+													
4105.0+													
4109.0+													
4125.0+													
4156.0+													
4165.0+													

SAMPLE DEPTH in Metres	ARENACEOUS BENTHONIC: Haplophragmoides sp.B & sp.C	Ammobaculites goodlandensis	A. cf. fragmentaria	Hyperammina elongata	Dorothia filiformis	Trochammina "depressa"	T. "subinflata"	Ammobaculites australis	A. cf. subcretacea	Marssonella oxycona	? Dorothia glabrella	STATISTICS: FORAM COUNT	% PLANKTONICS	% CALCAREOUS BENTHONICS	% ARENACEOUS BENTHONICS
2890.0α												NFF	-	-	-
2895.0+	x	•	•	•	•	•						40		12	88
2930 & 35α	•	•		•	•	•						20	-	-	100
2935.0+	•		•	•		•						25	4	4	92
2960 & 85α	•											5	-	-	100
3015.0+	•		•									10	-	-	100
3165 & 70α	x	•		x								75	-	15	85
3175.0+		•	•									10	10	-	90
3215.0+	•		•									10	-	-	100
3255.0+	•					•	•					10	-	-	100
3295.0α	•	•						•				20	5	5	90
3295.0+												NFF	-	-	-
3405.0α	D	•			•				•	•		75	9	9	82
3495.0α	•		•		•							10	-	10	90
3541.0α	•	•							•			10	-	-	100
3560.0+				x								20	-	-	100
3600.0+			•			?	?					10	-	-	100
3615.0α					•	?	?				•	10	10	-	90
3625.6α												NFF	-	-	-
3660.0α												NFF	-	-	-
3680.0+												NFF	-	-	-
3720.0+											•	1	-	-	100
3730.0α												NFF	-	-	-
3760.0+												NFF	-	-	-
3800.0+												NFF	-	-	-
3805.0α												NFF	-	-	-
3936.5α												NFF	-	-	-
4008.0+												NFF	-	-	-
4014.0+												NFF	-	-	-
4017.0+												NFF	-	-	-
4047.0+												NFF	-	-	-
4072.0+												NFF	-	-	-
4075.0α												NFF	-	-	-
4090.0α												NFF	-	-	-
4098.0+												NFF	-	-	-
4102.0+												NFF	-	-	-
4105.0+												NFF	-	-	-
4109.0+												NFF	-	-	-
4125.0+												NFF	-	-	-
4156.0+												NFF	-	-	-
4165.0+												NFF	-	-	-

SAMPLE DEPTH in Metres	OTHER FAUNA: pyritized discs	pyritized spheres	pyritized tubes	Inoceramus prisms	Fish scales, teeth & bone frags.	Fish otoliths	MINOR COMPONENTS: pyrite	glauconite	c.ang-subrd qtz & rock frags.	carbonaceous matter	mica	calcareous clay	orange limonitic f.qtz.sdst.& clay	?sideritic clay	"Otway Group" sdst. frags.	MAJOR COMPONENTS
2890.0α							A	r	A							o~o~o~o~o~o~o~o~o~o~o
2895.0+							C			C	r					♦•••••••••••••••••••••••
2930 & 35α	•							r	A							••••• ♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦
2935.0+	x	x	x				A			C	C					~•~o~o~o~o~o~o~o~•~o~•~
2960 & 85α																•••• ΔV ♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦
3015.0+							A	r		r	r					••••••••••••••••••••••••
3165 & 70α				•	•	•		r								•••• ⊔⊔⊔⊔⊔⊔⊔⊔⊔⊔⊔⊔
3175.0+								r		C	r					•••••••••••••••••••• ♦♦♦
3215.0+							C	C		C	C					•~•~o~o~o~o~•~•~o~o~o
3255.0+							A	C		A	A					~•~•~o~o~o~o~•~•~o~•~
3295.0α				D								A				•••• ~~~ ⊔⊔⊔⊔⊔⊔⊔⊔⊔⊔
3295.0+				D	•		A	A		C	C					o~o~o~o~o~o~o~o~o~o~o
3405.0α			•	x			A	C	A			A				••••• ⊔⊔⊔⊔⊔⊔⊔⊔⊔⊔⊔⊔
3495.0α				•				r	C				A			~o~o~ ⊔⊔⊔⊔⊔⊔⊔⊔⊔⊔⊔⊔
3541.0α							r	r		A	r		A			••••• ~o~o~o~o~o~o~o~o~
3560.0+							A		A							~•~•~o~o~o~o~o~o~•~o~
3600.0+								r	A							o~•~o~o~o~o~o~o~o~o~o
3615.0α				?			A			A						•O•O•O•O•O•O•O•O•O ΔVΔV
3625.6α																O•O•O•O•O•O•O•O• ~~~~
3660.0α									A			A				~~~~~~~~~~~~~~~~~~~~~~~
3680.0+																~~~~~~~~~~~~~~~~~~~~~~~
3720.0+		•					r									~~~~~~~~~~~~~~~~~~~~~~~
3730.0α									A			r	r			~~~~~~~~~~~~~~~~~~ ⊔⊔⊔
3760.0+							A				A					~~~~~~~~~~~~~~~~~~~~~~
3800.0+											A					~~~~~~~~~~~~~~~~~~~~~~
3805.0α		x										A	A			~•~•~o~o~o~o~•~o~•~•~
3936.5α							A		A	A						o~•~o~•~o~o~o~•~•~o~o
4008.0+							r									•O•O•O•O•O•O•O•O•O•O•
4014.0+							r			A						O•O•O•O•O•O•O•O•O•O•O
4017.0+							r			A						•O•O•O•O•O•O•O•O•O•O•
4047.0+							r			A						O•O•O•O•O•O•O•O•O•O•O
4072.0+																•O~•O~•O~•O~•O~•O~•O~•O
4075.0α								r		C			A			O~•O~•O~•O~•O~•O~•O~•O~
4090.0α							A			A						~•O~•O~•O~•O~•O~•O~•O~•
4098.0+																•O~•O~•O~•O~•O~•O~•O~•O
4102.0+																O~•O~•O~•O~•O~•O~•O~•O~
4105.0+																~•O~•O~•O~•O~•O~•O~•O~•
4109.0+																•O~•O~•O~•O~•O~•O~•O~•O
4125.0+										A				C	A	O~•O~•O~•O~•O~•O~•O~•O~
4156.0+										A						~•O~•O~•O~•O~•O~•O~•O~•
4165.0+										A				r		•O~•O~•O~•O~•O~•O~•O~•~

FIGURE 5: MID CRETACEOUS FORAMINIFERAL DISTRIBUTION and SEDIMENT ANALYSIS - BRIDGEWATER BAY # 1: 2890m to 4165m.

*refer text and Figure 2. Refer Figure 3 for Distribution Symbols.

David Taylor, February 1984.

BRNB 1 R900161 / P150

APPENDIX NO. 6

PALYNOLOGICAL REPORT

THE STRATIGRAPHIC PALYNOLOGY
of
BRIDGEWATER BAY # 1,
OTWAY BASIN.

for: PHILLIPS AUSTRALIAN OIL COMPANY.

February 8, 1984.

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BRIDGEWATER BAY # 1 - SUMMARY OF STRATIGRAPHIC PALYNOLOGY.

DEPTH (M)	SPORE-POLLEN ZONE	DINOFLAGELLATE ZONE	AGE	PALEOENVIRONMENT
887	Lower *N. asperus*	*C. incompositum*	LATE EOCENE	Marine
934-965	*P. asperopolus*	——	EARLY-MID EOCENE	Non marine
984-1000	*M. diversus*	?	EARLY EOCENE	marginal marine
1054		——		Non marine
1108-1200		?		Marginal marine
1210	? *L. balmei*	Paleocene	PALEOCENE	
1244-1457	*T. longus*	*I. pellucidum* *	MAASTRICHTIAN into EARLIEST PALEOCENE	
1495.5	*T. lilliei*		LATEST CAMPANIAN into MAASTRICHTIAN	
1522		*I. korojonense*		
1570-1613		*I. pellucidum* *	CAMPANIAN	
1663		——		Non marine
1700-1870		?		Marginal marine
1910-1939		——		Non marine
2015		*X. australis*		Marginal marine
2052-2130	*N. senectus*			
2175-2450		*N. aceras*		
2480-2590	*T. pachyexinus*		LATE SANTONIAN into EARLIEST CAMPANIAN	
2650-2775		*I. cretaceum*	SANTONIAN	
2815-2935		*O. porifera*	LATE CONIACIAN into EARLIEST SANTONIAN	
3015-73600	indeterminable			
73680-4098		indeterminable	?	

Helene A Martin, February 1984.

*For explanation, see Fig. 2 and text, page 5.

A. SIDEWALL CORES.

SPORES and POLLEN

The spores and pollen identified are listed in Table 1 and the ranges of diagnostic species are shown on Figure 1. The species in Table 1 are grouped into three categories:-

1) Spores, mostly from ferns and their allies.
2) Gymnosperm pollen: pines e.g. hoop pine, Huon pine etc. These would have been mostly forest trees. Their relatives are found today in forests of Tasmania, New Zealand, New Caledonia and New Guinea. Only a few grow on the Australian Mainland and they are restricted to rainforests and the wetter climates.
3) Angiosperm pollen : flowering plants. These may have been trees or shrubs.

An assessment of the abundance of plant tissue debris is included in Table 1. Plant tissue debris is abundant in non marine swamps but less so in fresh water lakes. Plant tissue debris is not abundant in marine environments unless the location is close to a river outlet. However, other factors are involved with the abundance of plant tissue debris, e.g. preservation. Poor preservation may destroy or render unrecognisable much of the plant tissue debris.

The ranges of Cretaceous diagnostic species follow Dettmann & Playford (1969) who based their ranges on data from the Otway Basin. Ranges for uppermost Cretaceous and Tertiary diagnostic species follow Stover & Playford (1973) as amended by Partridge (1976). These latter ranges are based on data from the Gippsland Basin. Where ranges for the same species are available for both basins, they are not always the same. When these species are encountered in Bridgewater Bay, their ranges conform to those given for the Otway Basin. Stacey (1982) slightly modifies the original dating of the zones by Dettmann & Playford.

Partridge (1976) presents further subdivisions of the zones in Stover & Partridge (1973), but without diagnosis or definition. As the criteria for these subdivisions is unknown, they cannot be used here.

1. 4102-4165m - Barren.

2. 3015-4098m - Indeterminable.

Preservation is exceedingly poor here and only the most robust spores and pollen have survived. Only the ones with characteristic shapes and gross features can be identified for all the fine detail has been destroyed. All of the species which can be recognised are long ranging and of no diagnostic value. The three lowermost samples have no pollen at all, but dinoflagellates are present (see Table 2).

3. *T. pachyexinus* Zone - Coniacian into Early Campanian, 2480-2935m.
Preservation here is poor, but somewhat better than the Indeterminable Zone beneath it. The lowermost core, 2935m, contains *Latrobosporites amplus* and *Proteacidites scaboratus* which both appear within the *T. pachyexinus* Zone. Whether 2935m marks the true base of the *T. pachyexinus* Zone or whether it continues deeper, but all diagnostic species have been destroyed, cannot be determined from the palynological evidence.

4. *N. senectus* Zone - Early-Mid Campanian, 2052-2450m.
Preservation is still poor, but it improves with decreasing depth. *T. gillii*, which first appears at the base of this zone is found in 2450m. Other diagnostic species found in this Zone are *Proteacidites amolosexinus*, *Nothofagidites senectus* and *Tricolpites sabulosus*.

5. *T. lilliei* Zone - Late Campanian into Early Maastrichtian, 1495.5-2015m.
Nothofagidites endurus, which first appears at the base of the Zone is found in 2015m and other diagnostic species are found within this depth interval (see Table 1 and Figure 1).

6. *T. longus* Zone - Maastrichtian into earliest Paleocene, 1244-1457m.
The first appearance of *Proteacidites angulatus* in 1457m marks the base of the *T. longus* Zone. Stover & Partridge (1973) state that the range of *Australopollis obscurus* begins within this zone, but Dettmann & Playford (1969) show that this species first appears in the *C. triplex* Zone (Turonian) of the Otway Basin. In Bridgewater Bay, *A. obscurus* is found from the *T. pachyexinus* Zone up.

7. ?*L. balmei* Zone - Paleocene, 1210m.
Haloragacidites harrisii, which first appears within the *L. balmei* Zone is present here, but it also continues into the *M. diversus* Zone. None of the

species whose ranges terminate at the top of the *T. longus* Zone are found here. The species whose ranges begin at the base of the *M. diversus* Zone are not found here either. This is a poor assemblage with insufficient evidence for a positive determination of the *L. balmei* Zone. The dinoflagellate evidence however, is more specific (see discussion below).

8. *M. diversus* Zone - Early Eocene, 984-1200m.
The 1200m level contains *Cupanieidites orthoteichus, Proteacidites grandis, P. leightonii, P. psuedomoides* and *P. reticuloscabratus* which all first appear at the base of the *M. diversus* Zone. In all, some 14 species whose ranges begin in the *M. diversus* Zone are found here.

9. *P. asperopolus* Zone - Early-Mid Eocene, 934-965m.
Heliciporites astrus, which first appears in the *P. asperopolus* Zone is found here. Species whose ranges terminate in the *M. diversus* Zone are not found here.

10. Lower *N. asperus* Zone - Late Eocene, 887m.
Proteacidites rectomarginis, which begins its range in the upper part of the Lower *N. asperus* Zone is found here. None of the species whose ranges terminate at the top of the *P. asperopolus* Zone are found here.

DINOFLAGELLATES.

The dinoflagellates identified are listed on Table 2 and the ranges of diagnostic species shown on Figure 2. Precise ranges are known for only the diagnostic species. Although ranges for the other species are not documented, the age of the type specimen is usually available, and is used as supporting evidence.

Cretaceous dinoflagellate zonation follows the scheme presented in Stacey (1982). There are no descriptions or diagnoses of the zones, but the text suggests that the first appearance of the nominate species designates the base of the zone and the first appearance of the nominate species of the next younger zone designates the top of the zone. The scheme presented in Stacey (1982) is a modification of that originally devised by Evans (1966) who clearly designates his zones by the method described above. Consequently, this method is adopted in this report.

It should be noted that the ranges of most of the nominate species extend beyond the zone, into younger zones. Harris (1983) reports one nominate species, *Xenikoon australis,* below its zone, in the older *Nelsoniella aceras* Zone. If this is not downhole contamination, then the extension of its range downwards contradicts the method used for zonation. However, it is not uncommon for the range of a species to be extended, with experience.

Tertiary dinoflagellate zonation follows Partridge (1976) and Stover et al (1979), but these zones have not been described either, so the diagnostic features are not known. It is assumed here that the method described for Cretaceous Zonation applies to the Tertiary. However, nominate species of Tertiary Zones are not often seen, so that assemblages cannot be placed in any zone, but if the ranges of the species in the assemblage are considered, they indicate a time which is in agreement with the pollen evidence.

<u>1. ?3680-4098m</u>, Indeterminable.
Extremely poor preservation is the reason for this zone being indeterminable. The uncertainty of the upper boundary is the result of poor preservation as well. Identification of *Odontochitina porifera,* the dominate species of the overlying zone, relies on its distinctive horns which may be broken off. Thus the lowest recorded identification occurs in 3015m, but specimens with broken off horns, recorded as *Odontochitina* sp. in Table 2, occur down to 3720m, and some of them could be *O. porifera*. In 3600m, specimens of *Odontochitina* spp. are relatively common, so the likelihood of some being *O. porifera* is increased.

There is one specimen in 3800m which resembles a badly deformed *Conosphaeridium striatoconus*. Cookson (1965) notes the frequent association of *C. striatoconus* and *Amosopollis cruciformis* in several wells of the Otway Basin. *A. cruciformis* occurs in 3720m, 3760m and possibly in 4014m (see Table 1), all poorly preserved. Thus this evidence would suggest the *C. striatoconus* Zone (see Figure 2), but it is unwise to rely on these uncertain identifications of very poorly preserved specimens. The palynological evidence is insufficient for a reliable zone designation.

2. *Odontochitina porifera* Zone - Coniacian into earliest Santonian, 2815-?3600m.

O. porifera is present and *Odontochitina* spp. are relatively common. Some of the poorly preserved specimens in the lower part of the zone are probably *O. porifera* (see discussion, page 4).

3. *Isabelidinium cretaceum* Zone - Santonian, 2650-2775m.

I. cretaceum is present throughout the Zone.

4. *Nelsoniella aceras* Zone - Late Santonian into Early Campanian, 2175-2590m.

N. aceras first appears at 2590m and is present through most of the Zone.

5. *Xenikoon australis* Zone - Middle Campanian, 2015-2130m.

X. australis first appears at 2130m and is present throughout the Zone.

6. 1700-1870m.

Dinoflagellates are present in low or trace quantities throughout this interval. Only long ranging species have been identified. The evidence is insufficient for zoning, but it does not contradict the spore-pollen evidence.

7. *Isabelidinium pellucidum* Zone - Late Campanian into Earliest Paleocene, 1244-1613m.

The long ranging *I. pellucidum* Zone of Evans (1966) is not used in Stacey (1982). However, the shorter ranging zones in the latter are not found here except for one occurrence of *Isabelidinium korojonense* (discussed further below), so it is useful to retain this older, longer ranging zone.

I. pellucidum is present through most of the interval, sometimes relatively common.

8. *Isabelidinium korojenense* Zone - Late Campanian into Early Maastrichtian, 1522m.

There is only one occurrence of this species. The zone occurs within the longer ranging *I. pellucidum* Zone.

9. 1210m - Paleocene.

Isabelidinium bakeri occurs here. This species is restricted to the early part of the Paleocene (see Figure 2).

10. 984-1000m and 1108-1200m - Early Eocene.

Dinoflagellates occur throughout these intervals but species diagnostic of zones have not been found. The ranges of all the species are in agreement with the Early Eocene *M. diversus* spore-pollen Zone.

11. *Corrudinium incompositum* Zone - Late Eocene, 887m.

The presence of this species indicates the Zone.

PALAEOECOLOGY.

Almost all of the deposition occurred under marginal marine conditions. There are four minor intervals of non marine deposition, 1910-1939m, 1663m, 1054m and 984-1000m respectively. The top of this sequence, 887m is marine.

PRESERVATION and ABUNDANCE.

A feature of the deeper levels of this well is the poor preservation which gets progressively worse with depth. As well, the abundance of spores and pollen is low, decreasing with depth.

Samples prepared for kerogen assessment showed an abundance of very fine particulate matter, some of it rod-shaped, and this is consistent with bacterial activity. Thus the scarcity of pollen probably results from initial destruction, before burial in the sediments. Alteration after burial has had an effect as well, especially in the deepest levels. Here, the spores and pollen are darker in colour, frequently deformed and the finer morphological features obliterated.

Dinoflagellates show these same trends in preservation and abundance, but to a lesser degree.

B. COMPARISON of RESULTS from SIDEWALL CORES and CUTTINGS.

Cuttings were supplied for urgent determinations. The necessary accelerated procedure for the treatment of the samples gives satisfactory results but it is not as good as the slower, normal procedure given to non-urgent samples.

The time available for microscopic examination of urgent samples was very limited. There was no time for a review or a cross check to make certain that the determinations were correct.

Determinations of *T. pachyexinus* Zone from cuttings for 2850-2935m are the same as those from sidewall cores. A result of *C. triplex* Zone from cuttings for 3165-3295m has not been confirmed by the sidewall cores which are indeterminable. The *C. triplex* Zone determination was made on the presence of two species which first appear at the base of this zone but which continue into the Campanian, at least. Thus downhole contamination would be possible and cuttings from this interval were not washed! The sidewall cores failed to yield either of these two species.

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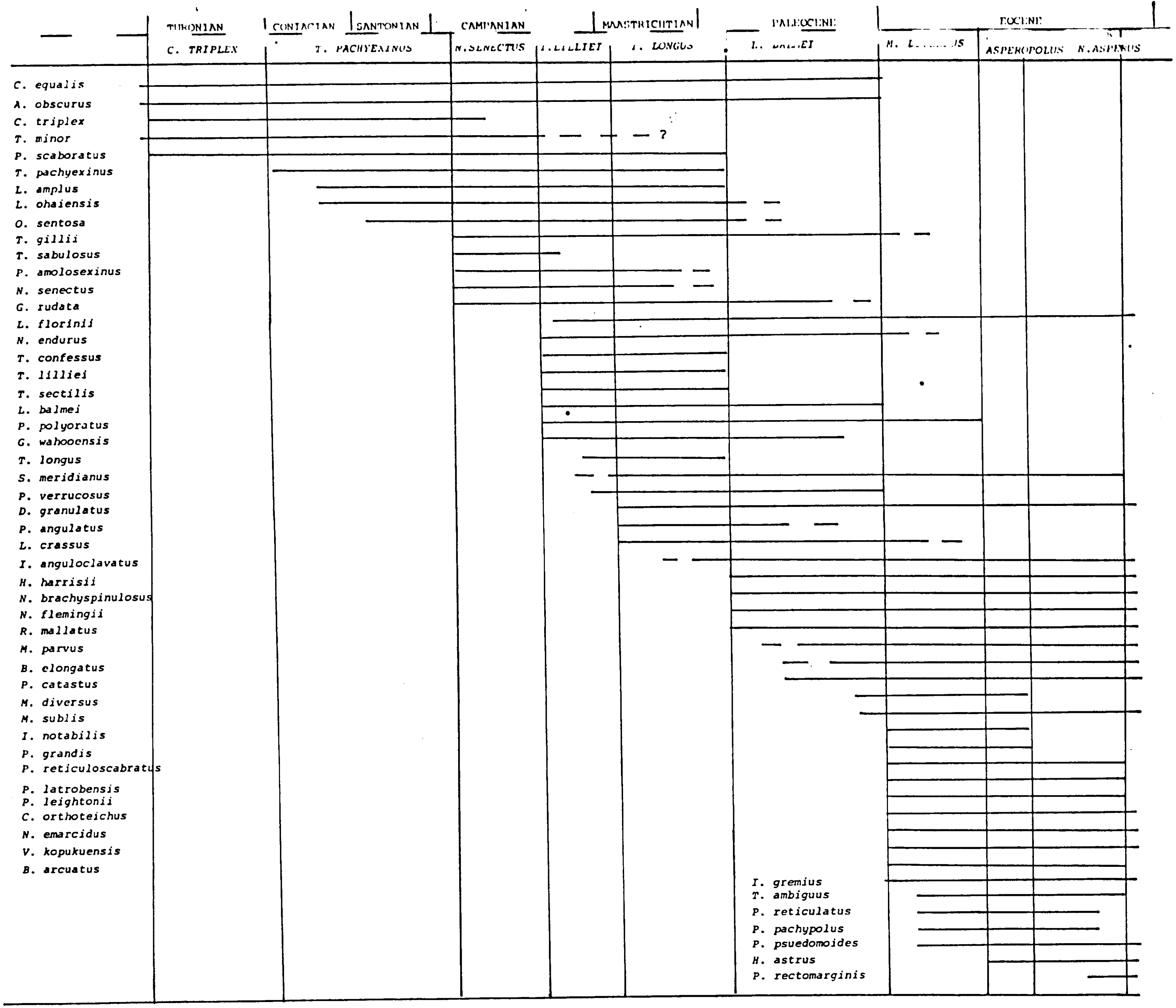


FIGURE 1: SPORE and POLLEN RANGE CHART.
From Dettmann & Playford (1969) and
Stover & Partridge (1973).

*Position of boundary modified
according to reasons in Martin (1983).

Helene A Martin, February 1984.

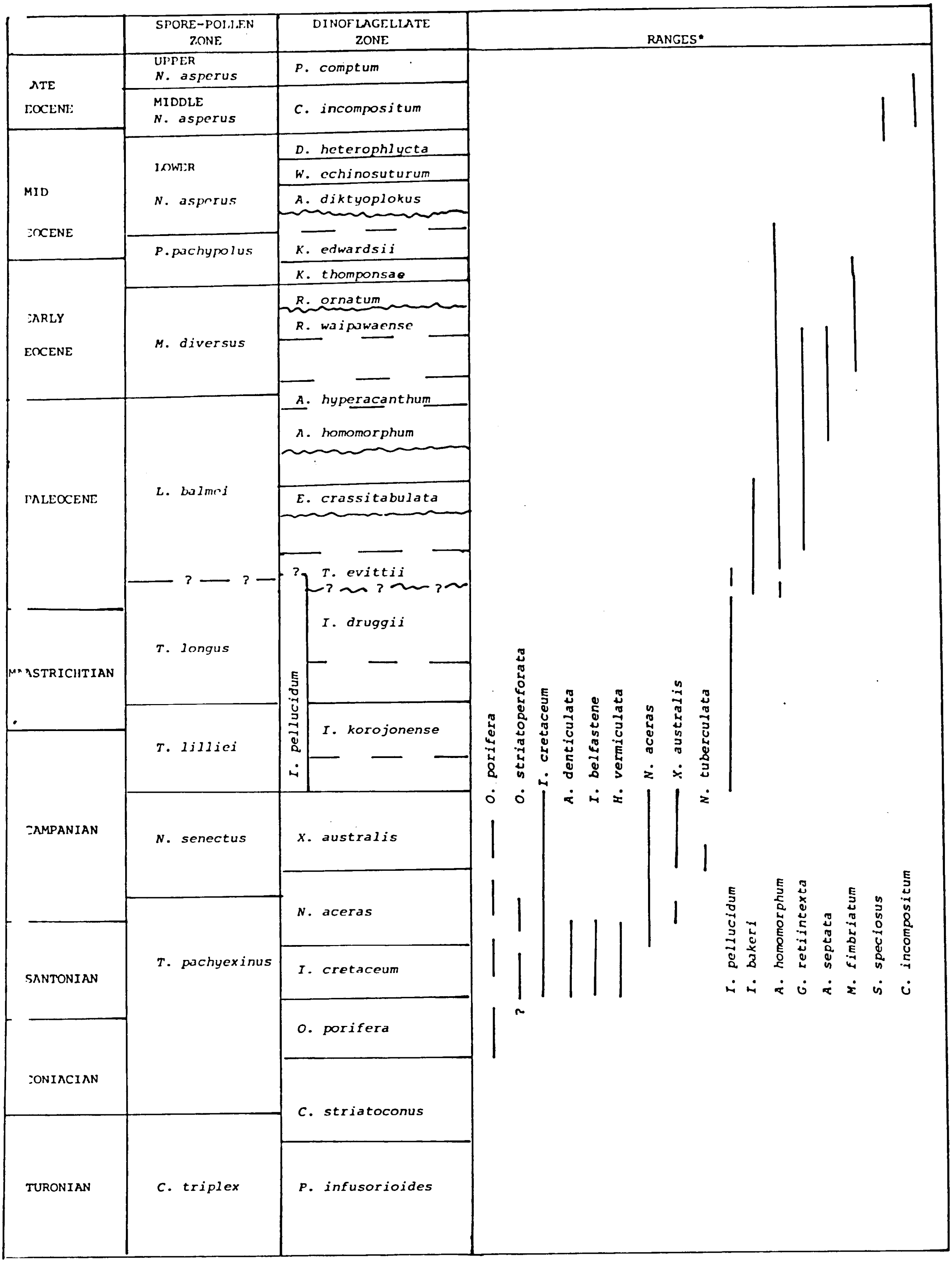
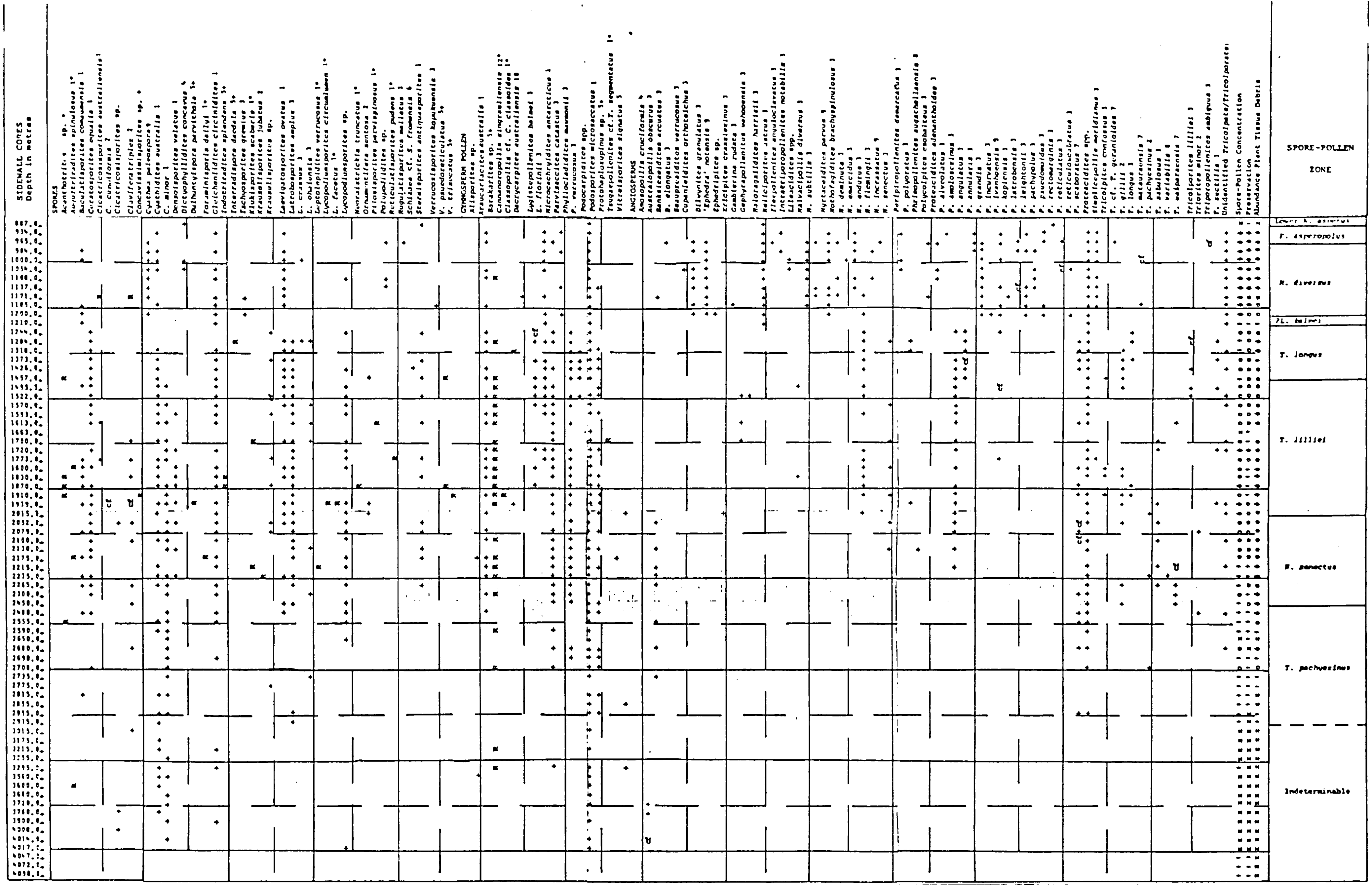


FIGURE 2: DINOFLAGELLATE RANGE CHART.

*Compiled from - Evans, 1966.
Stover, Helby & Partridge, 1979.
Stacey, 1981, 1982.
Harris, 1983.

Helene A Martin, February 1984.



Reference to Species:
1. Dettmann, 1963
2. Dettmann & Playford, 1969
3. Stover & Partridge, 1973
4. Harris, 1965
5. Foster, 1979
6. Cookson, 1956
7. Couper, 1960
8. Norvick & Burger, 1975
9. Martin, 1973
10. Cookson & Pike, 1953

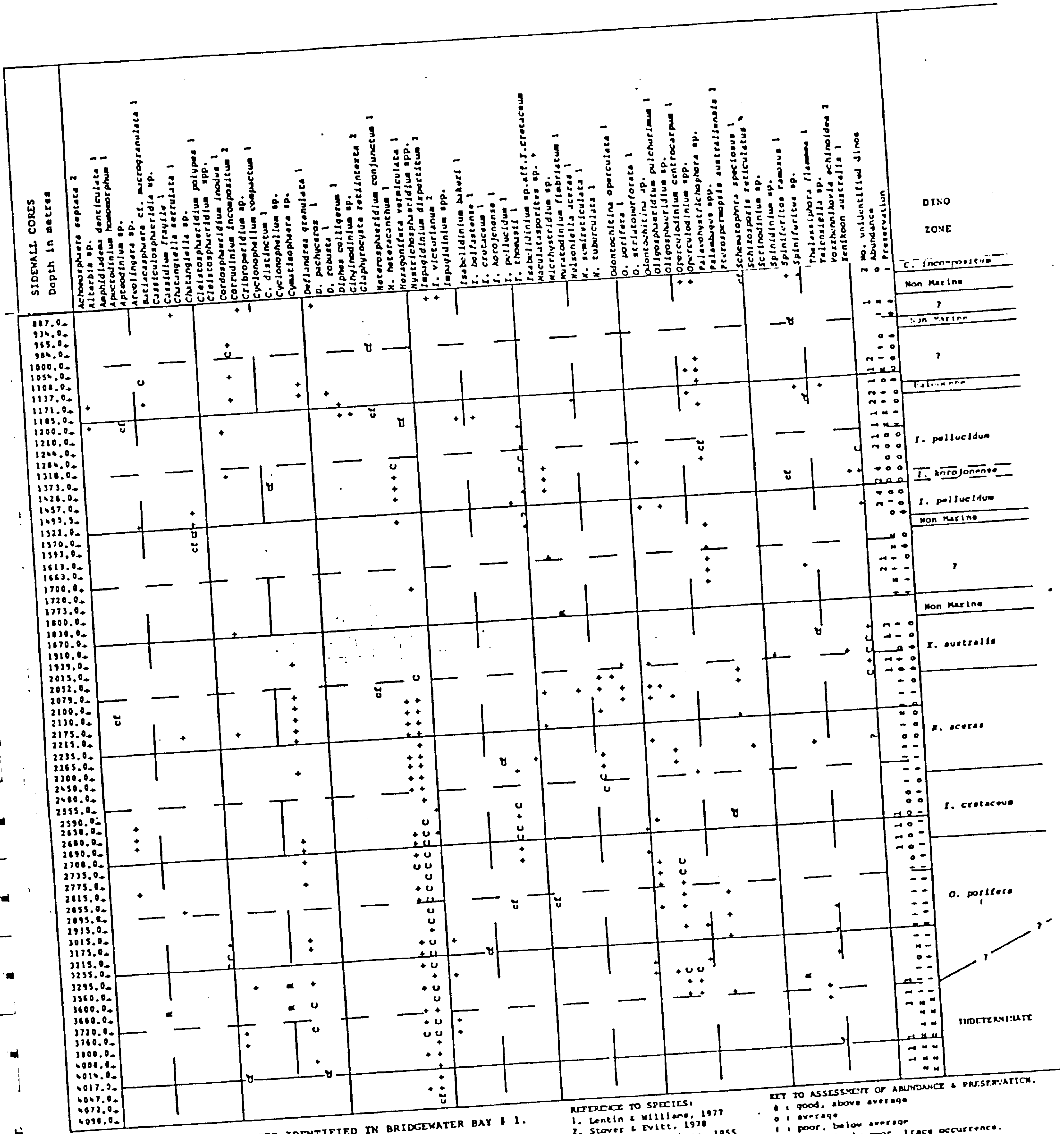
Key to assessment of abundance & preservation:
- ● : good, above average
- ● : average
- ● : poor, below average
- x : exceedingly poor, trace occurrence

Other Symbols:
- * Early Cretaceous species
- + Permian species
- R Reworked
- cf Probable identification, specimens usually poorly preserved

BARREN SAMPLES:
Depth (m)
4102
4105
4109
4125
4156
4165

TABLE 1: SPORES and POLLEN IDENTIFIED IN BRIDGEWATER BAY # 1.

Helene A Martin, February 1984.



REFERENCE TO SPECIES:
1. Lentin & Williams, 1977
2. Stover & Evitt, 1978
3. Deflandre & Cookson, 1955
4. Dettmann, 1963.

KEY TO ASSESSMENT OF ABUNDANCE & PRESERVATION.
0 : good, above average
o : average
1 : poor, below average
x : exceedingly poor, trace occurrence.

OTHER SYMBOLS:
+ : Permian species
R : Probable Reworking
cf : Probable identification, specimens usually poorly preserved
C : Relatively common

TABLE 2: DINOFLAGELLATES IDENTIFIED IN BRIDGEWATER BAY # 1.

Helene A Martin, February 1984.

APPENDIX NO. 7

BASIC HYDROCARBON SOURCE ROCK POTENTIAL

ANALYSIS OF BRIDGEWATER BAY No. 1

SIDEWALL CORE SAMPLES*

PETROLEUM GEOCHEMISTRY

HYDROCARBON SOURCE ROCK

EVALUATION STUDY

BRIDGEWATER BAY NO. 1

Prepared for

PHILLIPS AUSTRALIAN OIL COMPANY

MARCH, 1984.

ANALABS
A Division of Macdonald Hamilton & Co. Pty. Ltd.
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Telephone (09) 458 7999 Telex: ANALAB AA92560

HYDROCARBON SOURCE ROCK

EVALUATION STUDY

BRIDGEWATER BAY NO. 1

SUMMARY

Organic geochemical analyses performed on well cutting samples between 1130m to 4200m in the Phillips Australian Oil Company, Bridgewater Bay No. 1 well drilled in Vic-P-14 offshore Victoria, Australia in the Otway Basin have indicated:

- The rocks from 2800m to 3200m are marginally mature and considered to be in the initial stages of petroleum generation. Reliable maturity data is unavailable for the remaining intervals penetrated by this well, however, we suspect that the maturity at the bottom of the well does not exceed oil generating maturation levels.

- The rocks between 2700m to 3550m have an overall poor oil and gas source character with marginal to moderate hydrocarbon source potential at 2700m, 2945m and 3050m.

- The rocks below 3550m are contaminated with an oil base mud additive, which has affected the total organic carbon and pyrolysis results. The C_1-C_7 light hydrocarbon results appear to be unaffected, however the values are low and indicate these rocks have poor oil and gas generating capabilities.

Paul Tybor

PAUL TYBOR

INTRODUCTION

Organic geochemical analyses have been performed on well cutting samples between 1130m to 4200m in the Phillips Australian Oil Company's Bridgewater Bay No. 1 well, drilled in Vic-P-14 offshore Victoria, Australia in the Otway Basin (38° 32'26"S; 141° 21'48"E).

The purpose of this study has been to evaluate the hydrocarbon source quality (oil vs gas), richness and state of thermal maturity (pre oil, oil-generative, post oil-generative) of the rocks analysed from this well.

Analytical

The samples from this well were assigned the Analabs Job Number 31840. A total of two hundred and seventy-seven (277) wet canned well cuttings were submitted to C_1-C_7 light hydrocarbon head space gas chromatography. Another thirty-one (31) samples, which were picked and high graded by Phillips personnel, were analysed by % total organic carbon and Rock-Eval pyrolysis analysis. Four (4) samples were chosen for vitrinite reflectance, and these were sent to David Marchioni and Associates for assessment.

The results of these analyses are presented in the following:

Type of Analysis	Figure	Table
C_1-C_7 light hydrocarbon head space gas chromatography	1	1
% total organic carbon determination	2	2
Pyrolysis analysis	2	2
Vitrinite reflectance and coal maceral description	1,2,3	

A description of the various analyses performed on these samples is provided in the Theory and Methods section, located at the rear of this report.

General Information

Copies of this report have been sent to Mr. Dave Murray of the Phillips Australian Oil Company in Perth, Western Australia. Any questions regarding the data or interpretations given herein may be directed to either Mr. Paul Tybor or Dr. Garry Woodhouse of Analabs, Perth, Western Australia.

All of the contents contained in this study are considered proprietary to the Phillips Australian Oil Company, and are treated as highly confidential material by all Analabs personnel.

RESULTS AND INTERPRETATIONS

A. Thermal Maturity of Sediments

The maturity data available for samples from this well are limited due to apparent poor quality organic matter, within the sediments, and contamination added to the drilling mud.

Vitrinite reflectance was performed on four samples at 2800m, 3200m, 3600m and 4200m, with only the two samples at 2800m and 3200m containing measurable vitrinite. Both samples gave marginally mature reflectances (0.55 % Ro and 0.53 % Ro; Figures 1, 2 and 3), which places these rocks in the initial stages of petroleum generation.

Tmax pyrolysis temperatures were obtained from thirty-one (31) picked cuttings samples. The temperatures in the contaminated zone below 3600m are interpreted to be unreliable due to this contamination. In the overlying uncontaminated section the temperatures vary greatly, without any recognisable maturity trend present. The pyrograms illustrate very erratic S_2 peaks, the peak at which Tmax is recorded, which we interpret to be due to the poor quality organic matter present in these samples (ie. reworked, inertinite).

In summary, the sedimentary section penetrated by this well, has probably experienced a low degree of thermal maturation, based on the marginally mature % Ro values obtained at 2800m and 3200m. Below these depths we can only speculate on the maturity of the rocks, however, we feel that the sediments do not obtain levels much higher than marginally/ moderately mature, and would be within the top to middle portions of the oil window.

B. Hydrocarbon Source Characterisation

Due to the drilling mud contamination present in the samples below 3600m, it is difficult to determine the hydrocarbon source rock character of these sediments. However, the C_1-C_7 light hydrocarbon headspace gas chromatography data does not appear to have affected, as has the % T.O.C. and pyrolysis data. This gas data is low (Figure 1; Table 1), and consequently we interpret these sediments have poor hydrocarbon source rock characteristics.

The samples in the uncontaminated section contain good amounts of organic matter (>1.0% T.O.C.; Figures 1 and 2; Table 2), but the quality appears to be low due to the overall low hydrogen index values observed (Figure 2; Table 2). As a result, the potential yields are low (S_1+S_2; Figure 2; Table 2), which gives these sediments an overall poor hydrocarbon source character. The samples at 2700m, 2945m and 3050m, have moderate hydrogen index values, with marginal to moderate potential yields.

In summation, the sediments between 2700m to 3600m have overall poor oil and gas source potential, with thin zones at 2700m, 2945m and 3050m having marginal to moderate oil and gas potential at higher levels of thermal maturity.

PE902247

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at this location in this document.

The enclosure PE902247 has the following characteristics:

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CONTAINER_BARCODE	= PE900161
NAME	= Bridgewater Bay 1 Figure 1 (Appendix 7) ANA-LOG Hydrocarbon Source Rock Evaluation C1-C7 Light Hydrocarbon
BASIN	= OTWAY
TYPE	= WELL
SUBTYPE	= LOG
DESCRIPTION	= Bridgewater Bay 1 Figure 1 (Appendix 7) ANA-LOG Hydrocarbon Source Rock Evaluation C1-C7 Light Hydrocarbon
W_NO	= W831
WELL_NAME	= BRIDGEWATER BAY-1
CLIENT_OP_CO	= PHILLIPS AUSTRALIAN OIL COMPANY

FIGURE 1

FEBRUARY 1984

ANA-LOG

HYDROCARBON SOURCE ROCK EVALUATION

PHILLIPS AUSTRALIAN OIL COMPANY

BRIDGEWATER BAY #1

LIME
DOLOMITE
CLAY
SILT
SAND
COAL
IGNEOUS
META
EVAPORITE

IN METRES ■
IN FEET □

SAMPLE TYPE
■ CUTTINGS
□ CONV. CORE
□ SWC

SAMPLE QUALITY
□ POOR
□ FAIR
■ GOOD

C1 - C7 LIGHT HYDROCARBON

C1 - DRY GAS
C2 - C4 - WET GAS +
C1 - C4 - TOTAL GAS ×
C5 - C7 - CONDENSATE

% GAS WETNESS

$$\frac{C2 - C4}{C1 - C4} \times 100$$

iC4 - ISOBUTANE

nC4 - NORMAL BUTANE

PRE OIL WINDOW

OIL WINDOW

WET GAS/COND

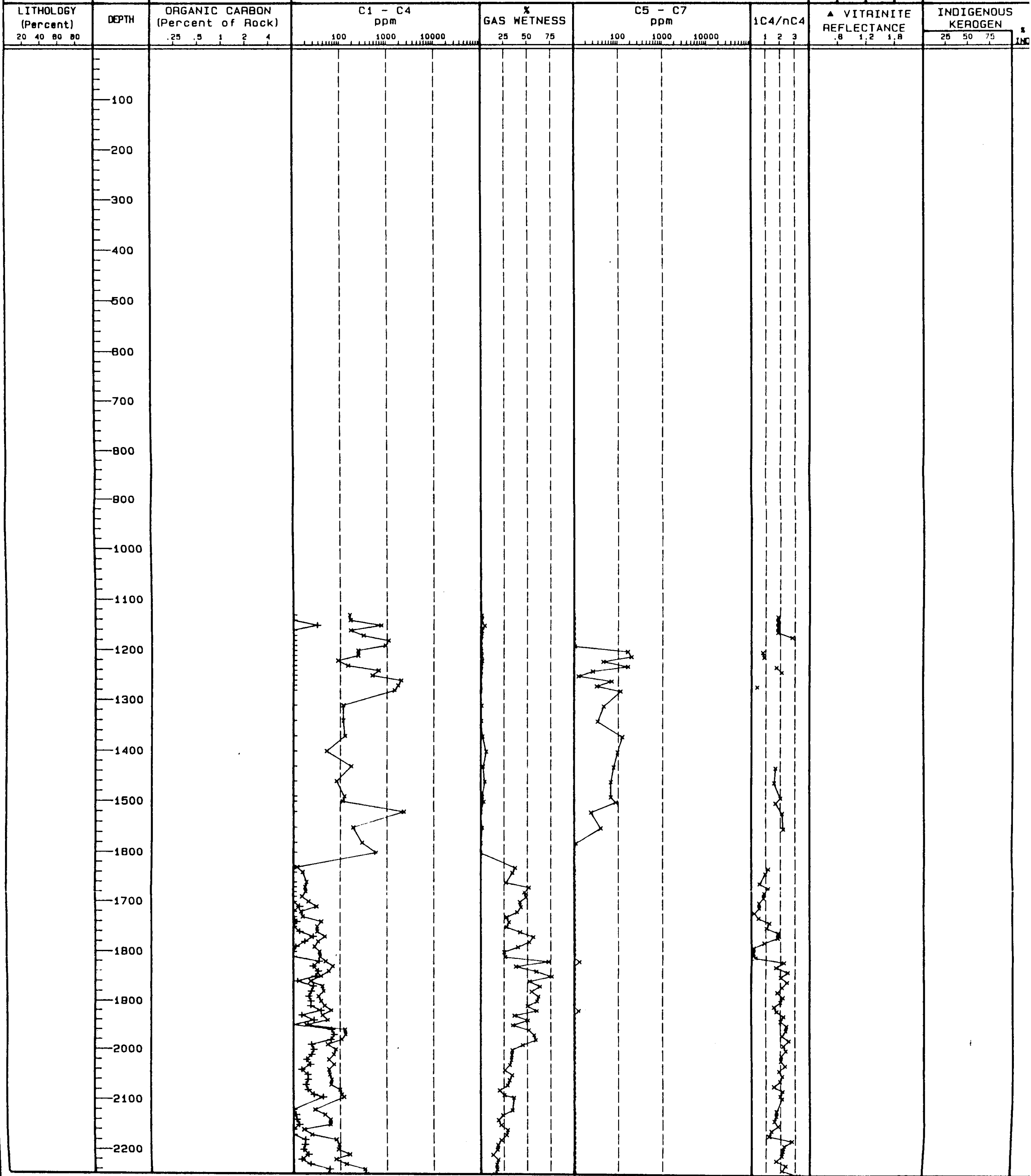
THERMAL C_1

INDIGENOUS KEROGEN

□ ALGINITE
EXINITE
VITRINITE
■ INERTINITE

OIL

GAS



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PE902246

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The enclosure PE902246 has the following characteristics:

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CONTAINER_BARCODE	= PE900161
NAME	= Bridgewater Bay 1 Figure 1 (Appendix 7) ANA-LOG Hydrocarbon Source Rock Evaluation C1-C7 Light Hydrocarbon
BASIN	= OTWAY
TYPE	= WELL
SUBTYPE	= LOG
DESCRIPTION	= Bridgewater Bay 1 Figure 1 (Appendix 7) ANA-LOG Hydrocarbon Source Rock Evaluation C1-C7 Light Hydrocarbon
W_NO	= W831
WELL_NAME	= BRIDGEWATER BAY-1
CLIENT_OP_CO	= PHILLIPS AUSTRALIAN OIL COMPANY

FIGURE 1

FEBRUARY 1984

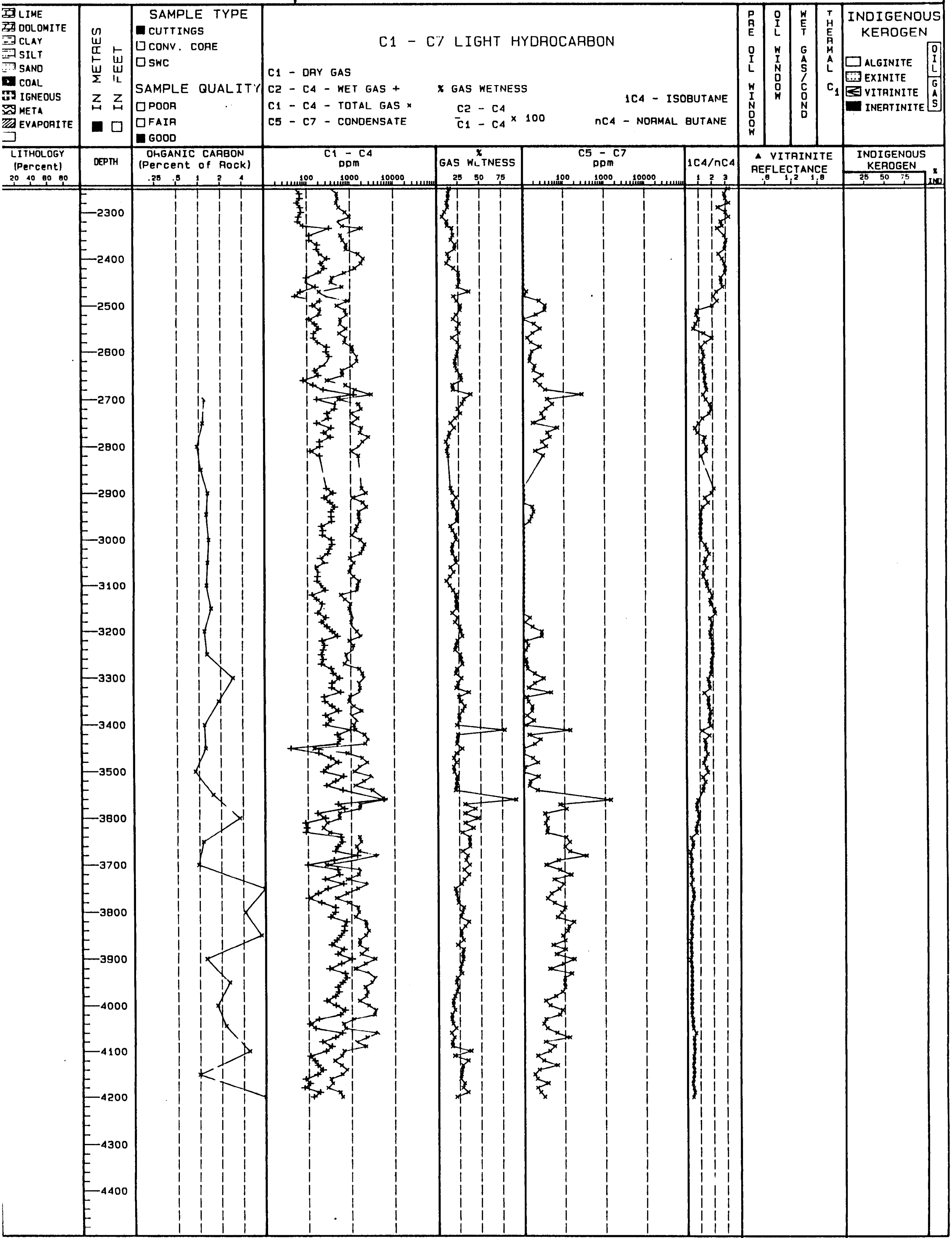
DEPT. NAT. RES & ENV
PE902246

ANA-LOG

HYDROCARBON SOURCE ROCK EVALUATION

PHILLIPS AUSTRALIAN OIL COMPANY

BRIDGEWATER BAY #1



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PE902245

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The enclosure PE902245 has the following characteristics:

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CONTAINER_BARCODE	= PE900161
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BASIN	= OTWAY
TYPE	= WELL
SUBTYPE	= LOG
DESCRIPTION	= Bridgewater Bay 1 Figure 2 (Appendix 7) ANA-LOG Hydrocarbon Source Rock Evaluation S1, S2, S3, HI, OI & PI
W_NO	= W831
WELL_NAME	= BRIDGEWATER BAY-1
CLIENT_OP_CO	= PHILLIPS AUSTRALIAN OIL COMPANY

FIGURE 2

FEBRUARY 1984

DEPT. NAT. RES & ENV
PE902245

ANA-LOG

HYDROCARBON SOURCE ROCK EVALUATION

PHILLIPS AUSTRALIAN OIL COMPANY

BRIDGEWATER BAY #1

LIME
DOLOMITE
CLAY
SILT
SAND
COAL
IGNEOUS
META
EVAPORITE

IN METRES ■ IN FEET □

SAMPLE TYPE
■ CUTTINGS
□ CONV. CORE
□ SWC

SAMPLE QUALITY
□ POOR
□ FAIR
■ GOOD

S_1 = VOLATILE HYDROCARBONS (HC) ×

S_2 = HC GENERATION POTENTIAL

$S_1 + S_2$ = TOTAL HYDROCARBON +

S_3 = ORGANIC CO_2

PI = PRODUCTION INDEX

$PI = \frac{S_1}{S_1 + S_2}$

HI = HYDROGEN INDEX

$HI = \frac{S_2}{TOC} \times 100$

OI = OXYGEN INDEX

$OI = \frac{S_3}{TOC} \times 100$

T_{max} [Max. Temp. S_2]

PRE OIL WINDOW

OIL WINDOW

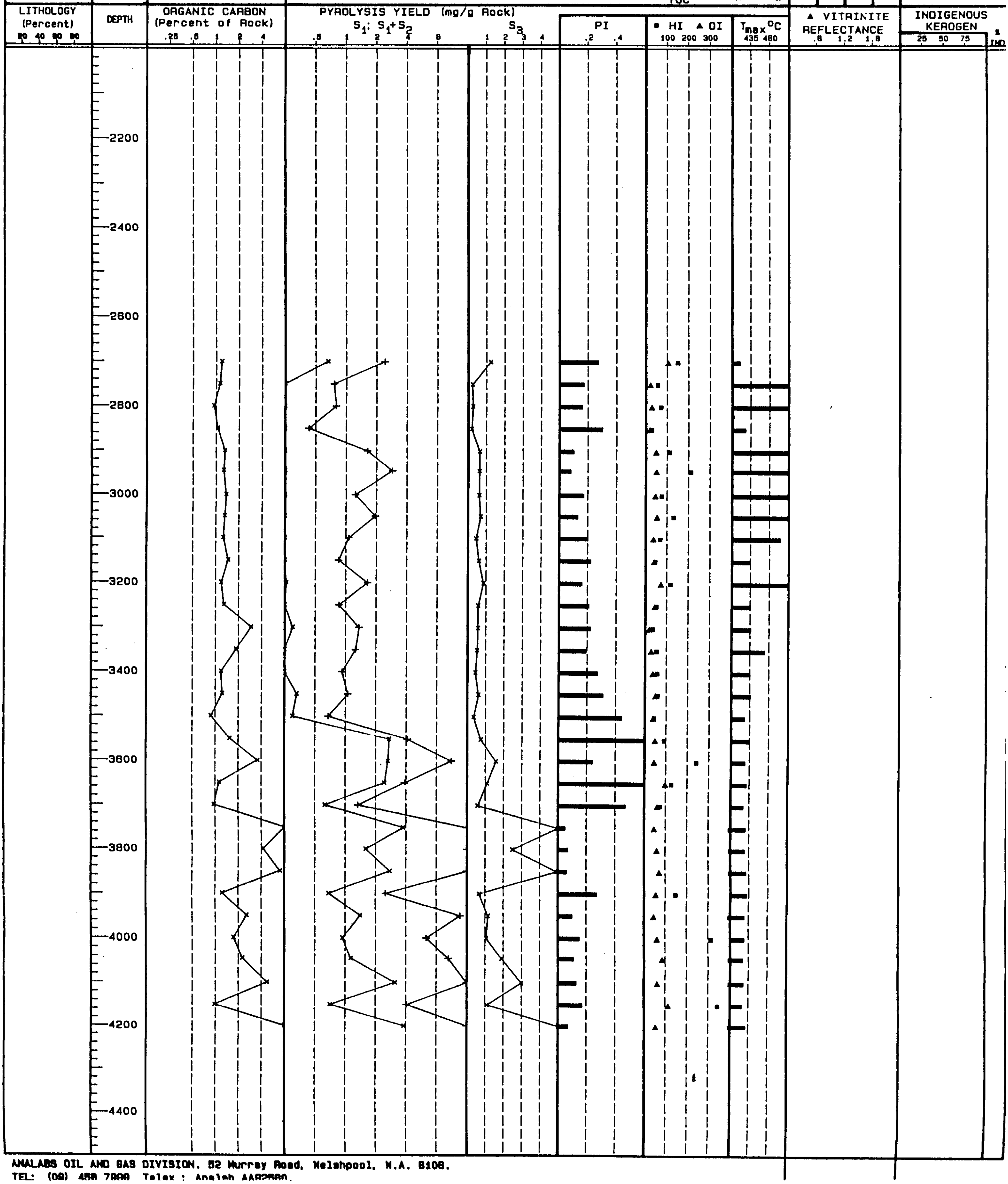
WET GAS/COND

THERMAL C_1

INDIGENOUS KEROGEN

OIL / GAS

□ ALGINITE
EXINITE
VITRINITE
■ INERTINITE



ANALABS OIL AND GAS DIVISION. 52 Murray Road, Welshpool, W.A. 6108.

TEL: (09) 458 7999 Telex : Analab AA92560.

PE902244

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at this location in this document.

The enclosure PE902244 has the following characteristics:

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CONTAINER_BARCODE	= PE900161
NAME	= Bridgewater Bay 1 Figure 3 (Appendix 7) Vitrinite Reflectance & Coal Maceral Identification
BASIN	= OTWAY
TYPE	= WELL
SUBTYPE	= DIAGRAM
DESCRIPTION	= Bridgewater Bay 1 Figure 3 (Appendix 7) Vitrinite Reflectance & Coal Maceral identification
W_NO	= W831
WELL_NAME	= BRIDGEWATER BAY-1
CLIENT_OP_CO	= PHILLIPS AUSTRALIAN OIL COMPANY

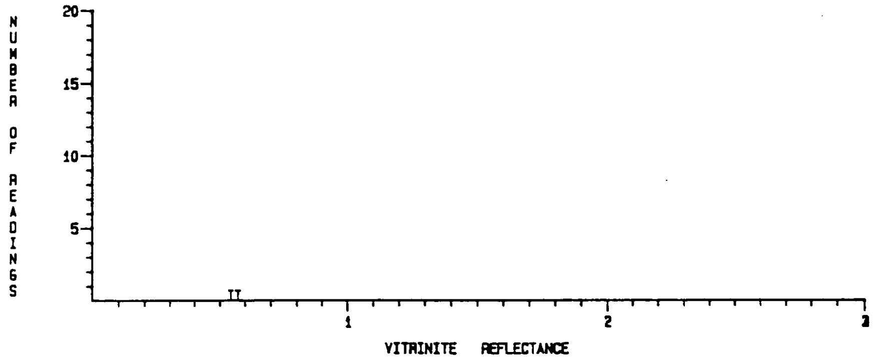
FIGURE : 3
VITRINITE REFLECTANCE AND COAL MACERAL IDENTIFICATION

CLIENT NAME : PHILLIPS AUSTRALIA DATE : MARCH 1984 WELL NAME : BRIDGEWATER BAY #1

DEPTH OR SAMPLE No : 2800 Meters SAMPLE TYPE : CUTTINGS

(Total No. of Readings = 2) 0.54 0.57

VITRINITE REFLECTANCE								MACERAL IDENTIFICATION			
POPULATION Number	POPULATION %	No. of Readings	Mean Ro (%)	Min. Ro (%)	Max. Ro (%)	STD. Dev. (%)	Comments	% Alginite	% Exinite	% Vitrinite	% Inertinite
1	100	2	0.56	0.54	0.57	0.02	INDIGENOUS (I)	0.00	60.00	25.00	15.00

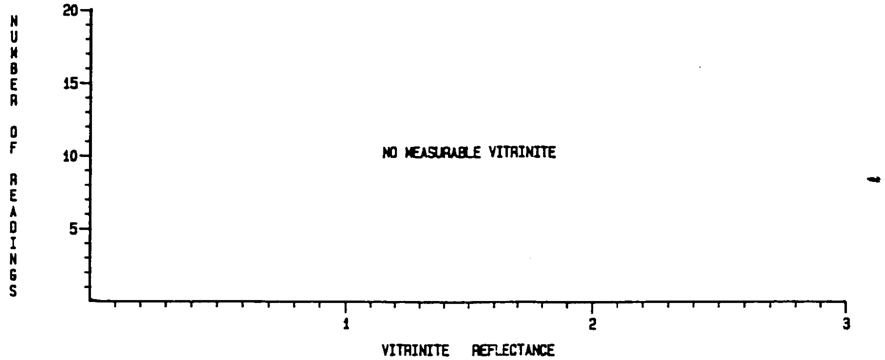


CLIENT NAME : PHILLIPS AUSTRALIA DATE : MARCH 1984 WELL NAME : BRIDGEWATER BAY #1

DEPTH OR SAMPLE No : 3600 Meters SAMPLE TYPE : CUTTINGS

(Total No. of Readings = 0)

VITRINITE REFLECTANCE								MACERAL IDENTIFICATION			
POPULATION Number	POPULATION %	No. of Readings	Mean Ro (%)	Min. Ro (%)	Max. Ro (%)	STD. Dev. (%)	Comments	% Alginite	% Exinite	% Vitrinite	% Inertinite

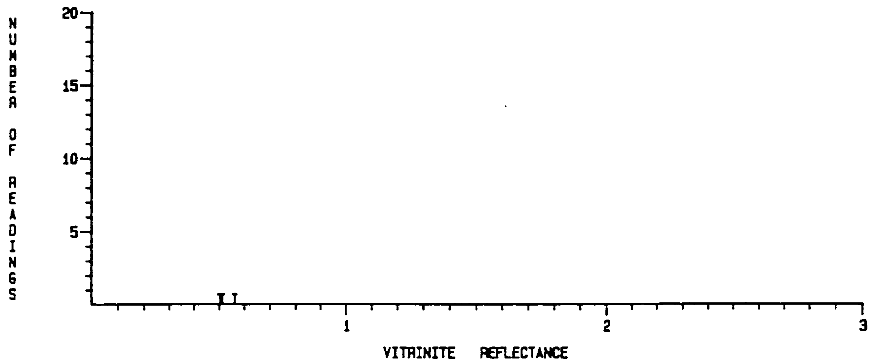


CLIENT NAME : PHILLIPS AUSTRALIA DATE : MARCH 1984 WELL NAME : BRIDGEWATER BAY #1

DEPTH OR SAMPLE No : 3200 Meters SAMPLE TYPE : CUTTINGS

(Total No. of Readings = 3) 0.50 0.51 0.56

VITRINITE REFLECTANCE								MACERAL IDENTIFICATION			
POPULATION Number	POPULATION %	No. of Readings	Mean Ro (%)	Min. Ro (%)	Max. Ro (%)	STD. Dev. (%)	Comments	% Alginite	% Exinite	% Vitrinite	% Inertinite
1	100	3	0.52	0.50	0.56	0.03	INDIGENOUS (I)	0.00	11.00	4.00	85.00



CLIENT NAME : PHILLIPS AUSTRALIA DATE : MARCH 1984 WELL NAME : BRIDGEWATER BAY #1

DEPTH OR SAMPLE No : 4200 Meters SAMPLE TYPE : CUTTINGS

(Total No. of Readings = 0)

VITRINITE REFLECTANCE								MACERAL IDENTIFICATION			
POPULATION Number	POPULATION %	No. of Readings	Mean Ro (%)	Min. Ro (%)	Max. Ro (%)	STD. Dev. (%)	Comments	% Alginite	% Exinite	% Vitrinite	% Inertinite

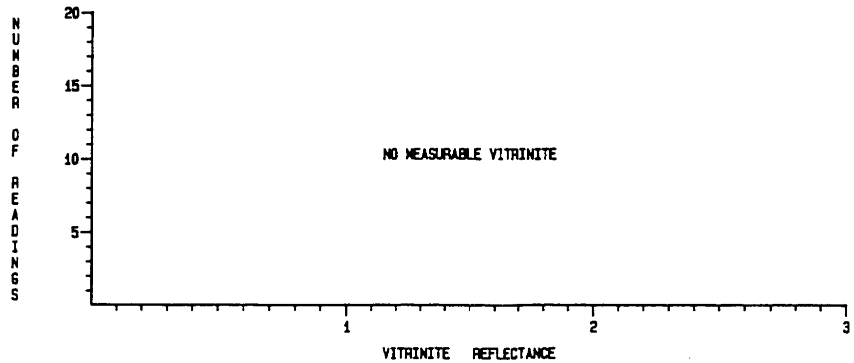


TABLE 1

WELLNAME = BRIDGEWATER BAY #1 DATE OF JOB = JANUARY 1984

HEADSPACE ANALYSIS DATA

DEPTH(m)	METHANE	ETHANE	PROPANE	ISOBUTANE	BUTANE	C1-C4	C2-C4	%WETNESS	C5-C7	i-C4/n-C4
1130.0	157.7	0.9	0.5	0.5	0.3	159.8	2.1	1.3	<0.1	1.83
1140.0	162.0	0.5	0.2	0.4	0.2	163.4	1.4	.9	<0.1	1.83
1150.0	721.1	14.3	8.8	6.1	3.3	753.6	32.5	4.3	<0.1	1.83
1160.0	164.3	1.4	0.7	0.4	0.2	167.0	2.7	1.6	<0.1	1.83
1170.0	311.2	1.8	0.9	0.4	0.1	314.4	3.2	1.0	<0.1	2.80
1180.0	1072.3	1.5	0.7	0.3	<0.1	1074.8	2.6	.2	<0.1	bdl
1190.0	934.6	0.2	0.3	0.1	<0.1	935.2	0.7	.1	10.5	bdl
1200.0	237.8	0.9	0.5	0.2	0.2	239.7	1.8	.8	164.7	0.79
1210.0	240.6	1.3	0.7	0.3	0.3	243.2	2.5	1.0	199.6	0.88
1220.0	87.9	0.6	0.4	0.3	<0.1	89.3	1.5	1.7	45.7	bdl
1230.0	145.6	0.6	0.4	0.3	0.2	147.0	1.4	.9	166.4	1.73
1240.0	662.2	2.2	0.4	0.3	0.1	665.2	3.0	.4	26.5	2.09
1250.0	479.5	1.0	0.3	0.2	<0.1	481.1	1.6	.3	12.5	bdl
1260.0	2014.1	0.5	0.3	<0.1	0.2	2015.1	1.0	.0	70.8	bdl
1270.0	1723.1	0.7	0.4	0.1	0.3	1724.7	1.5	.1	32.4	0.40
1280.0	1457.5	0.5	0.4	<0.1	0.2	1458.7	1.2	.1	112.2	bdl
1310.0	115.0	1.0	0.4	<0.1	<0.1	116.4	1.4	1.2	46.9	bdl
1340.0	115.8	0.8	0.3	<0.1	<0.1	116.9	1.1	.9	34.0	bdl
1370.0	123.2	2.1	0.7	<0.1	<0.1	126.0	2.8	2.2	122.3	bdl
1400.0	47.9	2.1	0.9	<0.1	<0.1	51.0	3.1	6.0	95.7	bdl
1430.0	166.8	2.8	1.2	0.5	0.3	171.6	4.8	2.8	77.9	1.67
1460.0	79.7	2.1	0.8	0.5	0.3	83.4	3.7	4.5	67.5	1.57
1490.0	120.5	1.3	0.6	0.3	0.1	122.8	2.3	1.9	67.4	2.00
1500.0	108.9	2.2	0.9	0.4	0.2	112.6	3.7	3.3	87.4	1.67
1520.0	2315.8	3.9	1.5	0.8	0.4	2322.4	6.6	.3	24.0	2.12
1550.0	183.6	2.1	0.9	0.3	0.1	187.0	3.4	1.8	39.9	2.20
1580.0	290.4	0.9	0.4	0.2	<0.1	292.0	1.5	.5	10.9	bdl
1600.0	586.4	1.1	0.3	<0.1	<0.1	587.8	1.4	.2	3.1	bdl
1630.0	7.6	1.8	1.4	0.7	0.6	12.0	4.4	36.9	0.4	1.16
1640.0	10.4	1.8	1.7	0.9	1.0	15.8	5.4	33.9	0.5	0.96
1660.0	14.0	1.7	1.4	0.7	1.3	19.2	5.1	26.8	3.9	0.57
1670.0	8.7	2.8	3.5	1.6	1.4	17.9	9.3	51.6	2.9	1.16
1680.0	9.8	2.9	2.9	1.3	1.5	18.5	8.6	46.7	4.3	0.86
1690.0	7.9	2.4	2.5	1.2	1.4	15.4	7.4	48.5	4.3	0.84
1700.0	12.3	2.5	2.8	1.2	2.3	21.1	6.8	41.8	3.8	0.53
1710.0	17.9	4.2	4.3	1.8	3.3	31.5	13.6	43.1	9.7	0.55
1720.0	6.9	1.5	1.4	0.5	2.3	14.6	5.7	39.0	4.1	0.22
1730.0	11.4	1.5	1.3	0.5	1.0	15.8	4.4	27.7	1.7	0.51
1740.0	27.7	5.0	4.2	1.5	1.2	39.7	12.0	30.2	4.0	1.24
1750.0	23.4	4.4	2.1	1.2	1.2	32.3	8.9	27.6	5.2	1.05
1760.0	18.8	6.3	5.1	1.5	0.8	32.4	13.7	42.1	0.7	1.84
1770.0	20.7	9.7	11.0	3.9	2.2	47.4	26.8	56.4	5.4	1.81
1780.0	16.3	5.5	6.6	2.6	2.8	33.8	17.5	51.8	3.9	0.90
1790.0	17.1	2.9	2.2	0.8	5.4	28.4	11.3	39.8	6.2	0.15
1800.0	27.5	3.2	1.8	0.5	3.6	36.6	9.1	24.9	7.0	0.15
1810.0	27.9	3.6	2.2	0.9	3.1	37.7	9.8	25.9	7.3	0.27
1820.0	13.5	15.7	14.5	4.0	1.8	49.4	35.9	72.6	13.1	2.23
1830.0	43.7	11.9	9.9	2.9	1.7	70.1	26.4	37.6	6.9	1.[illegible]9

N.B. 1. GAS CONCENTRATIONS EXPRESSED IN PPM (VOL. GAS/VOL. SEDIMENT)
2. bdl = BELOW DETECTION LIMIT

TABLE 1 (cont)

WELLNAME = BRIDGEWATER BAY #1 DATE OF JOB = JANUARY 1984

HEADSPACE ANALYSIS DATA

DEPTH(m)	METHANE	ETHANE	PROPANE	ISOBUTANE	BUTANE	C1-C4	C2-C4	%WETNESS	C5-C7	i-C4/n-C4
1840.0	23.3	16.6	13.2	3.2	1.3	57.6	34.3	59.6	1.0	2.50
1850.0	9.3	15.4	10.9	2.4	1.2	39.1	29.8	76.2	1.4	2.02
1860.0	11.2	6.4	4.3	1.0	0.4	23.3	12.2	52.1	0.2	2.45
1870.0	15.4	13.0	9.8	2.8	1.3	42.2	26.9	63.6	2.4	2.10
1880.0	20.3	10.9	8.6	3.1	1.7	44.6	24.3	54.5	4.8	1.79
1890.0	13.1	10.1	7.3	2.6	1.2	34.5	21.4	61.9	1.8	2.16
1900.0	15.6	10.8	7.5	3.7	1.8	39.3	23.8	60.4	2.9	2.00
1910.0	23.5	10.0	7.8	3.6	2.3	47.1	23.6	50.1	6.7	1.57
1920.0	26.0	16.6	13.2	6.0	3.5	65.3	39.3	60.2	12.7	1.74
1930.0	26.8	7.3	4.6	2.2	1.0	41.9	15.1	36.0	3.0	2.21
1940.0	27.1	12.8	9.2	3.8	1.9	54.8	27.7	50.6	3.5	2.01
1950.0	12.5	3.9	1.8	0.6	0.2	18.9	6.5	34.2	0.4	2.42
1960.0	62.3	36.1	20.7	6.5	2.8	128.4	66.1	51.5	3.2	2.36
1970.0	56.6	41.5	22.9	7.5	3.6	132.1	75.4	57.1	5.5	2.10
1980.0	44.5	46.6	12.3	3.7	1.4	108.6	64.1	59.0	1.4	2.57
1990.0	29.8	12.9	7.5	2.7	1.2	54.2	24.3	44.9	1.5	2.20
2000.0	53.9	16.7	7.2	2.4	1.0	81.3	27.4	33.7	3.0	2.36
2010.0	49.1	14.1	6.6	2.6	1.3	73.6	24.5	33.3	5.0	2.05
2020.0	38.9	10.2	5.6	2.2	1.1	57.9	19.0	32.8	2.8	2.02
2030.0	51.4	12.4	6.8	2.8	1.2	74.6	23.2	31.1	3.0	2.31
2040.0	42.9	7.8	4.1	2.1	1.1	57.9	15.0	25.9	4.5	1.90
2050.0	40.0	10.1	6.4	2.6	1.3	60.4	20.4	33.7	3.0	2.11
2060.0	45.9	10.6	6.1	2.6	1.3	66.5	20.6	31.0	2.4	1.96
2070.0	45.7	9.2	5.3	2.3	1.5	64.1	18.5	28.8	1.6	1.54
2080.0	80.0	11.5	5.7	2.3	1.1	100.5	20.5	20.4	2.8	2.14
2090.0	81.9	15.5	7.9	2.8	1.4	109.5	27.6	25.3	3.2	1.97
2095.0	78.0	19.9	14.4	6.2	2.9	121.4	43.4	35.7	4.9	2.10
2120.0	18.9	4.4	2.9	1.6	0.9	28.7	9.8	34.1	3.4	1.72
2130.0	36.4	4.8	3.3	2.0	1.2	47.7	11.4	23.8	3.6	1.70
2140.0	50.0	5.3	3.2	2.0	1.3	61.8	11.8	19.1	3.4	1.57
2150.0	48.5	6.5	3.7	2.2	1.2	62.0	13.5	21.8	3.3	1.82
2160.0	11.9	2.5	1.4	0.6	0.4	16.8	4.9	29.0	5.0	1.36
2170.0	17.9	3.6	1.9	0.7	0.6	24.8	6.9	27.7	7.1	1.20
2180.0	64.3	7.5	5.4	3.7	1.4	82.3	18.0	21.9	2.6	2.76
2190.0	77.6	9.1	5.4	2.1	0.9	95.2	17.6	18.4	1.3	2.23
2200.0	75.1	8.6	4.9	2.0	0.9	91.4	16.3	17.9	1.5	2.15
2210.0	139.2	11.8	6.0	2.3	1.1	160.3	21.1	13.2	2.0	2.07
2220.0	65.3	7.2	4.4	2.1	1.3	80.2	14.9	18.6	2.1	1.68
2230.0	111.7	14.0	6.1	2.2	0.9	134.9	23.2	17.2	2.4	2.34
2240.0	279.3	36.5	15.8	4.7	2.3	338.6	59.3	17.5	4.2	2.09
2250.0	309.6	38.3	13.0	3.0	0.9	364.9	55.3	15.1	1.3	3.20
2260.0	427.1	45.7	17.3	3.5	1.2	494.9	67.8	13.7	2.0	2.90
2270.0	443.1	46.3	18.4	3.6	1.2	512.7	69.6	13.6	2.1	2.96
2280.0	423.9	38.9	15.8	3.0	0.9	482.5	58.6	12.1	1.2	3.23
2290.0	476.1	48.3	17.9	3.1	1.3	546.7	70.6	12.9	1.3	2.42
2300.0	695.7	52.4	17.8	2.9	1.0	769.7	74.1	9.6	1.2	2.99
2310.0	912.5	50.2	12.2	1.9	0.6	977.4	64.9	6.6	0.7	3.22
2320.0	453.7	44.2	14.0	2.4	0.9	515.3	61.5	11.9	1.3	2.63

N.B. 1. GAS CONCENTRATIONS EXPRESSED IN PPM (VOL. GAS/VOL. SEDIMENT)
2. bdl = BELOW DETECTION LIMIT

TABLE 1 (cont)

WELLNAME = BRIDGEWATER BAY #1 DATE OF JOB = JANUARY 1984

HEADSPACE ANALYSIS DATA

DEPTH(m)	METHANE	ETHANE	PROPANE	ISOBUTANE	BUTANE	C1-C4	C2-C4	%WETNESS	C5-C7	i-C4/n-C4
2330.0	583.6	62.6	16.8	2.6	0.9	666.5	82.9	12.4	1.1	2.73
2335.0	1516.8	208.4	97.4	15.9	6.7	1845.3	328.5	17.8	5.6	2.37
2350.0	490.0	84.9	23.5	3.6	1.2	603.2	113.2	18.8	1.6	2.88
2360.0	560.1	87.3	21.8	3.3	1.1	673.6	113.5	16.8	1.6	3.02
2370.0	643.3	126.4	39.6	6.5	2.2	818.2	174.8	21.4	2.7	2.95
2380.0	637.9	111.9	42.6	9.5	3.3	805.2	167.3	20.8	3.3	2.90
2390.0	1343.0	118.8	51.9	14.8	6.0	1534.6	191.6	12.5	5.9	2.45
2400.0	1731.8	191.5	76.6	20.3	7.5	2027.7	296.0	14.6	6.3	2.71
2410.0	1575.9	126.3	56.3	16.7	5.8	1781.1	205.1	11.5	4.8	2.88
2420.0	1037.7	151.6	73.1	20.0	6.7	1289.1	251.4	19.5	5.7	2.97
2430.0	546.4	111.9	54.0	13.5	4.6	730.3	183.9	25.2	5.3	2.92
2440.0	283.8	55.4	27.6	9.6	3.7	380.1	96.3	25.3	5.4	2.62
2450.0	263.1	52.4	25.9	10.0	3.8	355.2	92.1	25.9	4.9	2.64
2460.0	490.0	86.6	45.7	18.5	6.7	647.4	157.4	24.3	8.0	2.76
2470.0	118.1	24.7	25.6	13.8	6.0	188.2	70.2	37.3	12.4	2.30
2480.0	219.4	22.6	17.3	8.2	4.0	271.6	52.2	19.2	10.8	2.05
2490.0	673.5	97.5	63.9	27.1	11.5	873.5	200.0	22.9	25.1	2.35
2500.0	353.4	55.2	45.7	22.0	11.1	487.3	133.9	27.5	35.3	1.99
2510.0	552.2	86.3	71.9	21.7	25.0	757.2	205.0	27.1	34.7	0.87
2520.0	635.3	89.5	60.6	14.8	18.7	819.0	183.6	22.4	21.3	0.79
2530.0	477.5	61.3	36.0	6.7	6.9	588.3	110.8	18.8	2.9	0.96
2540.0	427.9	63.4	53.7	13.7	18.6	577.3	149.4	25.9	18.8	0.74
2550.0	610.9	77.6	65.9	15.0	26.6	796.0	185.1	23.3	26.5	0.56
2560.0	413.8	58.9	51.7	18.3	13.8	556.6	142.8	25.7	17.5	1.33
2570.0	649.7	62.9	49.2	18.4	9.4	789.7	139.9	17.7	12.8	1.96
2580.0	554.6	73.7	64.1	21.6	14.9	728.9	174.3	23.9	15.7	1.45
2590.0	801.9	117.3	107.7	32.5	29.0	1088.5	286.6	26.3	26.4	1.12
2600.0	868.6	120.8	96.7	29.9	23.8	1139.7	271.1	23.8	16.7	1.26
2610.0	1097.1	159.6	108.3	31.3	23.4	1419.7	322.6	22.7	15.2	1.34
2620.0	1122.0	152.8	95.1	25.8	21.5	1417.2	295.2	20.8	14.7	1.20
2630.0	837.0	101.3	78.0	26.1	20.0	1062.3	225.3	21.2	19.6	1.31
2640.0	492.1	74.6	39.0	18.8	14.3	638.9	146.8	23.0	18.3	1.31
2650.0	476.3	68.1	67.5	26.6	18.9	657.5	181.2	27.6	30.0	1.41
2660.0	203.6	27.0	30.6	13.3	9.6	284.1	80.5	28.3	19.9	1.38
2670.0	627.7	57.8	47.0	19.2	13.1	764.8	137.1	17.9	26.6	1.46
2680.0	1042.5	103.3	81.3	31.4	20.4	1278.9	236.4	18.5	35.2	1.54
2690.0	1842.1	382.5	469.0	191.0	148.9	3033.4	1191.3	39.3	279.6	1.28
2700.0	362.6	56.6	63.2	27.4	18.7	528.5	165.9	31.4	38.8	1.47
2710.0	1090.4	174.8	169.7	64.7	36.5	1536.2	445.8	29.0	52.9	1.77
2720.0	1339.7	195.6	149.2	53.0	28.3	1765.9	426.2	24.1	36.6	1.87
2730.0	759.1	126.8	100.0	36.7	21.3	1043.9	284.8	27.3	28.2	1.73
2740.0	1162.7	138.2	107.9	35.0	28.5	1472.3	309.6	21.0	32.7	1.23
2750.0	892.7	80.7	51.2	16.2	17.2	1058.0	165.3	15.6	17.4	0.94
2760.0	1437.9	149.6	118.6	35.9	53.6	1795.5	357.7	19.9	69.8	0.67
2770.0	1399.0	112.6	69.2	25.6	30.4	1636.8	237.8	14.5	39.5	0.84
2780.0	2239.1	177.5	103.9	36.0	25.5	2582.0	342.9	13.3	45.8	1.41
2790.0	1697.1	94.1	59.0	21.0	16.2	1887.3	190.2	10.1	29.1	1.30
2800.0	1349.2	87.2	64.8	25.7	17.1	1544.1	194.9	12.6	37.2	1.50

N.B. 1. GAS CONCENTRATIONS EXPRESSED IN PPM (VOL. GAS/VOL. SEDIMENT)
2. bdl = BELOW DETECTION LIMIT

TABLE 1 (cont)

WELLNAME = BRIDGEWATER BAY #1 DATE OF JOB = JANUARY 1984

HEADSPACE ANALYSIS DATA

DEPTH(m)	METHANE	ETHANE	PROPANE	ISOBUTANE	BUTANE	C1-C4	C2-C4	%WETNESS	C5-C7	i-C4/n-C4
2810.0	913.6	56.3	37.0	13.3	8.9	1029.1	115.4	11.2	19.6	1.50
2820.0	1314.2	87.9	62.8	20.9	18.7	1504.5	190.3	12.6	31.2	1.12
2890.0	1510.8	165.3	78.3	20.6	10.0	1785.0	274.2	15.4	6.1	2.07
2900.0	1852.2	231.8	113.5	28.4	14.9	2240.8	388.6	17.3	9.6	1.90
2910.0	875.6	127.5	77.7	21.5	15.4	1117.7	242.1	21.7	10.2	1.39
2920.0	1556.7	187.6	101.5	25.8	15.7	1887.3	330.6	17.5	10.0	1.64
2930.0	1856.5	234.5	132.3	32.2	26.1	2281.5	425.0	18.6	16.6	1.23
2940.0	1170.8	179.9	114.0	28.3	26.3	1519.3	348.5	22.9	17.9	1.08
2950.0	1168.3	191.1	116.8	21.2	20.1	1517.5	349.2	23.0	15.9	1.05
2960.0	1254.0	211.0	118.7	17.3	15.7	1616.7	362.7	22.4	14.2	1.10
2970.0	1183.6	129.6	62.7	8.7	8.2	1392.7	209.1	15.0	9.3	1.06
2980.0	1069.5	135.8	71.8	9.2	8.8	1295.2	225.7	17.4	7.4	1.05
2990.0	832.0	126.8	70.2	11.0	10.6	1050.6	218.6	20.8	8.0	1.03
3000.0	1296.2	214.4	110.9	16.7	15.6	1653.8	357.6	21.6	9.0	1.07
3010.0	1709.8	232.9	106.5	18.4	13.4	2081.0	371.2	17.8	7.0	1.38
3020.0	1574.7	191.9	93.9	20.3	13.5	1894.3	319.6	16.9	7.4	1.51
3030.0	1392.1	174.9	86.0	20.3	12.1	1685.4	293.3	17.4	7.9	1.68
3040.0	750.9	110.1	61.7	14.2	10.1	947.0	196.1	20.7	7.1	1.41
3050.0	919.1	143.5	78.5	16.8	12.6	1170.5	251.4	21.5	6.9	1.33
3060.0	847.7	90.6	43.1	9.7	6.5	997.6	149.9	15.0	3.3	1.51
3070.0	749.6	95.0	53.8	13.7	10.9	923.0	173.3	18.8	7.5	1.25
3080.0	987.6	101.0	48.2	10.8	8.5	1156.1	168.5	14.6	7.5	1.26
3090.0	1393.4	107.5	39.9	10.0	6.7	1557.5	164.1	10.5	5.2	1.50
3100.0	1222.9	116.9	59.1	16.8	10.9	1426.6	203.6	14.3	6.5	1.54
3110.0	1146.4	138.4	78.7	24.4	14.3	1402.2	255.8	18.2	9.2	1.71
3120.0	461.2	53.3	47.0	17.3	9.0	587.8	126.7	21.5	5.5	1.92
3130.0	568.3	74.9	55.3	19.2	10.9	728.6	160.3	22.0	7.3	1.77
3140.0	766.9	98.8	77.1	26.6	14.6	984.0	217.1	22.1	8.7	1.82
3150.0	707.9	92.2	71.9	26.0	12.4	910.4	202.5	22.2	9.2	2.09
3160.0	815.1	83.3	56.8	21.2	9.8	986.2	171.1	17.3	7.6	2.16
3170.0	868.0	110.3	98.4	35.7	20.5	1132.9	264.9	23.4	14.6	1.74
3180.0	801.9	85.4	76.5	28.5	15.1	1007.4	205.6	20.4	11.0	1.89
3190.0	813.8	109.9	105.4	41.9	22.6	1093.5	279.8	25.6	16.7	1.85
3200.0	998.9	126.5	150.3	60.5	34.8	1370.9	372.0	27.1	28.4	1.74
3210.0	1211.5	193.7	190.5	69.1	38.7	1703.6	492.0	28.9	28.4	1.78
3220.0	709.4	95.6	76.0	28.1	14.7	923.8	214.4	23.2	11.7	1.91
3230.0	897.9	112.9	86.4	31.6	16.4	1145.1	247.2	21.6	13.1	1.93
3240.0	887.0	111.0	76.2	27.2	14.1	1115.6	228.6	20.5	11.5	1.93
3250.0	577.4	94.2	74.1	26.2	13.3	785.1	207.7	26.5	9.5	1.97
3260.0	607.2	101.4	83.8	29.6	15.8	837.8	230.6	27.5	11.6	1.87
3270.0	507.0	86.6	75.9	29.2	15.7	714.4	207.3	29.0	12.1	1.85
3280.0	1211.4	167.3	124.0	40.4	21.5	1564.5	353.2	22.6	12.7	1.87
3290.0	1440.3	176.1	139.4	48.1	26.7	1830.7	390.4	21.3	19.0	1.80
3300.0	1435.2	219.3	212.7	73.9	45.9	1986.9	551.7	27.8	31.8	1.61
3310.0	1150.9	143.2	145.0	48.5	28.8	1516.4	365.5	24.1	19.0	1.69
3320.0	1266.4	150.5	138.4	42.2	24.2	1621.7	355.3	21.9	13.4	1.74
3330.0	1008.6	167.2	251.7	92.5	70.2	1590.2	581.6	36.6	48.0	1.32
3340.0	720.8	91.1	95.4	32.2	19.7	959.0	238.3	24.8	12.0	1.63

N.B. 1. GAS CONCENTRATIONS EXPRESSED IN PPM (VOL. GAS/VOL. SEDIMENT)
2. bdl = BELOW DETECTION LIMIT

TABLE 1 (cont)

WELLNAME = BRIDGEWATER BAY #1 DATE OF JOB = JANUARY 1984

HEADSPACE ANALYSIS DATA

DEPTH(m)	METHANE	ETHANE	PROPANE	ISOBUTANE	BUTANE	C1-C4	C2-C4	%WETNESS	C5-C7	i-C4/n-C4
3350.0	654.8	88.0	103.1	35.3	21.8	902.9	248.2	27.5	13.2	1.62
3360.0	792.7	139.3	152.2	46.5	27.8	1158.4	365.7	31.6	16.5	1.67
3370.0	1265.4	229.5	205.2	53.6	30.1	1783.7	518.3	29.1	16.3	1.78
3380.0	768.4	110.4	99.2	29.9	17.1	1024.9	256.6	25.0	12.3	1.74
3390.0	1012.6	135.4	141.0	43.0	25.5	1357.5	344.9	25.4	18.3	1.69
3400.0	908.1	115.3	100.2	29.9	16.6	1170.1	262.0	22.4	11.3	1.80
3410.0	275.5	151.1	472.3	191.6	164.7	1255.3	979.8	78.1	142.0	1.16
3420.0	1563.1	264.2	168.4	31.0	18.1	2044.7	481.6	23.6	13.8	1.71
3430.0	1897.9	285.7	202.2	47.9	34.8	2468.6	570.7	23.1	26.4	1.37
3440.0	1655.6	240.5	172.0	38.9	26.9	2133.9	478.3	22.4	19.0	1.45
3450.0	100.0	18.6	15.6	3.6	2.6	140.4	40.4	28.8	1.8	1.42
3460.0	644.9	80.7	69.1	17.5	11.1	823.3	178.4	21.7	7.3	1.58
3470.0	1467.8	163.5	124.6	29.9	21.4	1807.2	339.4	18.8	16.9	1.40
3480.0	1852.8	250.5	188.2	39.4	30.9	2361.8	509.0	21.6	22.8	1.28
3490.0	1286.6	160.7	100.3	20.9	14.1	1582.6	296.0	18.7	10.9	1.48
3500.0	955.2	120.6	79.5	17.6	11.0	1183.9	228.7	19.3	7.9	1.59
3510.0	2317.0	341.1	241.9	47.6	39.1	2986.7	669.7	22.4	23.4	1.22
3520.0	1532.3	228.7	160.2	26.7	19.2	1967.1	434.8	22.1	14.5	1.39
3530.0	970.3	128.3	101.2	22.9	18.3	1241.1	270.7	21.8	13.8	1.25
3540.0	2462.8	342.2	226.0	39.7	32.7	3103.5	640.7	20.6	21.7	1.22
3560.0	571.0	5067.2	416.3	85.6	103.3	6243.4	5672.4	90.9	1368.5	0.83
3570.0	1092.4	209.1	208.4	33.9	45.9	1589.7	497.2	31.3	77.0	0.74
3580.0	899.1	217.3	333.7	62.6	83.3	1596.0	696.8	43.7	111.7	0.75
3590.0	366.1	46.6	87.2	15.2	17.3	532.4	166.3	31.2	32.5	0.88
3600.0	285.8	51.2	139.8	28.3	31.4	536.5	250.7	46.7	38.2	0.90
3610.0	188.7	21.3	47.4	8.0	10.2	275.7	87.0	31.5	33.8	0.78
3620.0	131.7	22.3	51.9	7.7	11.2	225.0	93.2	41.4	38.3	0.69
3630.0	228.2	30.4	43.8	6.2	8.6	317.2	89.0	28.1	36.8	0.72
3640.0	984.6	221.5	221.1	31.5	98.8	1557.5	572.9	36.8	108.4	0.32
3650.0	1066.6	211.6	259.5	47.9	105.3	1690.8	624.2	36.9	133.6	0.45
3660.0	823.3	175.5	196.5	34.9	81.6	1311.7	488.5	37.2	101.5	0.43
3670.0	1066.0	200.7	143.6	15.7	63.9	1489.9	423.9	28.5	132.9	0.25
3680.0	2636.4	570.6	485.2	71.9	257.3	4021.4	1385.1	34.4	342.1	0.28
3690.0	824.8	165.0	146.0	21.5	62.6	1219.9	395.1	32.4	69.9	0.34
3700.0	166.4	36.3	34.2	5.5	20.6	263.0	96.6	36.7	34.5	0.27
3710.0	1106.2	209.0	168.8	26.1	73.9	1584.0	477.8	30.2	75.9	0.35
3720.0	947.7	209.2	192.2	29.5	98.8	1477.4	529.7	35.9	144.7	0.30
3730.0	559.1	115.3	86.5	12.2	30.0	803.2	244.1	30.4	54.6	0.41
3740.0	1735.0	315.4	212.9	27.1	95.0	2385.3	650.3	27.3	94.3	0.28
3750.0	1130.5	140.0	92.9	14.1	33.8	1411.4	280.9	19.9	73.1	0.42
3760.0	621.0	74.2	61.2	10.5	22.0	789.0	168.0	21.3	46.7	0.48
3770.0	344.2	44.6	38.3	6.1	12.6	445.8	101.6	22.8	37.5	0.49
3780.0	650.8	89.1	68.7	11.6	30.5	850.8	200.0	23.5	55.6	0.38
3790.0	994.5	184.3	145.3	22.7	69.6	1416.4	421.9	29.8	101.6	0.33
3800.0	1066.4	197.7	144.7	19.7	56.6	1485.2	418.7	28.2	83.8	0.35
3810.0	907.7	146.3	114.5	18.7	44.8	1231.9	324.3	26.3	65.9	0.42
3820.0	1385.4	299.8	286.7	44.3	137.2	2153.5	768.1	35.7	167.9	0.32
3830.0	1492.3	308.5	230.1	35.9	106.0	2172.8	680.4	31.3	127.1	0.34

N.B. 1. GAS CONCENTRATIONS EXPRESSED IN PPM (VOL. GAS/VOL. SEDIMENT)
2. bdl = BELOW DETECTION LIMIT

TABLE 1 (cont)

WELLNAME = BRIDGEWATER BAY #1 DATE OF JOB = JANUARY 1984

HEADSPACE ANALYSIS DATA

DEPTH(m)	METHANE	ETHANE	PROPANE	ISOBUTANE	BUTANE	C1-C4	C2-C4	%WETNESS	C5-C7	i-C4/n-C4
3840.0	1825.0	339.3	217.1	26.8	89.8	2498.0	673.0	26.9	117.8	0.30
3850.0	1558.4	288.2	188.1	25.0	69.4	2129.2	570.8	26.8	88.0	0.36
3860.0	1087.0	215.2	149.2	18.7	69.9	1540.0	453.0	29.4	102.3	0.27
3870.0	1175.3	177.6	110.0	12.3	40.7	1516.0	340.7	22.5	51.0	0.30
3880.0	1586.9	320.0	221.2	27.3	92.9	2248.3	661.4	29.4	105.1	0.29
3890.0	1187.0	241.7	149.8	20.0	60.8	1659.4	472.4	28.5	61.2	0.33
3900.0	2484.0	498.6	321.1	40.5	153.1	3497.4	1013.3	29.0	171.5	0.26
3910.0	1514.6	280.6	185.2	23.9	80.2	2084.5	570.0	27.3	92.4	0.30
3920.0	888.7	150.5	99.8	14.1	40.6	1193.6	304.9	25.5	42.2	0.35
3930.0	1827.6	322.5	220.8	39.6	112.7	2523.3	695.6	27.6	148.1	0.35
3940.0	2722.0	409.3	235.7	32.9	93.0	3492.9	771.0	22.1	99.6	0.35
3950.0	2322.7	322.1	180.3	29.4	81.7	2936.2	613.6	20.9	97.6	0.36
3960.0	1560.2	225.1	147.0	26.0	74.5	2032.7	472.5	23.2	100.9	0.35
3970.0	1820.7	268.3	145.5	23.6	67.7	2325.8	505.1	21.7	87.0	0.35
3980.0	1738.9	236.3	113.5	15.8	47.5	2151.9	413.0	19.2	59.6	0.33
3990.0	1238.5	148.0	73.5	10.2	27.5	1497.7	259.2	17.3	33.3	0.37
4000.0	2031.3	254.5	111.0	14.3	43.9	2454.9	423.7	17.3	42.9	0.33
4010.0	2899.3	389.9	194.3	28.3	82.5	3594.2	694.9	19.3	86.9	0.34
4020.0	2856.8	296.7	152.0	21.8	65.3	3392.5	535.8	15.8	74.3	0.33
4030.0	939.9	77.8	59.0	10.1	23.7	1110.4	170.5	15.4	33.8	0.42
4040.0	529.1	46.2	37.0	6.7	16.7	635.6	106.5	16.8	30.0	0.40
4050.0	562.3	54.0	52.3	11.6	26.0	706.3	143.9	20.4	36.4	0.45
4060.0	3377.5	282.0	234.3	32.1	49.9	3975.8	598.3	15.0	63.0	0.64
4070.0	1844.7	196.6	152.7	21.4	43.0	2258.3	413.6	18.3	129.5	0.50
4080.0	1077.8	85.5	82.6	12.5	24.2	1282.5	204.7	16.0	32.4	0.51
4090.0	1773.0	140.6	138.5	21.7	41.8	2115.6	342.6	16.2	55.6	0.52
4100.0	407.3	76.1	113.8	21.1	38.5	656.8	249.5	38.0	42.1	0.55
4110.0	468.4	54.9	40.9	3.8	8.0	576.1	107.6	18.7	21.0	0.48
4120.0	258.2	54.3	59.4	7.3	14.8	394.0	135.8	34.5	29.6	0.50
4130.0	405.8	70.8	65.6	7.2	16.5	566.0	160.2	28.3	65.5	0.44
4140.0	550.8	93.0	91.7	8.4	16.6	760.5	209.7	27.6	23.0	0.51
4150.0	434.4	75.6	64.7	6.0	12.0	592.8	158.3	26.7	18.0	0.50
4160.0	240.8	37.7	33.9	3.9	8.6	324.9	84.1	25.9	20.6	0.46
4170.0	247.1	44.9	43.9	5.5	13.3	354.6	107.5	30.3	38.5	0.41
4180.0	197.3	31.6	33.4	4.5	9.5	276.4	79.1	28.6	21.0	0.48
4190.0	349.8	82.8	74.6	9.1	16.6	532.9	183.1	34.4	25.0	0.55
4200.0	478.9	58.5	52.9	6.0	13.0	609.3	130.4	21.4	31.5	0.46

N.B. 1. GAS CONCENTRATIONS EXPRESSED IN PPM (VOL. GAS/VOL. SEDIMENT)
2. bdl = BELOW DETECTION LIMIT

TABLE 2

ROCK-EVAL PYROLYSIS DATA (two run)

WELLNAME = BRIDGEWATER BAY #1 DATE OF JOB = FEBRUARY 1984

DEPTH(m)	TMAX	S1	S2	S3	S1+S2	S2/S3	PI	PC	TOC	HI	OI
2700.0	421	0.66	1.76	1.23	2.42	1.43	0.27	0.20	1.18	149	104
2750.0	483	0.13	0.63	0.24	0.76	2.63	0.17	0.06	1.12	56	21
2800.0	530	0.13	0.67	0.27	0.80	2.48	0.16	0.07	0.94	71	28
2850.0	428	0.13	0.30	0.20	0.43	1.50	0.30	0.04	1.06	28	18
2900.0	501	0.17	1.46	0.64	1.63	2.28	0.10	0.14	1.31	111	48
2945.0	536	0.22	2.66	0.63	2.88	4.22	0.08	0.24	1.26	211	50
3000.0	502	0.21	1.03	0.62	1.24	1.66	0.17	0.10	1.36	75	45
3050.0	505	0.25	1.71	0.70	1.96	2.44	0.13	0.16	1.31	130	53
3100.0	474	0.21	0.86	0.46	1.07	1.87	0.20	0.09	1.26	68	36
3150.0	433	0.19	0.66	0.61	0.85	1.08	0.22	0.07	1.46	45	41
3200.0	508	0.26	1.39	0.86	1.65	1.62	0.16	0.14	1.19	116	72
3250.0	435	0.18	0.68	0.58	0.86	1.17	0.21	0.07	1.29	52	44
3300.0	436	0.30	1.06	0.57	1.36	1.86	0.22	0.11	2.93	36	19
3350.0	454	0.24	1.02	0.53	1.26	1.92	0.19	0.10	1.86	54	28
3400.0	435	0.25	0.68	0.44	0.93	1.55	0.27	0.08	1.19	57	36
3450.0	436	0.33	0.73	0.61	1.06	1.20	0.31	0.09	1.23	59	49
3500.0	428	0.30	0.38	0.35	0.68	1.09	0.44	0.06	0.88	43	39
3550.0	434	2.72	1.40	0.75	4.12	1.87	0.66	0.34	1.55	90	48
3600.0	429	2.64	8.58	1.58	11.22	5.43	0.24	0.93	3.57	240	44
3650.0	431	2.45	1.42	1.10	3.87	1.29	0.63	0.32	1.13	125	97
3700.0	427	0.63	0.71	0.59	1.34	1.20	0.47	0.11	0.97	73	60
3750.0	430	3.76	77.34	5.46	81.10	14.16	0.05	6.73	11.82	654	46
3800.0	429	1.60	21.86	2.50	23.46	8.74	0.07	1.95	4.22	518	59
3850.0	431	2.77	45.11	4.94	47.88	9.13	0.06	3.97	7.01	643	70
3900.0	432	0.69	1.82	0.67	2.51	2.72	0.27	0.21	1.24	146	54
3950.0	429	1.41	12.33	1.16	13.74	10.63	0.10	1.14	2.57	479	45
4000.0	429	0.94	5.40	1.06	6.34	5.09	0.15	0.53	1.73	312	61
4045.0	427	1.14	9.38	1.91	10.52	4.91	0.11	0.87	2.26	415	84
4100.0	428	3.13	21.08	3.00	24.21	7.03	0.13	2.01	4.78	441	62
4150.0	426	0.71	3.36	1.10	4.07	3.05	0.17	0.34	0.98	342	112
4200.0	431	3.82	51.60	5.14	55.42	10.04	0.07	4.60	9.55	540	53

TMAX = Max. temperature S2
S1+S2 = Potential yield
PC = Pyrolysable carbon
OI = Oxygen Index
S1 = Volatile hydrocarbons (HC)
S3 = Organic carbon dioxide
TOC = Total organic carbon
nd = no data
S2 = HC generating potential
PI = Production index
HI = Hydrogen index

THEORY AND METHODS

July, 1983

This section details a series of geochemical methods which are commonly used in our laboratory, including those used to obtain the data presented in this report. Where applicable, the discussion is accompanied by a summary of the general theory used to interpret the data generated by each method.

1. SEDIMENTARY GAS ANALYSIS

a) Headspace Analysis

Headspace analysis is carried out using sealed containers (usually tinned cans) of wet cuttings. The containers are approximately three quarters filled with the cuttings and water to leave an appreciable headspace into which volatile hydrocarbons contained in the cuttings diffuse.

After covering about $1cm^2$ of the container lid with liquid silicone and allowing the silicone to dry, the procedure involves placing a small hole in the lid through the silicone, then sampling an aliquot of the headspace gas with a gas injection syringe, and finally gas chromatographing this sample of gas under the following conditions: instrument = Shimadzu GC-8APF; column = 6' x 1/8" Chromosorb 102; column temperature = 110°C; carrier gas = nitrogen at 23mls/min; injector temperature = 120°C; detector temperature = 120°C; analysis cycle = C_1-C_4 components are flushed from the column in the forward direction and then the C_5-C_7 compounds are removed from the column by backflushing.

The integrated areas of peaks representing each of the C_1-C_7 components of the headspace gas are compared to the areas of the corresponding components of a standard gas of known composition. The calculated amount of each component in the sample gas is adjusted for the total headspace volume and reported as ppm (parts of gas per million parts of sediment by volume).

Data from headspace analysis is commonly used to identify the zone of oil generation by plotting gas wetness (C_2-C_4/C_1-C_4) expressed as a % against sediment burial depth. Gas containing appreciable quantities of C_2-C_4 components, termed wet gas (Fuex, 1977), is generally considered to be gas associated with oil generation. In addition, the ratio of isomeric butanes can sometimes be used for assement of sediment maturity (Alexander et al., 1981). The amount of gas in sediments can be used to identify zones of significant gas generation and out-of-place gas (LeTran et al., 1975).

b) Cuttings Gas Analysis

This analysis is the same as Headspace Analysis with the exception that instead of analysing the gas in the container headspace, a known volume of the wet cuttings are transferred to the blender bowl of a Kenwood electronic blender with the lid modified to incorporate a septum, water at 75°C is added to leave a headspace of 160ml, and the mixture is blended at maximum speed for 2 minutes. Following a 2 minute settling period 1ml of the blending bowl headspace gas is analysed as described in section 1 a).

It is recommended that for the most meaningful gas data both headspace and cuttings gas analysis are carried out. In such cases we provide tabulations of the headspace, cuttings gas, and combined headspace/cuttings gas data. Normally, the combined data is used for plotting purposes.

2. SAMPLE PREPARATION

a) Cuttings

Cuttings samples are inspected by our qualified geological staff and then water washed according to the level of drilling mud and the lithology. In special cases (e.g. diesel contamination) it is necessary to lightly solvent wash samples. After washing, the samples are air dried, either sieved or picked free of cavings, and crushed to 0.1mm using a ring pulveriser.

b) Sidewall Cores

Sidewall samples are freed of mud cake and any other visible contaminants, and are also inspected for lithologic homogeneity. For homogeneous samples, the minumum amount of material required for the requested analyses is air dried and hand-crushed to 0.1mm. For non-homogeneous samples, the whole sample is air dried and handcrushed to 0.1mm.

c) Conventional Core and Outcrop Samples

These sample types are firstly inspected for visible contaminants, and where applicable, are freed of these contaminants to the best of our ability. Commonly, the surface of conventional core and outcrop samples are lightly solvent washed. The samples are then crushed to approximately 1/8" chips using a jaw crusher, air dried, and finally further crushed to 0.1mm using a ring pulveriser.

d) Petroleum/Aqueous Mixtures

The most common sample type in this catagory are RFT tests containing oil, water and mud. The mixture is placed in a separation funnel and allowed to stand for several hours which enables the petroleum and water/mud fractions to separate. The neat petroleum is isolated by removal of the lower layer (water/mud) from the funnel. To remove the last traces of water and mud, the neat petroleum is centrifuged at moderate speed.

When the volume of petroleum accounts for only a very small part of the sample the method above is unsatisfactory and the petroleum is solvent extracted from the mixture with dichloromethane. The petroleum is recovered by careful evaporation of the solvent from the organic layer.

3. TOTAL ORGANIC CARBON DETERMINATION

The total organic carbon value (TOC) is determined on the unextracted sediment sample. The value is determined by treating a known weight of sediment with hot dilute HCl for 1 hour to remove carbonate minerals, and then heating the residue to 1700°C (Leco Induction Furnace CS-044) in a atmosphere of pure oxygen. The carbon dioxide produced is transferred to an infra-red detector which has been calibrated with a series of standards, and the microprocessor of the Leco unit then automatically calculates the % TOC in the sample. To ensure reliable data a standard is run after every 10 samples, regular sample repeats are carried out, and at least one blank determination is carried out for each batch of samples.

The following scales are normally used for source rock classification based on % TOC data:

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

4. ROCK-EVAL PYROLYSIS

Although a prelimenary source rock classification is made using TOC data a more accurate assessment accounting for organic source type and maturity is made by pyrolysis analysis. Two types of Rock-Eval pyrolysis services are offered: "one run" which involves pyrolysis of the crushed but otherwise untreated sediment and "two run" which involves pyrolysis of both the crushed, untreated sediment and sediment which has been rendered free of carbonate minerals by treatment with hot dilute HCl. The two run service offers considerably more reliable S_3 data.

The method involves accurately weighing approximately 100mg of the sample into a sintered steel crucible and subjecting it to the following pyrolysis cycle:

Stage (i) - Sample purged with helium for 3.5 minutes in unheated part of pyrolysis furnace;

Stage (ii) - Sample heated at 300°C for 3 minutes to liberate free petroleum (S_1 peak);

Stage (iii) - Sample heated from 300°C to 550°C at 25°C/minute to produce petroleum from kerogen (S_2 peak). The furnace is maintained at 550°C for one minute. Carbon dioxide produced during this pyrolysis up to 390°C in the case of "one run" and 550°C for "two run" is absorbed on a molecular sieve trap;

Stage (iv) - During cool-down period the carbon dioxide produced during pyrolysis is measured (S_3 peak).

The units used for Rock-Eval data are as follows:

S_1, S_2, S_3 = kg/tonne or mg/g of rock

T_{max} = °C

Hydrogen Index $= \frac{S_2}{TOC} \times \frac{100}{1}$

Oxygen Index $= \frac{S_3}{TOC} \times \frac{100}{1}$

Rock-Eval data is most commonly used in the following manner:

(i) S_1 - indicates the level of oil and/or gas already generated by the sample according to the following scale:

S_1 (mg/g or kg/tonne)	Classification
0.00 - 0.20	Poor
0.20 - 0.40	Fair
0.40 - 0.80	Good
0.80 - 1.60	Very Good
> 1.60	Excellent

(ii) S_1+S_2 - referred to as the genetic potential this parameter is used for source rock classification according to the following criteria:

S_1+S_2 (mg/g or kg/tonne)	Classification
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

(iii) $S_1/(S_1+S_2)$ - this parameter is the production index (PI) which is a measure of the level of maturity of the sample. For oil prone sediments, values less than 0.1 are indicative of immaturity, the values increase from 0.1 to 0.4 over the oil window and values greater than 0.4 represent overmaturity. For gas prone sediments, the PI data shows a relatively smaller change with increasing maturity.

(iv) T_{max} - the temperature corresponding to the S_2 maxima. This temperature increases with increasingly mature sediments. Values less than 430°C are indicative of immaturity while values from 430/435 to 460°C represent the maturity range of the oil window. T_{max} values greater than 460°C are indicative of overmaturity.

(v) HI, OI - the hydrogen ($[S_2 x100]/TOC$) and oxygen ($[S_3 x100]/TOC$) indices when plotted against one another provide information about the type of kerogen contained in the sample and the maturity of the sample. Both parameters decrease in value with increasing maturity. Samples with large HI and low OI are dominantly oil prone and conversely samples with low HI and large OI are at best gas prone.

5. EXTRACTION OF SEDIMENT SAMPLES

Crushed sediment (maximum of 250g) and 300mls of purified dichloromethane are placed in a 500ml conical flask and are then blended for ten minutes with a Janke and Kunkel Ultra-Turrax T45/2G high efficiency disperser. After a ten minute settling period the solvent is separated from the sediment using a large Buchner filtration system. The extract is recovered by careful evaporation of the solvent on a steam bath and weighed. The weight of extract is used to calculate % EOM and ppm EOM using the following formulas:

$$\%\ \text{EOM} = \frac{\text{Wt EOM (g)}}{\text{Wt Sediment Extracted (g)}} \times \frac{100}{1}$$

$$\text{ppm EOM} = \frac{\text{Wt EOM (mg)}}{\text{Wt Sediment Extracted (kg)}}$$

The following scale is used to classify the source rock richness of samples based on $C_{12}+$ extractables:

Classification	ppm Total Extract
Poor	0 - 500
Fair	500 - 1000
Good	1000 - 2000
Very Good	2000 - 4000
Excellent	> 4000

6. SEPARATION OF PETROLEUM INTO CONSTITUENT FRACTIONS

Sediment extracts and crude oil or condensate samples are separated into saturate, aromatic and NSO (asphaltenes plus resins) fractions by medium pressure liquid chromatography (MPLC). That part of the petroleum which is soluble in pentane is applied to the MPLC system via a sample loop and is then pumped using pentane to a partially activated silicic acid pre-column which prevents further movement of the non-hydrocarbon compounds. The hydrocarbon components are pumped further to a Merck Si60 column where the saturate fraction is obtained by forward flushing and the aromatic fraction is recovered by reverse flushing. This separation procedure is monitored using a refractive index detector. To complete the separation the pre-column is removed from the MPLC system and flushed with dichloromethane: methanol (1:10). This non-hydrocarbon fraction is combined with the pentane insoluble material which is not applied to the MPLC system, and is labelled as the NSO fraction. The neat fractions are recovered by careful removal of the solvent by distillation and are weighed.

The weight of each fraction is used to calculate the % of each fraction in the petroleum and the ppm of each fraction in the sediment according to the following formulas:

$$\%\ \text{Fraction} = \frac{\text{Wt Fraction}}{\text{Wt All Fractions}} \times \frac{100}{1}$$

$$\text{ppm Fraction} = \frac{\text{Wt Fraction (mg)}}{\text{Wt Sediment Extracted (kg)}}$$

The ppm hydrocarbon (saturates + aromatics) and ppm saturate values can be used to classify source rock richness and oil source potential respectively according to the following criteria:

Classification	ppm Hydrocarbon	ppm Saturates
Poor	0 - 300	0 - 200
Fair	300 - 600	200 - 400
Good	600 - 1200	400 - 800
Very Good	1200 - 2400	800 - 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 increased 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.

N.B. If requested by a client the NSO fraction is separated into asphalentenes and resins by conventional methods.

7. EXTRACTABLE/TOTAL ORGANIC CARBON RATIOS

The ratios of EOM(mg)/TOC(g) and SAT(mg)/TOC(g) are determined from the appropriate data. The EOM (mg)/TOC(g) ratio can be used as a maturation indicator, especially if the parameter is plotted against depth for a given sedimentary sequence. In an absolute sense it is less reliable as a maturation indicator, although previous work (Tissot et. al., 1971; LeTran et. al., 1974) suggests that the following criteria can be used to determine maturity with this parameter:

<50	Low maturity
50-100	Moderate maturity
>100	High maturity

The ratios of EOM(mg)/TOC(g) and SAT(mg)/TOC(g) can be used collectively to provide information about source type. For example, if SOM(mg)/TOC(g) is >100, suggesting a high level of maturity, but the SAT(mg)/TOC(g) <20 it is very likely that the organic matter is gas prone. Conversely, the same EOM (mg)/TOC(g) value with a SAT(mg)/TOC(g) value >40 suggests oil prone source type.

8. C_{12}+ GAS CHROMATOGRAPHY

C_{12}+ gas chromatography is commonly carried out on the saturate fraction but in certain instances is carried out on neat oil, condensate or extract. The analysis is carried out under the following conditions: instrument = Shimadzu GC-9A; column = 50m x 0.2mm ID OV101 vitreous silica; column temperature = programmed from 60°C to 280°C at 4°C/min; injection system = Grob splitless using a 30 sec. dump time and split ratio of 25:1; carrier gas = hydrogen at 2mls/min; injector temperature = 300°C; detector temperature = 310°C; recorder/integrator speed = 0.5cm/min; Sample = 1µl of 0.5% soln in pentane.

The following information is commonly obtained from C_{12}+ gas chromatographic analysis:

(a) n-Alkane Distribution - The C_{12}-C_{31} n-alkane distribution is determined from the area under peaks representing each of these n-alkanes. This distribution can yield information about both the level of maturity and the source type (LeTran et. al., 1974).

(b) Carbon Preference Index - Two values are determined:

$$CPI(1) = \frac{(C_{23} + C_{25} + C_{27} + C_{29})Wt\% + (C_{25} + C_{27} + C_{29} + C_{31})Wt\%}{2 \times (C_{24} + C_{26} + C_{28} + C_{30})Wt\%}$$

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

The CPI is believed to be a function of both the level of maturity (Cooper and Bray, 1963; Scalan and Smith, 1970) and the source type (Tissot and Welte, 1978). Marine extracts tend to have values close to 1 irrespective of maturity whereas values for terrestrial extracts decrease with maturity from values as high as 20 but don't usually reach a value of 1.

(c) $C_{21}+C_{22}/C_{28}+C_{29}$ - This parameter provides information about the source of the organic matter (Philippi, 1974). Generally, a terrestrial source gives values <1.2 whereas a marine source results in values >1.5.

(d) Pristane/Phytane Ratio - This value was determined from the areas of peaks representing these compounds. The ratio renders information about the depositional environment according to the following scale (Powell and McKirdy, 1975):

<3.0	Relatively reducing depositional environment
3.0-4.5	Reducing/oxidizing depositional environment
>4.5	Relatively Oxidizing depositional environment

(e) Pristane/nC_{17} Ratio - This ratio was determined from the areas of peaks representing these compounds. The value can provide information about both the depositional environment and the level of maturation (Lijmbach, 1975). Very immature crude oil has a pristane/n-C_{17} ratio >1.0, irrespective of the depositional environment. However, the following classification can be applied to mature crude oil:

<0.5	Open water depositional environment
0.5-1.0	Mixed depositional environment
>1.0	Peat-swamp depositional environment

In the case of sediment extracts these values are significantly higher and the following classification is used:

<1.0 Open water depositional environment
1.0-1.5 Mixed depositional environment
>1.5 Peat-swamp depositional environment

(f) Phytane/n-C_{18} Ratio - This ratio was determined from the areas of peaks representing these compounds. The value usually only provides information about the level of maturity of petroleum. The value decreases with increased maturation.

(g) Relative Amounts of n-Alkanes and Naphthenes - Since n-alkanes and naphthenes are the two dominant classes of compounds in the saturate fraction, a semi-quantitative estimate of the relative amounts of these compounds can be made from saturate GLC's. This information can be used to assess the degree of maturation and/or the source type of the petroleum (Philippi, 1974; Tissot and Welte, 1978). Very immature petroleum has only small proportions of n-alkanes, but as maturity increases the relative amount of n-alkanes increases. In addition, terrestrial petroleum has a greater proportion of high molecular weight naphthenes than marine petroleum.

9. API/SPECIFIC GRAVITY

A specific gravity (SG) bottle was accurately weighed, then filled with crude oil at 60°F and finally reweighed. The weight difference was divided by the weight of an equal volume of water at 60°F to obtain the specific gravity. The following formula was then used to calculate the API gravity:

$$\text{API Gravity} = \left(\frac{141.5}{\text{SG (60°F)}}\right) - 131.5$$

The reported gravity value is the average of duplicate determinations.

10. SULPHUR DETERMINATION

The % sulphur by weight is determined by dissolving 0.5g of the petroleum in 50mls kerosene and then analysing this mixture with an inductively coupled plasma (ICP) instrument which has been calibrated with a series of sulphur standards.

This parameter is influenced by the nature of the soure material from which a crude is derived, the depositional environment of the source rocks, and reservoir alteration processed such as bacterial alteration.

11. C_1-C_{31} WHOLE SAMPLE GAS CHROMATOGRAPHY

This method of analysis is normally only applied to oil or condensate samples. The technique provides a "picture" of the sample which shows good resolution of the low, medium and high molecular weight components. Whole sample GC data is considered to be more useful than C_{12}+ saturate fraction GC data for oil or condensate samples.

The analysis is carried out under the same conditions as for the C_{12}+ GC analysis with the following exceptions: column temperature = programmed from -20°C to 280°C at 4°C/min (uses cryogenic mode); injection is carried out in split mode; sample = 0.1μl of neat petroleum.

C_1-C_{31} analysis data can be used to obtain the same information as that obtained from C_{12}+ GC but further provides detailed compositional data on the C_1-C_{11} fraction and enables calculation of the distillation range of the sample.

12. MOLECULAR SIEVE EXTRACTION

This technique is used to isolate the branched/cyclic alkanes from the saturate fraction for gas chromatography/mass spectrometry analysis. A mixture of saturates: 5A molecular sieves: purified benzene in the proportions 1:5:12 by weight is placed in a 100ml round bottom flask and refluxed for 24 hours. After cooling, the sieves are filtered from the liquid phase and are washed with 4 x 10ml aliquots of benzene. The liquid phase plus washings are freed of benzene by distillation yielding the branched/cycle compounds.

13. COMPUTERIZED GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GC/MS)

Gas chromatography/mass spectrometry employs a capillary column gas chromatograph linked in series with a mass spectrometer and data system (GC/MS/DS). As molecules are eluted from the capillary column they are bled into the analyser tube of the mass spectrometer where they are bombarded with high energy electrons and consequently fragment to form several ions each with molecular weights less than that of the parent molecule. The fragmentation pattern is characteristic of the particular molecular type. The spectrum of these ions (referred to as a mass spectrum) is recorded approximately once every second and all of the mass spectra recorded during a GC/MS/DS analysis are memorized by the data system. Since any given class of molecules will break down in the analyser tube to give one or more characteristic ion fragments of known molecular weight, after a GC/MS/DS analysis it is possible to examine the distribution of compounds within a given class by having the data system reproduce a mass fragmentogram (plot of ion concentration against gas chromatography retention time) representative of the particular class.

GC/MS/DS analyses can be carried out using one of the following two modes of operation:

(i) Acquire mode - in which all ions in each mass spectrum are memorized by the data system;

(ii) Selective ion monitoring (SIM) mode - in which only selected ions of interest are memorized by the data system.

At present the sterane/triterpane fraction of petroleum is considered most useful for GC/MS/DS analysis and therefore we commonly use the second of the above mentioned modes of operation and run the following twenty ions which are pertinent to the sterane/triterpane fraction.

Ion	Molecular Type
177	Demethylated triterpanes
191	Normal triterpanes
205	Methyl triterpanes
163	Specific dethylated triterpanes
356	Parent ion - C_{26} triterpanes
370	Parent ion - C_{27} triterpanes
384	Parent ion - C_{28} triterpanes
398	Parent ion - C_{29} triterpanes
412	Parent ion - C_{30} triterpanes
426	Parent ion - C_{31} triterpanes
183	Isoprenoids
217	Normal steranes
218	Normal steranes
231	4-methyl steranes
259	Diasteranes
358	Parent ion - C_{26} steranes
372	Parent ion - C_{27} steranes
386	Parent ion - C_{28} steranes
400	Parent ion - C_{29} steranes
414	Parent ion - C_{30} steranes

GC/MS/DS analysis of the sterane/triterpane fraction can often provide information about the maturity and source type of petroleum and whether it has been affected by microorganisms. This technique is also often useful for oil:oil and oil:source rock correlation. The following sections indicate which parameters are used to obtain this information and summarize the theory behind their use.

Maturity

(i) Based on Steranes

(a) The biologically produced ααα(20R) sterioisomer is converted in sediments to a mixture of the ααα(20R) and ααα(20S) compounds. The ratio of $C_{29}\ \frac{\alpha\alpha\alpha(20S)}{\alpha\alpha\alpha(20R)+\alpha\alpha\alpha(20S)}$ expressed as a percentage is about 25% at the onset of oil generation and increases almost linearly to a value of about 50% at the peak of oil generation.

(b) The biologically produced ααα steranes are partially converted during catagenesis to the corresponding αββ series. The percentage of the C_{29} αββ component in the total C_{29} steranes is another measure of maturation. The value of this parameter is about 25% at the onset of oil generation and it increases exponentially to a value of about 70% at the peak of oil generation.

(ii) Based on Triterpanes

(a) The C_{31}, C_{32}, C_{33}, C_{34}, and C_{35} hopanes have the biological R configuration at C_{22}. On mild thermal maturation equilibration occurs to produce a 60/40 mixture of S/R. This equilibration occurs before the onset of oil generation.

(b) The conversion of the biological 17β,21β hopanes to the corresponding 17α,21β and 17β,21α compounds is also maturation dependent. For C_{30} triterpanes the ration of $\frac{17\beta,21\alpha}{17\alpha,21\beta}$ decreases steadily from a value of about 0.4 at the onset of oil generation to a value of about 0.1 at peak oil generation.

(c) Two of the C_{27} triterpanes can also be used as maturity indicators. The ratio of 18α(H) trisnorhopane to 17α(H) trisnorhopane increases exponentially with increasing maturity from a value of approximately 0.2 at the onset of oil generation to approximately 1.0 at peak oil generation.

(d) It is our experience that the ratio of the C_{27} 18α(H) + C_{27} 17α(H) ratio decreases from values around 1.0 at the onset of oil generation to a value of approximately 0.4 at peak oil generation. With increasing maturity at levels greater than that equivalent to peak oil generation the ratio increases steadily to values greater than 3.0.

Source Type

(i) Based on Steranes
Algal organic matter contains steranes in which the C_{27} compounds are more abundant than the C_{29} compounds. General marine organic matter has approximately equivalent amounts of the C_{27} and C_{29} compounds while organic matter rich in land-plants usually has more of the C_{29} steranes.

(ii) Based on Triterpanes
The triterpane components in petroleum can be derived from both bacteria and higher plants. The common bacterial products are the C_{27}-C_{35} hopanes and moretanes whereas the higher plant triterpanes are compounds other than hopanes or moretanes and are commonly C_{30} compounds.

(iii) Based on Diasteranes
The diasteranes are not produced biologically but are formed during early diagenesis from sterane precursors. The diasterane ratios $\frac{C_{27}(20R)}{C_{29}(20R)}$ and $\frac{C_{27}(20R+20S)}{C_{29}(20R+20S)}$ should reflect the nature of the organic matter in the same manner as that outlined above for the steranes.

Biodegradation

It has been observed that in severely biodegraded petroleum the series of normal hopanes are converted to a series of A ring demethylated hopanes and the C_{29} $\alpha\alpha\alpha$(20R) sterane is selectively removed. For altered crudes which have not been degraded to this extent the severity of biodegradation can often be gauged by studying the isoprenoid and aromatic fractions. However, this type of investigation extends beyond a standard GC/MS/DS analysis.

Correlation

Our present approach to oil:oil or oil:source rock correlation problems is as follows:

(i) Compare the distribution of compounds in the 177, 191, 217, 218, 259 and 400 mass fragmentograms for an oil or sediment extract to the distribution of compounds in the respective fragmentograms for the other oil(s) or sediment extract(s). It is necessary in this type of comparison to make allowance for small variations due to possible maturity differences.

(ii) Examine the fragmentograms for peaks or sets of peaks which may represent compounds that are specific to the geological system under investigation. Normal steranes, diasteranes and bacterial hopanes cannot be used for this purpose because they are present in virtually all crude oils and sediment extracts. However, compounds like higher plant triterpanes, 4-methyl steranes, bisnorhopane and botryococcane can often prove very useful for this purpose.

14. CARBON ISOTOPE ANALYSIS

The measurement is carried out on one or more of the following mixtures; topped oil; saturate fraction; aromatic fraction; NSO fraction. The organic matter is combusted at 860°C in oxygen and the carbon dioxide formed is purified and transferred to an isotope mass spectrometer. The carbon isotope ratio is measured relative to a standard gas of known isotopic composition. In our case the standard gas is prepared from the NBS No. 22 oil. However, since the isotopic relationship between NBS No. 22 oil and the international reference PDB limestone are known, the values are adjusted to be relative to PDB limestone.

Although carbon isotope data has been commonly used for oil to oil and oil to source rock correlation its most significant application is the identification of source of gas according to following criteria (Fuex, 1977):

$\delta^{13}C$ (PDB)	Gas Type
-85 → -58	Biogenic methane
-58 → -40	Wet gas/associated with oil
-40 → -25	Thermal methane

15. VITRINITE REFLECTANCE MEASUREMENT

Vitrinite is a coal maceral which responds to increasing levels of thermal maturity. This response can be measured by the percent of light reflected off a polished surface of a vitrinite particle emursed in oil. Reflectance measurements are made on a number (40 if possible) of vitrinite particles in each sample, in order to establish a range and mean for reflectance values. Immature rocks have low reflectance values (0.2% Ro to 0.6% Ro), with mature values ranging from 0.6% Ro to 1.6% Ro. Very mature values are between 1.6% Ro and 2.4% Ro, while severly altered rocks have reflectances above 2.5% Ro.

Vitrinite reflectance results are best obtained from coals or rocks deposited in environments receiving large influxes of terrestrially-derived organic matter. Unfortunately, these environments are not conducive to the accumulation of large quantities of oil-prone organic matter. Also vitrinite reflectance cannot be performed on rocks older than Devonian Age, due to the absence of land plants in the older geologic time periods.

16. VISUAL KEROGEN

Visual kerogen assessment is carried out by the coal petrologist and/or the palynologist. In the case of the petrologist the assessment is made in reflected light using the plug prepared for vitrinite reflectance measurement, and reports the relative amounts of alginite, exinite, vitrinite and inertinite particles.

Visual study of kerogen by the palynologist is carried out in transmitted light and can indicate the relative abundance, size, and state of preservation of the various recognizable kerogen types and hence indicates the source character of a sedimentary rock. In addition, the color of the kerogen is related to the thermal maturity of the sediments and is often used as a maturation indicator.

The preparation of slides for visual kerogen assessment by the palynologist firstly involves concentration of the organic matter by removal of the rock matrix using hydrochloric and hydrofluoric acid treatment and heavy liquid separation. The organic concentrate is then mounted on a glass slide using Petropoxy.

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APPENDIX NO. 8

SOURCE ROCK POTENTIAL ANALYSIS OF THE

BRIDGEWATER BAY NO. 1 WELL

(PHILLIPS PETROLEUM COMPANY - CONFIDENTIAL)

PHILLIPS 66

INTER-OFFICE CORRESPONDENCE / SUBJECT:
BARTLESVILLE, OKLAHOMA

January 4, 1984

Source Rock Potential Analysis
of the Bridgewater Bay #1 Well,
Otway Basin, Australia
Charge No. RA4061
EPS Report No. 2524L
Copy 1 of 7 Copies

BVP-003-84

O. J. Koop
Perth Office

Attn: N. C. Tallis

No significant liquid hydrocarbon source rock potential is indicated for the 13 sidewall cores (934 to 4175M) examined from the above cited well. Gas potential is indicated in the section (below approx. 3800 meters) that has Ro values higher than 1.0%. Seven of 13 samples are dominated by a liquid prone amorphous kerogen type, but the lack of fluorescence in the blue light range coupled with the low hydrogen index values (maximum of 135) indicate poor liquid potential. An oxidizing depositional environment probably lowered the kerogen's oil potential. An adjacent area with more reducing conditions could still be a candidate for a liquid hydrocarbon source rock.

Total organic carbon (TOC) values are "rich" in 9 out of 13 samples. The remaining TOC values are in the "fair" range for the 4 deepest samples collected between 3295 and 4175 M. This lower TOC zone unfortunately coincides with maturity levels that are optimum for liquid hydrocarbon generation or are approaching the thermal dry gas range.

The only missing parameter for a good liquid hydrocarbon source rock appears to be a more reducing, anoxic depositional environment, which could be nearby if paleogeography and paleocirculation patterns were favorable. Two references for pursuing this topic are: 1) Parrish, J. T. and Curtis, R. L., 1982. "Atmospheric circulation, upwelling, and organic rich rocks in the Mesozoic and Cenozoic eras." Palaeogeography, Palaeoclimatology, Palaeoecology, 40: pp. 31-66; and 2) Demaison, G. J. and Moore, G. R., August 1980, "Anoxic Environments and Oil Source Bed Genesis," AAPG Bulletin, V. 65-2, pp. 181-190.

A very high S1 pyrolysis peak in core 2733 meters may suggest an oil reservoir, migration pathway, or contamination. The production index (S1/(S1 + S2) and the thermal extraction index (S1 x 100)/TOC generally indicate both increasing maturity and generation with increasing depth. These data are consistent with the TAI (spore color) and Ro (vitrinite reflectance) maturity information. The hydrogen index values are low for all 13 samples. These figures again are consistent with the visual observations in which a combination of non-fluorescent, probably oxidized amorphous algal kerogen and land derived gas-prone kerogens indicates a low potential for liquid hydrocarbons.

Vitrinite quality in sample 4175 meters is poor and therefore the confidence in the data obtained is low.

Figures and Tables included in this report include:

Figure 1. Thermal alteration and source rock potential plot.

Figure 2. Pyrolysis results plot.

Figure 3. Log % reflectance, unedited vitrinite data plot.

Table 1. Thermal alteration and source rock potential data.

Table 2. Pyrolysis results data.

D L Pearson
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Approved: E A Stanley
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PE902248

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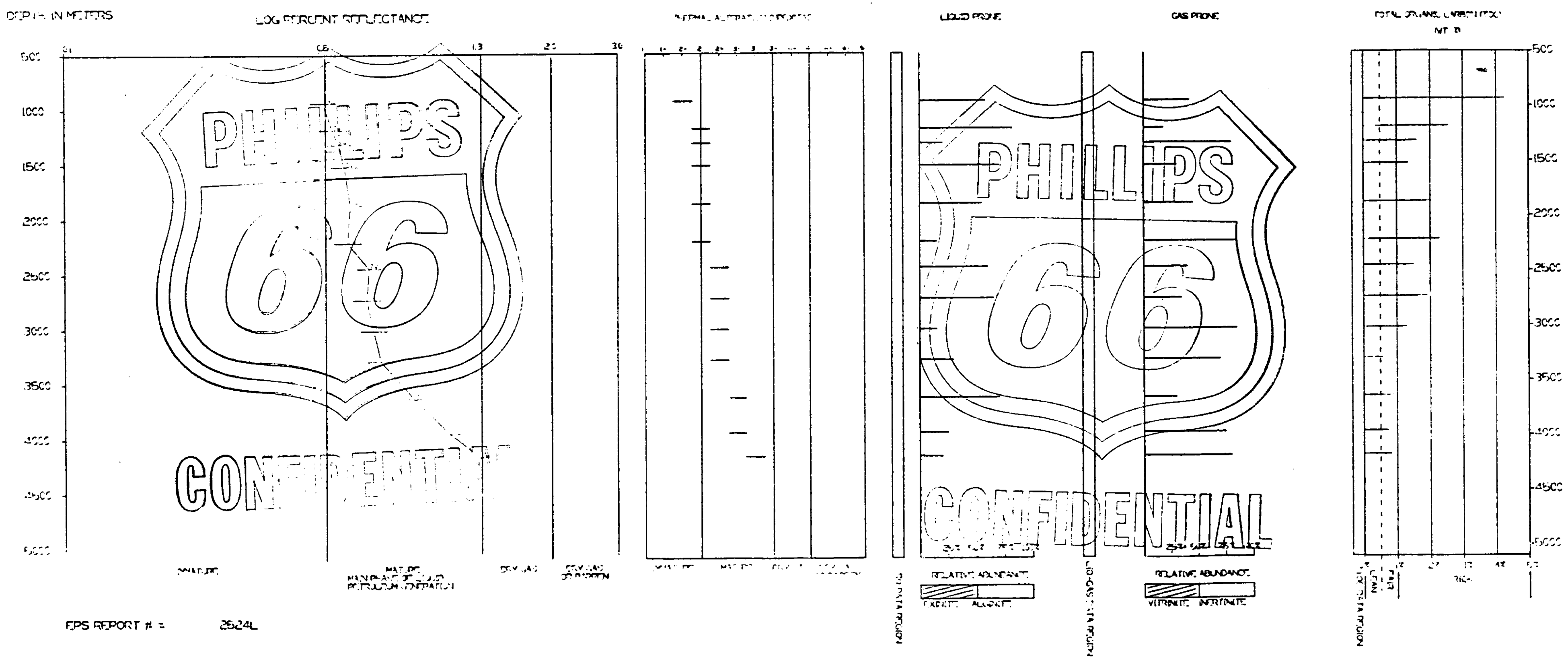
The enclosure PE902248 has the following characteristics:

ITEM_BARCODE	= PE902248
CONTAINER_BARCODE	= PE900161
NAME	= Bridgewater Bay 1 Figure 1 (Appendix 8) Thermal alteration And Source Rock Potential
BASIN	= OTWAY
TYPE	= WELL
SUBTYPE	= DIAGRAM
DESCRIPTION	= Bridgewater Bay 1 Figure 1 (Appendix 8) Thermal alteration And Source Rock Potential
W_NO	= W831
WELL_NAME	= BRIDGEWATER BAY-1
CLIENT_OP_CO	= PHILLIPS AUSTRALIAN OIL COMPANY

THERMAL ALTERATION AND SOURCE ROCK POTENTIAL OF BRIDGEWATER BAY#1,OTWAY BASIN,AUSTRALIA

FIGURE 1



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ITEM_BARCODE	= PE902249
CONTAINER_BARCODE	= PE900161
NAME	= Bridgewater Bay 1 Figure 2 (Appendix 8) Pyrolysis Results
BASIN	= OTWAY
TYPE	= WELL
SUBTYPE	= DIAGRAM
DESCRIPTION	= Bridgewater Bay 1 Figure 2 (Appendix 8) Pyrolysis Results
W_NO	= W831
WELL_NAME	= BRIDGEWATER BAY-1
CLIENT_OP_CO	= PHILLIPS AUSTRALIAN OIL COMPANY

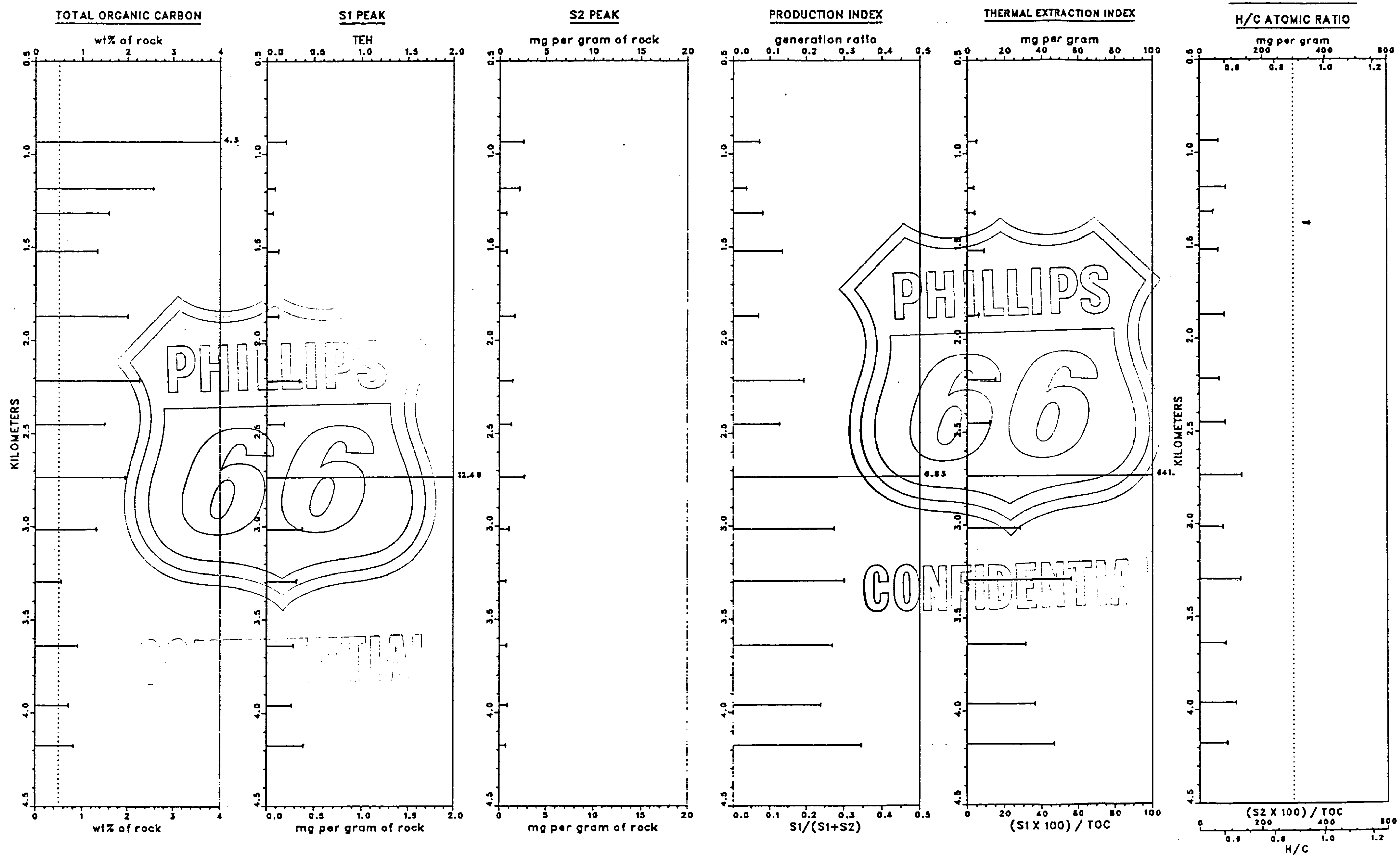
CORE
CUTTINGS

PHILLIPS #1 BRIDGEWATER BAY, OTWAY BASIN, AUSTRALIA

PYROLYSIS RESULTS

FIGURE 2

EPS REPORT #2524L



PHILLIPS PETROLEUM COMPANY — CONFIDENTIAL

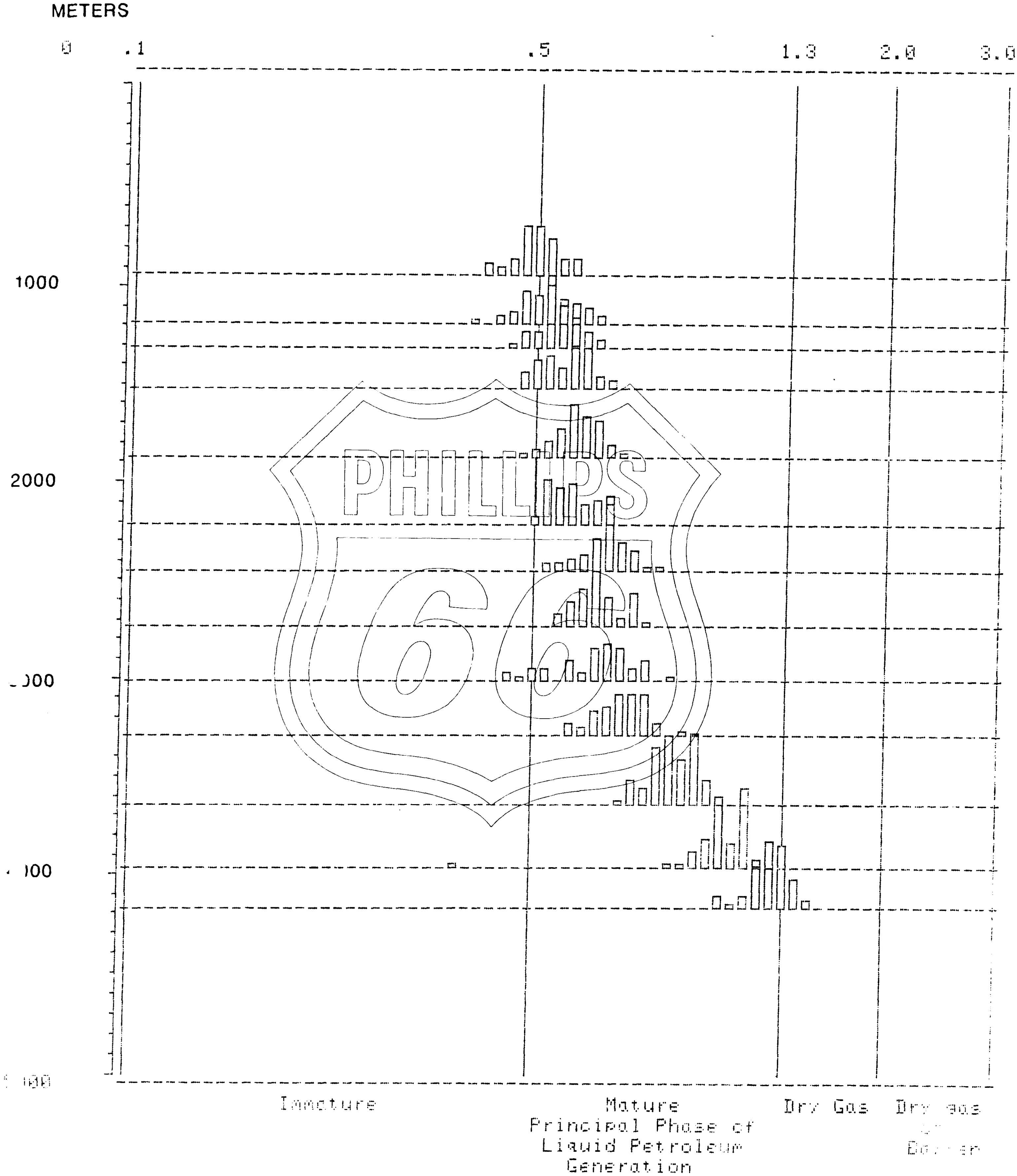
BRIDGEWATER BAY #1, Otway Basin, Australia

FIGURE 3

EPS REPORT #2524L

Log % Reflectance

Unedited Vitrinite Data



L [illegible] DG. IFR YF1, CA[illegible] SIN, STR [illegible]A
LPS REPORT # 3524L

NORMALIZED TO 100% BY VOLUME
(LIQUID PRONE) (GAS PRONE)

INTERVAL (METERS) TOP	BASE	TYPE	TAI	EXI-NITE	ALGI-NITE	VITRI-NITE	INERTI-NITE	RO MEAN	STND. DEV	MODE	RANGE LOW	RANGE HIGH	NO. OF VIT. READINGS	TOTAL ORGANIC CARBON (WT %)
934.	934.	SW	2-	3.	55.	40.	2.	0.49	0.04	0.50	0.40	0.57	50	4.26
1165.	1165.	SW	2	2.	80.	15.	3.	0.52	0.05	0.52	0.42	0.60	48	2.56
1313.	1313.	SW	2	10.	1.	35.	43.	0.54	0.04	0.54	0.45	0.63	50	1.59
1522.	1522.	SW	2	5.	65.	15.	15.	0.56	0.05	0.61	0.46	0.66	53	1.23
1870.	1870.	SW	2	0.	55.	20.	25.	0.53	0.05	0.55	0.47	0.69	50	2.01
2215.	2215.	SW	2	5.	1.	30.	65.	0.57	0.05	0.52	0.50	0.67	50	2.07
2450.	2450.	SW	2+	5.	55.	20.	20.	0.65	0.05	0.67	0.52	0.74	48	1.50
2745.	2745.	SW	2+	5.	50.	15.	2[illegible].	0.64	0.06	0.63	0.54	0.77	53	1.45
3015.	3015.	SW	2+	5.	1.	15.	79.	0.67	0.06	0.64	0.57	0.77	40	1.31
3293.	[illegible]	SW	2+	10.	20.	30.	40.	0.70	0.05	0.66	0.58	0.82	51	0.55
3640.	3640.	SW	3-	5.	60.	15.	15.	0.80	0.07	0.87	0.71	1.00	77	0.90
3960.	3960.	SW	3-	5.	20.	30.	45.	1.07	0.07	1.12	0.92	1.20	57	0.71
4175.	4175.	SW	3	5.	1[illegible].	40.	4[illegible].	1.29	0.06	1.34	1.16	1.42	52	0.81

TERMINOLOGY USED FOR SOURCE ROCK PLOT

TAI = THERMAL ALTERATION INDEX (SPORE COLOR) (1-2 YELLOW) (2-3 BROWN) (3-4 DARK BROWN) (5 BLACK)
EXINITE = POLLEN AND SPORE EXINE + PLANT CUTICLES + RESINS + OTHER STRONGLY FLUORESCENT ORGANIC MATERIALS
+ AMORPHOUS HERBACEOUS (IF RECOGNIZABLE AS FROM TERRESTRIAL SOURCE - IF NOT IT IS RECORDED
UNDER ALGINITE)
ALGINITE = (ALGAL DEBRIS - CYSTS AND BODIES) + AMORPHOUS SAPROPEL
VITRINITE = WOODY TISSUE (ALTERED TO HUMIC COMPOUNDS) + NONFLUORESCENT STRUCTURED TRANSLUCENT MATERIAL
INERTINITE = COALY MATERIAL INCLUDING FUSINITE, SEMIFUSINITE, PSEUDOVITRINITE, MACRINITE, & INERTODETRINITE
[illegible] RATIO = EOM / (1.2[illegible] + TOC)

PYROLYSIS RESULTS FOR SAMPLES FROM THE PHILLIPS #1 BRIDGEWATER BAY, OTWAY BASIN, AUSTRALIA TABLE 2

EPS REPORT #2524L

STRAT. INTERVAL	SPL TYP	SAMPLE DEPTH METERS	TOTAL ORGANIC CARBON WT.%	S1 MG.HC/ G.ROCK	S2 MG.HC/ G.ROCK	PRODUCTION INDEX S1/(S1+S2)	THERMAL EXTRACTION INDEX MG/G.	HYDROGEN INDEX MG/G.	HYDROGEN TO CARBON ATOMIC RATIO	GEOCHEM SAMPLE CODE
	SWC	934.0	4.26	.20	2.57	.072	4.69	60.3	.576	EP83GCD
	SWC	1184.0	2.56	.08	2.14	.036	3.12	83.6	.605	EP83GCE
	SWC	1318.0	1.59	.06	.68	.081	3.77	42.8	.554	EP83GCF
	SWC	1522.0	1.35	.12	.77	.135	9.02	57.9	.573	EP83GCG
	SWC	1873.0	2.01	.12	1.61	.069	5.97	80.1	.601	EP83GCH
	SWC	2215.0	2.27	.34	1.42	.193	14.98	62.6	.579	EP83GCI
	SWC	2450.0	1.50	.18	1.24	.127	12.00	82.7	.604	EP83GCJ
	SWC	2735.0	1.95	12.49	2.63	.826	640.51	134.9	.670	EP83GCK
	SWC	3015.0	1.31	.37	.98	.274	28.24	74.8	.594	EP83GCL
	SWC	3295.0	.55	.31	.72	.301	56.36	130.9	.665	EP83GCM
	SWC	3640.0	.90	.28	.76	.260	31.11	84.4	.606	EP83GNV
	SWC	3960.0	.71	.26	.83	.239	36.62	116.9	.647	EP83GNW
	SWC	4175.0	.81	.38	.72	.345	46.91	88.9	.612	EP83GNX

APPENDIX NO. 9

LOG ANALYSIS

APPENDIX NO. 9

Log Analysis

Table 1 lists all the wireline logs run in the Bridgewater Bay No. 1 well. The final Computer Well Log Plot (CPI) computed over the interval 1600 metres to 3530 metres indicates no potential hydrocarbon productive zones (Enclosure 6).

The primary water saturation parameters for this analysis are:

> aR_w = 0.28 ohm/m at 18.3°C
> where "a" is the Formation Resistivity Factor Constant = 1
> Cementation Exponent (m) = 1.8 (Sandstones), 2 (Limestones)
> Saturation Exponent (n) = 2.0

Lithological descriptions from several sources were used to choose the appropriate coding. However, the mud log, the litholog, the daily reports, and the sidewall core descriptions are not entirely consistent. Consequently, the lithology portrayed on the Well Log Print may not exactly match the final interpretation on the Composite Log.

APPENDIX NO. 9

BRIDGEWATER BAY NO. 1 WIRELINE LOGS

Suite	Run	Log	Interval (metres)
1	1	DIL-SLS-GR	493m - 1602m
1	2	BGL	493m - 1602m
1	3	CST	550m - 1593m 30 attempted - 28 recovered
2	1	DIL-SLS-GR	1594m - 3533m
2	2	LDL-CNL-GR	1594m - 3533m
2	3	HDT	1594m - 3533m
2	4	CST	1613m - 3335m 51 attempted - 39 recovered
3	1	DIL-SLS-GR	3519m - 4199m
3	2	LDL-CNL-GR	3900m - 4193m
3	3	HDT	3850m - 4183m
3	4	CST	3560m - 4175m 30 attempted - 22 recovered
3	5	Velocity Survey	23 shots

APPENDIX NO. 10

DIPMETER INTERPRETATION*

APPENDIX NO. 10

Dipmeter Analysis, Bridgewater Bay No. 1

A Computer Processed Four-Arm High Resolution Continuous Dipmeter was run over the interval 3850 - 4188 metres. Sandstones associated with the Belfast Formation and the Waarre Formation were found to have log-derived porosities of less than two (2) percent and lack thick shale sequences within the Waarre Formation. For that reason standard analyses such as polar plots, grouping of dip agimuths, etc were not formed. Instead, a visual analysis was performed over the interval 3850 - 4188 metres. This was done primarily to confirm the existence of a seismically-defined angular unconformity at the top Waarre Formation (4102 metres).

An average six degree dip was observed above 4102 metres, within the lowermost Belfast Formation, with a random but positive trend in a northerly direction. Also observed was a very strong dip amplitude trending northwest across the juncture of the Belfast Formation and the Waarre Formation. This strong northwest dip trend is greater than ten degrees ranging between twelve and fourteen degrees. This strong northwest orientation at and within the Waarre Formation strongly supports the seismic interpretation of an angular unconformity at the top Waarre Formation.

High Resolution Dipmeter Tool (HDT) observations indicate a low regional structural dip in the Wangerrip Group sediments. Wangerrip Group sediments between 901 metres and 1240.5 metres have structural dips of between one and three degrees to the southwest. As above, the underlying Sherbrook Group sediments between 1240.5 metres and 4102 metres display northerly dips ranging from zero degrees to three degrees, becoming more northwesterly with increasing depth.

The basal sandstones of the Paaratte Formation between 2632 metres and 2668 metres have dips between five and twelve degrees, averaging six degrees. These sediments dip in a south-southwesterly direction, possibly indicating that the sedimentary source for this fluvial/marginal marine unit is from the north.