BHP

CONAN-1, VIC P/31

WELL COMPLETION REPORT

INTERPRETIVE VOLUME

BHP Petroleum

CONAN-1

VIC/P31

WELL COMPLETION REPORT

INTERPRETIVE VOLUME

PREPARED BY: S.Horan

71583.WCR

DATE: February, 1996

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

Acknowledgments

This report was prepared with the help of the following:

Jim Preston	Senior Petroleum Geologist
Richard Carter	Senior Petroleum Geophysicist
Tracey Norman	Technical Assistant
Cathy Ellis	Technical Assistant

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1. WELL INDEX SHEET

Well Name:	CONAN-1
Basin(s):	Otway
Country:	Australia
State/District/Province:	Victoria
Permit:	VIC/P31
Well Type:	Wildcat
Current Well Status:	Dry Hole - Abandoned

Total Depth:

Drillers:	1985m
Planned:	2325m

Surface Location:

Actual:	Lat:	38 deg 52 min 14.95 sec S
	Long:	142 deg 46 min 52.22 sec E
	Survey System:	Australian Geodetic Datum 1984
	Source of Location Data:	BHPE GPS Survey
Planned:	Lat:	38 deg 52 min 14.80 sec S
	Long:	142 deg 46 min 52.50 sec E
	Survey System:	Australian Geodetic Datum 1984
	Source of Location Data:	Application To Drill

Onshore/Ofshore:	Offshore - Marine		
Seismic Reference:	Line: OH94-246 SP: 1147		
Elevations:	Log Ref.:	RT,	25.0m above MSL
	Ground Level:		70.0m below MSL
	Water Depth:		70.0m
Operation Dates:	On Location:		22-JUL-1995, 09:00
	Spudded:		24-JUL-1995, 02:00
	Total Depth Reached:		31-JUL-1995, 22:30
	Rig Released:		05-AUG-1995, 13:30
Operator:	BHP Petroleum	Interest:	90%
Partners:	Parker and Parsley	Interest:	10%
Cost:	$4,930,000AUD		

Objectives:

Primary Objectives:	Minerva Formation
Secondary Objectives:	La Bella Formation

Drilling Summary:

Rig Name: Ocean Bounty
Rig Type: Semi-submersible
Drilling Contractor: Diamond M Offshore Pty Ltd

Bit Size	Interval	Casing	Shoe Depth
36 IN	95 - 142m	20 IN	142m
17.5 IN	142 - 1208m	13.375 IN	1200m
12.25 IN	1208 - 1985m		

Plugs:

Type	No.	Interval	Tagged	Sacks Cement
ABN	1	1730 - 1649 m	N	
ABN	2	1230 - 1136 m	Y	
ABN	3	139 - 109 m	N	

Conventional Cores: none

DST and Production Tests: none

Wireline Logs:

Suite	Run	Tool String	Interval	Date Run
1	1	AS-MSFL-GR-DLL-AMS	1957 - 95m	01-AUG-95
1	2	CSI-VSP	1955 - 600m	01-AUG-95
1	3	LDL-CNL-GR-AMS	1940 - 1675m	02-AUG-95
1	3	FMI-IMAGES	1949 - 1675m	02-AUG-95
1	4	CST-GR	1950 - 1539m	02-AUG-95
1		MSD	1949 - 1675m	02-AUG-95
		MWD	1985 - 1208m	01-AUG-95
		FEL	1985 - 95m	31-JUL-95
		GAS/RAT	1985 - 95m	31-JUL-95
		PRESSURE	1985 - 95m	31-JUL-95
		DDP	1985 - 95m	31-JUL-95

2 WELL SUMMARY

Conan-1 was an exploration well drilled in VIC/P31 in the eastern part of the offshore Otway Basin (Fig.1). The well was the fourth exploration well to be drilled by the VIC/P31 Joint Venture in the permit area and is located 23km SW of Minerva-1 and 17km NE of La Bella-1.

The well was designed to test the Minerva Formation in a northwest-southeast trending horst feature. Top seal and cross fault seal was expected to be provided by Late Cretaceous Group Sherbrook Group claystones. Hydrocarbon charge was expected from coals and claystones of the Middle and Lower Eumeralla Coal Measures beneath the prospect and from source kitchens to the south and north.

The semi-submersible MODU Ocean Bounty spudded the well on the 24th of July 1995 in 70m of water.

The well was drilled to a total depth of 1985mRT penetrating water saturated Minerva and La Bella Formation sandstones. No hydrocarbon shows were seen. The well reached total depth in Early Cretaceous Otway Group argillaceous lithic sandstones and claystones.

There were no conventional cores cut, no RFT/MDT or DST programs conducted in this well.

The well was plugged and abandoned on the 5th of August 1995.

The primary reason for the lack of hydrocarbons was either the lack of a source rock or that source rock intervals were ineffective. Good quality Minerva Formation sandstone was present along with Sherbrook Group claystones of sufficient thickness and competency to seal the structure.

3 HYDROCARBONS

No fluorescence shows or significant ditch cuttings gas peaks were seen during drilling. Coals from 1800-1815mRT gave minor peaks with C_3 and C_4, trace amounts of C_3 were seen from 1700-1725mRT from thin sandstones.

A petrophysical interpretation was carried out over the interval 1700-1930mRT (Sherbrook, Shipwreck and Otway Groups) and a copy of the resultant report is presented in Appendix 1. In summary, all the sandstone beds in the Shipwreck and Otway Groups were water bearing.

No RFT/MDT pretests or samples were attempted and no DSTs were performed.

4 STRUCTURE

4.1 Trap Type and Structural Style

The Conan Prospect was mapped as a northwest to southeast trending horst feature at top Shipwreck Group level. The prospect was mapped as a horst feature composed of a series of tilted fault blocks. The structure is bounded to the southwest by a down to the south normal fault and to the northeast by a down to the north normal fault. Dip closure occurred to the northwest and southeast. Structuring began during the Early Cretaceous with structural movement continuing until the end of the Late Cretaceous.

4.2 Pre Drill Mapping

The Conan Prospect was defined by a 1 x 1 km spaced grid of dip and strike lines. The closure measured approximately 11km in the northwest to southeast direction, 4km in the northeast to southwest direction, with 220m of vertical closure in the most likely case. Sherbrook Group claystones were mapped as top seal and cross fault seal to the southwest and northeast.

The Sherbrook Group and younger sediments showed gentle, basinward (southwesterly) dip. The Shipwreck Group reservoir units below the base-Sherbrook Group Unconformity dip to the northeast by fault rotation and, along the southwestern flank of the Conan Prospect, show truncation at the unconformity surface.

4.3 Post Drill Mapping

No post drill re-mapping has been undertaken. The Top Minerva Formation Depth Map is still believed to reflect the form of the structure, although the horizon was intersected 150m deep to prognosis.

5 STRATIGRAPHY

5.1 Predicted Versus Actual

The stratigraphic sequence penetrated in Conan-1 ranges in age from Recent to Early Cretaceous. The proposed stratigraphy was based on seismic interpretation and wireline log correlations from La Bella-1, Mussel-1 and Minerva-1 (Fig.1). A predicted vs actual section is shown in Figure 2 and is summarised below:

- Top Nirranda Group 15m high
- Top Wangerrip Megasequence 37m high
- Top Sherbrook Group 25m high
- Top Minerva Formation 151m high
- Top La Bella Formation 362m high
- Otway Group penetrated.

The Minerva Formation came in 151m high to prognosis due to slower than expected interval velocities in the Late Cretaceous and Tertiary section (see section 6.2).

The section from 1705-1717mRT may belong to the Napier Formation based on spore pollen age determination, wireline log characteristics and stratigraphic position immediately above the Minerva Formation. Zone diagnostic dinoflagellates, however, are not present to confirm the presence of the Napier Formation and hence this sequence is assigned to the Belfast Formation of the Sherbrook Group.

The La Bella Formation came in 362m high and Otway Group sediments were penetrated due to the unexpected structural elevation of the prospect. Total depth was reached in Otway Group sediments at 1985mRT.

5.2 Stratigraphic Summary

A generalised stratigraphic column for the Otway Basin is presented in Figure 3.

Lithological descriptions from ditch cuttings, SWCs and conventional core, together with MWD/Wireline log character, provide the basis for the stratigraphic breakdown. Delineation of age units is based on palynology (Appendix 2) and log correlation with nearby wells. The composite log (Enclosure 1) provides a detailed illustration of the actual lithology and stratigraphy encountered in the well.

No ditch cuttings were obtained above 170 mRT.

5.2.1 Tertiary Heytesbury Group

Port Campbell Limestone

Depth: 170-350mRT
Thickness: 180m
Age: Miocene to Recent

First returns were established at 170mRT and consisted of light grey to off white calcarenite which becomes interbedded with light to medium olive grey marl with depth.

No palynological/micropalaeontological data is available to determine the age or likely depositional environment. Regional studies (Preston, 1995) suggest the Port Campbell Limestone ranges in age from Miocene to Recent and was deposited in a shallow marine carbonate shelf environment.

Gellibrand Marl

Depth: 350-568mRT
Thickness: 218m
Age: Miocene

The boundary with the overlying Port Campbell Limestone is transitional and was picked on a significant change in ROP and the increasing amount of marl in the sequence.

The Gellibrand Marl consists of light to medium olive grey marl with minor interbedded light brown to light grey calcarenite.

No palynological/micropalaeontological data is available to determine the age or likely depositional environment. Regional studies (Preston, 1995) suggests the Gellibrand Marl is Miocene in age and was deposited in a shallow marine carbonate shelf environment.

5.2.2 Tertiary Nirranda Group

Narawaturk Marl

Depth: 568-868mRT
Thickness: 300m
Age: Oligocene

The boundary with the overlying Gellibrand Marl is unconformable.

The Narawaturk Marl consists of light grey to brownish grey marl with minor interbedded clear to off white calcarenite.

No palynological/micropalaeontological data is available to determine the age or likely depositional environment. Regional studies (Preston, 1995) suggest it is of Oligocene age and was deposited in a shallow marine carbonate shelf environment.

5.2.3 Tertiary Wangerrip Megasequence

Depth:	868-1189mRT
Thickness:	321m
Age:	Eocene

The boundary with the overlying Narawaturk Marl is unconformable. The unconformity is marked on the gamma ray log by a significant decrease in gamma ray counts.

The Wangerrip Megasequence consists of an upper massive sandstone interval with a lower claystone and minor interbedded sandstone interval. Sandstones were predominantly clear to translucent, fine to coarse grained in the upper massive sandstone interval. The top 30m of this upper massive sandstone interval was ferruginous and reddy/brown in colour. Sandstones in the lower claystone/sandstone interval were fine grained and the claystones medium to dark grey

No palynological/micropalaeontological data is available to determine the age or likely depositional environment. Regional studies (Preston, 1995) suggest it is Eocene in age.

5.2.4 Late Cretaceous Sherbrook Group

Belfast Formation

Depth:	1189-1717mRT
Thickness:	528m
Biozone:	T.*lillei* - Middle T.*apoxyexinus*, I.*korojoneses* - lower I.*cretaceum*.
Age:	Santonian-Campanian.
Depositional Environment:	Nearshore marine to marginal marine/brackish.

The boundary with the overlying Wangerrip Megasequence is unconformable and is referred to as the Base Tertiary Unconformity, a regionally mappable seismic event. The unconformity was picked from seismic.

The Belfast Formation consists of olive grey to medium grey claystones which become medium grey to grey brown with depth. Claystones are interbedded with minor fine to medium grained sandstone. The gamma ray log and resistivity log through the Belfast are typically featureless with the exception of minor low gamma ray/high resistivity cemented sandstone beds and calcite/dolomite? interbeds. The sonic log transit times decrease overall with depth but between approximately 1400-1650mRT remains relatively constant and in places slightly increases suggesting potential undercompaction.

Depositional environments range from nearshore marine at the base shallowing up hole to marginal marine/brackish in the upper 200m. Environmental determinations are based on the ratio and diversity of dinoflagellates, spores, pollens and the presence of freshwater algae (*Botroyococcus*).

5.2.5 Late Cretaceous Shipwreck Group

Minerva Formation

Depth:	1717-1801mRT
Thickness:	84m
Biozone:	Lower P.*mawsonii*, P.*infusorioides*
Age:	Conician-Turonian
Depositional Environment:	nearshore marine.

The boundary with the overlying Belfast Formation is unconformable.

The Minerva Formation consists of an upper massive coarse grained sandstone with a lower medium grey to grey brown claystone and dark grey siltstone interval.

Nearshore marine environments are indicated by the low dinoflagellate amount and diversity compared to spores and pollens. The presence of freshwater algae (*Botroyococcus*) suggest a significant lacustrine influence.

La Bella Formation

Depth:	1801-1858mRT
Thickness:	57m
Biozone:	A.*distocarinutus*, P.*infusorioides*.
Age:	Cenomanian
Depositional Environment:	non-marine to marginally marine

The boundary with the overlying Minerva Formation is unconformable.

The La Bella Formation consists of interbedded light grey to pinkish grey argillaceous sandstone with minor amounts of light grey to light brownish grey siltstone and light to dark grey claystone.

Non-marine to marginally marine depositional environments are indicated by low dinoflagellate content and diversity compared to spores and pollens. Significant lake influence is indicated by frequent freshwater algae (*Botryococcus*).

5.2.6 Early Cretaceous Otway Group

Eumeralla Formation

Depth:	1858-1985mRT
Thickness:	127m+
Biozone:	C.*paradoxa*
Age:	Albian
Depositional Environment:	non-marine to brackish.

The boundary with the overlying La Bella Formation is unconformable.

The Eumeralla Formation consists of light greenish grey to grey green fine to coarse grained argillaceous quartz sandstone with minor interbedded light to medium grey claystone.

Non-marine to brackish depositional environments are indicated by lack of in-situ dinoflagellates with dominate and diverse spores and pollens. Brackish and lacustrine environments are indicates by the presence of the spiny acritarch *Schizosporis* and freshwater algae (*Botryococcus*).

6 GEOPHYSICAL DISCUSSION

6.1 Seismic Coverage

The Conan Prospect was defined by a 1x1km grid of OH91, reprocessed OE80A and OH94 seismic data. Table 1 lists more information on the seismic surveys.

Table 1
Seismic Surveys

SURVEY	OPERATOR	DATE
OE80A	ESSO	1980
OE81A	ESSO	1981
OH91	BHPP	1991
OH94	BHPP	1994

Seismic data quality was good down to the Top Minerva Formation but only fair beneath this horizon.

6.2 Velocities

Table 2 details predicted versus actual depths, TWT reflection times and interval velocities for major seismic horizons. Mussel-1 time-depth curve was used for depth conversion over the Conan Prospect as the Mussel-1 well was expected to best represent the geological setting at Conan.

Table 2
Prognosed Vs Actual Depths to major seismic horizons

HORIZON	**DEPTH (mSS)**		**TWT (ms)**		**Vint (m/s)**	
	Predicted	*Actual*	*Predicted*	*Actual*	*Predicted*	*Actual*
Mean Sea Level	0	0	-	-	2488	2392
Top Nirranda	558	523	NP	476		
Top Wangerrip	880	843	NP	747		
Base Tertiary U/C (Top Sherbrook)	1189	1164	956	973	3270	2893
Top Minerva	1843	1692	1356	1338	NC	-
Top La Bella	2078	1776	1500	1386	NC	-
Top Eumeralla	2325+	1833	NP	1433	NC	-

NC = not calculated

The error between the predicted vs actual MSL-Top Sherbrook Group (Base Tertiary Unconformity) interval velocity is approximately 4%. This difference is masked however by the Top Sherbrook Group predicted pick being 17ms high to the VSP pick. If the time pick had been correct then the predicted velocities may have been only 2%. At Top Minerva Formation level there was an 11% error between predicted and actual interval velocity due to an over estimation in the velocity for the Top Sherbrook Group to Top Minerva Formation.

The reasons for slower average interval velocities to top Minerva Formation level at Conan-1 are not fully understood and likely to be complex. For example, facies controls on variations in lithology and the different structural histories between the Conan and Mussel locations.

6.3 VSP Interpretation

The VSP tie to Conan-1 is fairly good. The best tie is obtained with the Normal Polarity Corridor Stack, with a +11msec static shift. The phase-matched (-40 degree phase rotation) seismic-to-VSP tie produces only a minor waveform change at the Top Minerva Formation event. The critical event ties are summarised as follows:

- Top Sherbrook Group: VSP ties 17 msec lower than the pre-drill pick; fair-quality tie.
- Top Minerva Formation: VSP ties 18 msec higher than pre-drill pick; excellent-quality tie.
- To La Bella Formation: No predicted pre-drill pick; good-quality tie.
- Top Otway Group: No predicted pre-drill pick; good quality tie.

7 GEOLOGICAL DISCUSSION

7.1 Summary of Permit History

Conan-1 was drilled in VIC/P31 in the eastern offshore Otway Basin. The permit is currently held by BHP Petroleum (90%, Operator) and Parker and Parsley Australasia Ltd (10%).

Table 3 lists the wells drilled in VIC/P31 prior to the drilling of Conan-1.

Table 3
WELLS DRILLED IN VIC/P31

WELL NAME	CURRENT PERMIT	COMPLETION DATE	TOTAL DEPTH	STATUS
Mussel-1	VIC/P31	SEPT 1969	2450	P/A
Eric The Red-1	VIC/P31	MAR 1993	1875	P/A
Minerva-1	VIC/P31	APRIL 1993	2425	Suspended, Minerva FM gas discovery
Minerva-2A	VIC/P31	SEPT 1993	2170	Suspended, successful Minerva FM gas appraisal well
Loch Ard-1	VIC/P31	OCT 1993	2425	P/A

7.2 Regional Geology

The first phase of rifting in the Otway Basin was initiated during the Late Jurassic to very Early Cretaceous period. The syn-rift Crayfish Group was deposited during the Valanginian to Barremian period as fluvial and alluvial fan sands, silts and clays, in tilted NW-SE half graben settings.

Rifting effectively ceased by early Aptian time, giving way to a thermal-sag phase of basin development. During this phase, the post-rift Aptian to Albian Eumeralla Formation was deposited, comprising fluvial and lacustrine lithic sandstones, siltstones and claystones provenanced by a volcanic arc system to the east. The Middle and Lower Eumeralla Coal Measures represent two discrete coal-bearing units deposited in lake-margin environments, and are dominated by claystones and thin coals, with significant hydrocarbon source potential.

A second phase of rifting commenced during the earliest Cenomanian (96 Ma), inheriting and enhancing the structural style of the previous rifting episode, and resulting in block faulting, uplift and erosional truncation of the Eumeralla Formation sequences (which can therefore be thought of as representing the post-rift section of the first-rift phase, and the pre-rift section of the second rift-phase). A series of NW-SE trending terraces, stepping down towards the basin centre, were created at this time (for example, the Mussel Terrace of VIC/P30-31).

This second phase of rifting continued from Cenomanian to Santonian time. The La Bella, Minerva and Napier Formations of the syn-rift Shipwreck Group were deposited within a vast delta system, depositional facies varying from non-marine/fluvial in the north and east of the VIC/P30-31 permit areas, to nearshore and offshore/deltaic in the south and west. The litharenitic La Bella Formation represents the initial erosion product of the block-faulted Eumeralla section, particularly the Otway Ranges high-trend emerging to the east. The cleaner, more strongly quartz-arenitic Minerva Formation resulted from either a re-working of the La Bella Formation sediments, or a switch in sediment provenance to northern basin-flanking basement highs, or both. The Napier Formation claystones represent the pro-delta to delta-front facies of the retrograding Shipwreck Group delta system.

The second rifting episode ended, and sea-floor spreading began, at about 85 Ma (late Santonian). This event is marked by a regional, often angular, unconformity, with which an episode of NW-SE compression was associated (gently folding Shipwreck Group sediments in the permit areas).

The post-rift to drift-phase Sherbrook Group sediments, deposited from the late Santonian to late Maastrichtian, show onlap and downlap onto the gently folded break-up unconformity. The Sherbrook Group is dominated by the distal claystones and siltstones of several extensive delta systems. These lithologies grade vertically to more proximal delta sand and clay/silt facies as sediment supply came to match the available accommodation space. NE-SW extension, punctuated by periods of NW-SE compression, continued throughout this period.

Sherbrook Group sedimentation was ended by a period of compressional uplift and erosion. This was followed by thermal, south-westerly subsidence of the basin, with attendant relative fall in sea-level and marine transgression. A long period of sediment starvation followed within the basin proper, until the sands and silts of the Wangerrip Group Magasequence prograded south-westwards into the basin during the Eocene. This progradation was terminated by further sediment starvation, the likely result of an interplay between sediment supply, basin subsidence and eustatic sea-level rise.

This pre-Oligocene hiatus also coincided with the establishment of open-marine conditions, and a corresponding shift from clastic-dominated to carbonate-dominated sedimentary systems, along the southern margin of Australia. The Nirranda Group, comprising marls and limestones of the Narawaturk Marl, prograded into the basin during the Oligocene, followed by the prograding bioclastic carbonate systems of the Miocene to Recent Heytesbury Group (Gellibrand Marl and Port Campbell Limestone).

7.3 Contributions to Geological Concepts and Conclusions

7.3.1 Stratigraphy

The well penetrated a complete Late Cretaceous section except for the Napier Formation. The interval from 1705-1717mRT may represent the Napier Formation based on wireline log characteristics but palynological analysis of a sample from this interval does not unequivocally indicate its presence.

The presence of Minerva and La Bella Formation sediments at the well increases the known distribution of these formation throughout VIC/P31. Both these formations, however, were thinner than expected (84m and 57m respectively) and significantly thinner than equivalent sections in offset wells. The Minerva and La Bella Formations are approximately 250m+ and 170m+ at Minerva-1, and 250m+ and 450m+ respectively at La Bella-1. This indicates that sediments encountered in Conan-1 under went a different structural/stratigraphic history than those at Minerva-1 and La Bella-1.

The presence of Otway Group sediments at only 1858mRT, approximately 450m shallower than expected, further indicates that sediments at the well have under gone a significantly different structural/stratigraphic history than expected.

7.3.2 Reservoir

Good quality Minerva Formation quartzose sandstones were intersected at the mapped closure in the well.

Quartzose sandstones of the Minerva Formation were intersected and a petrophysical evaluation was carried out over the interval 1717-1801mRT (see appendix 1). This interval contained 37.5m of clean quartzose sandstone, over a 84m gross interval, giving a net to gross of 44% (10% porosity and 50% Vsh cut-off used) with porosities ranging from 15% to 24% with an average of 18.9%.

The La Bella Formation (1801-1858mRT) consists of argillaceous quartz sandstones with abundant lithic fragments. In general, the porosities are low (less than 10%) due to the high argillaceous content; however, significant porosity is interpreted over the interval 1840-1858, with 11m of net sand (10% porosity and 50% Vsh cut-off used) having an average porosity of 14.5%.

The Eumeralla Formation consists of argillaceous quartzose/lithic sandstones with up to 50% lithic content in some sandstones. Porosity's are typically poor ranging from 2-12% but in the upper 1.5m there is a zone with porosities ranging from 10-20%. The higher porosities seen at this point are mostly likely due to porosity enhancement related to the Base La Bella Formation unconformity.

Regional studies (Preston, 1995) indicate that although the La Bella and Eumeralla Formations may have significant porous intervals their permeability is typically very low due to the presence of unstable lithics, particularly volcanolithics.

7.3.3 Seal

A 528m interval of Belfast Formation claystone was penetrated which was of sufficient thickness and competency to act as a good top seal and cross fault seal.

7.3.4 Source, Migration and Timing

Analysis of the vitrinite reflectance and spore coloration vs depth data suggests that the Cretaceous section penetrated in the well has been warmer than it is at present, due either to elevated palaeo-heat flow, or deeper burial, or both.

Two possible reasons for the failure to find hydrocarbons at Conan-1 in relation to the source rock are: that there was either no source rocks present in the drainage cells of the prospect or the source rocks were ineffective. Preliminary thermal modelling studies at the well location suggest that the Middle Eumeralla Coal Measures may not have reached levels of maturity sufficient for the expulsion of gas, while the Lower Eumeralla Coal Measures may have exhausted their source potential prior to trap formation (J. Preston pers common).

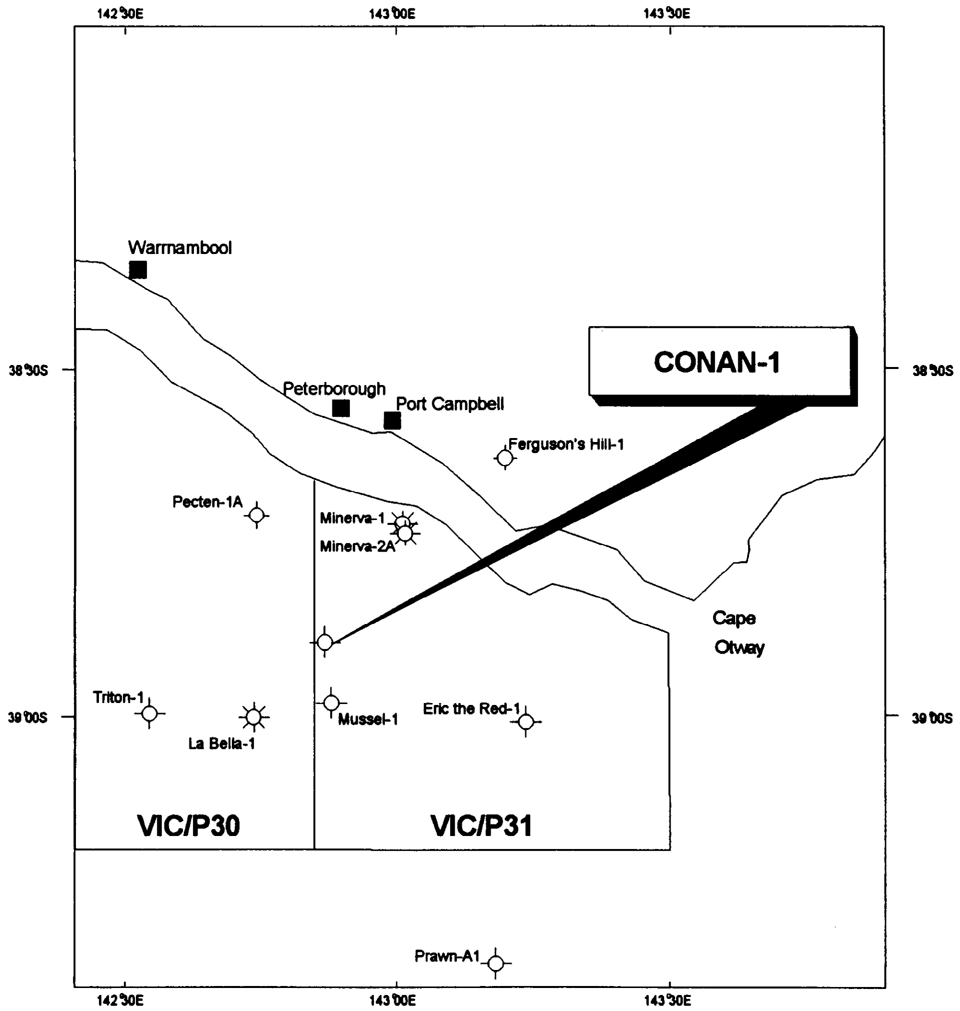
REFERENCES

Preston, J., 1995, Conan-1 Prospect File, *BHPP report*.

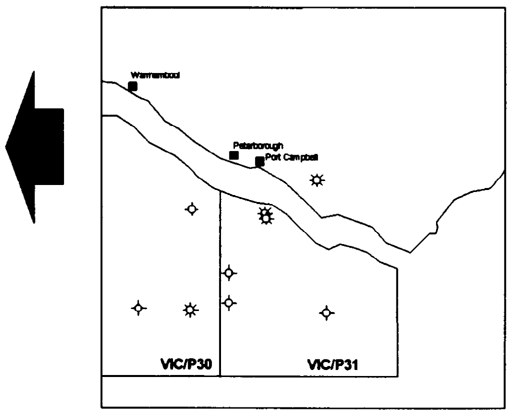
FIGURES

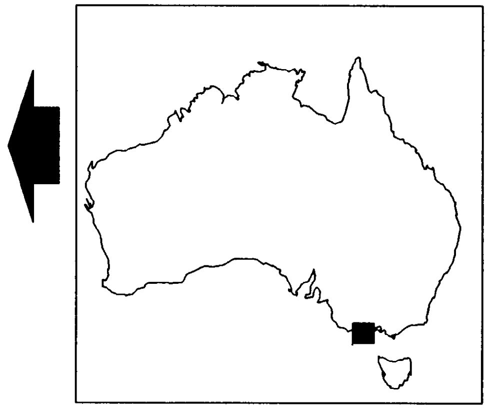
CONAN-1
LOCATION MAP

BHP



Permit No.	:	VIC/P31
Rig	:	OCEAN BOUNTY
Latitude	:	38° 52' 14.953" S
Longitude	:	142° 46' 52.224" E





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25 Sep, 1995

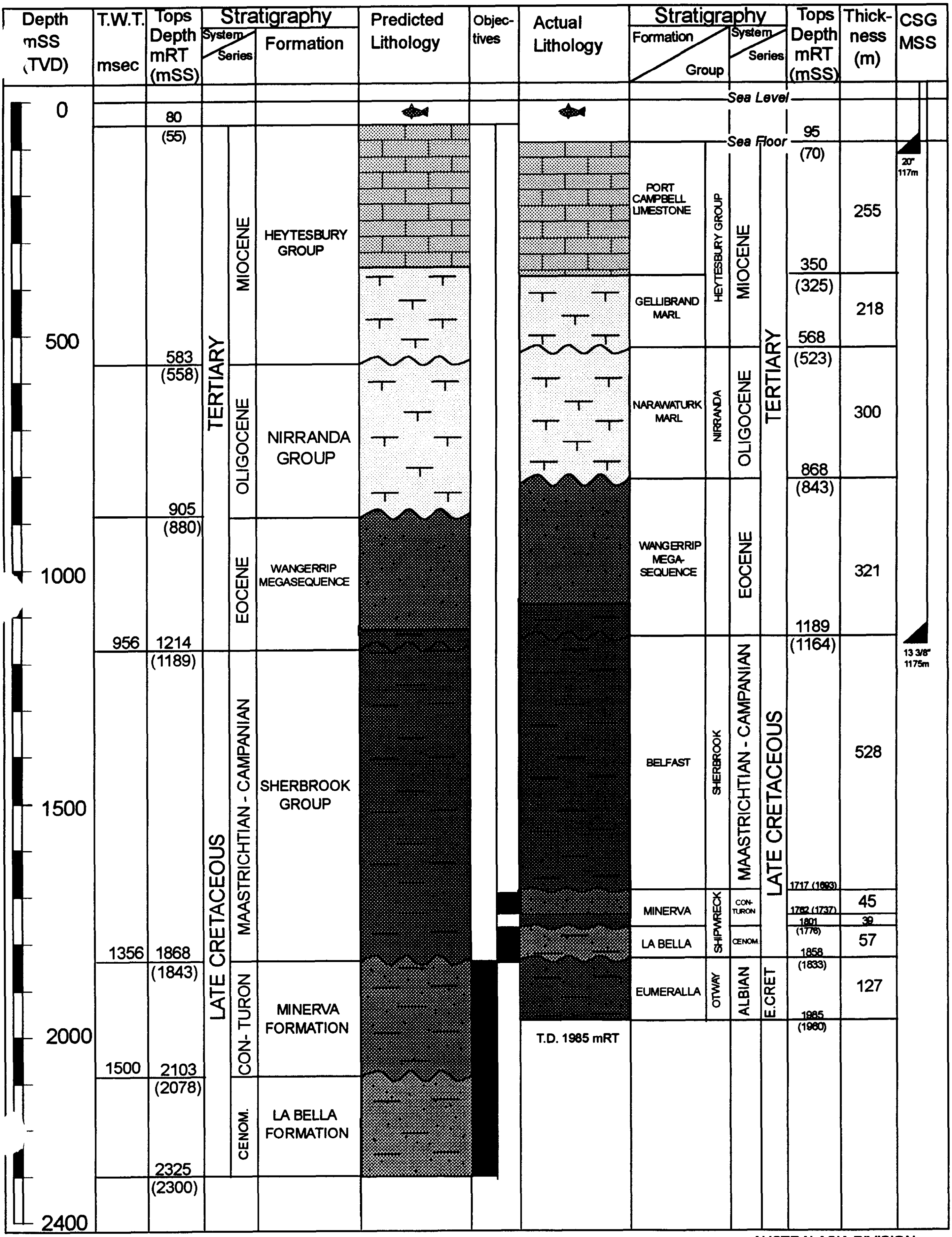
Figure 1

Australia Division
BHP Petroleum

CONAN - 1
PREDICTED v ACTUAL

PERMIT: VIC/P31

LINE: OH94-246 LAT: 38°52'14.95"S ELEV: RT: 25m SPUD: 24/7/95 STATUS: P&A
SP: 1147 LONG: 142°46'52.22"E WATER DEPTH: 70.0m RIG RELEASE: 4/8/95 RIG: Ocean Bounty



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NOVEMBER 1995

Figure 2

AUSTRALASIA DIVISION
BHP Petroleum

OTWAY BASIN
STRATIGRAPHIC COLUMN

BHP

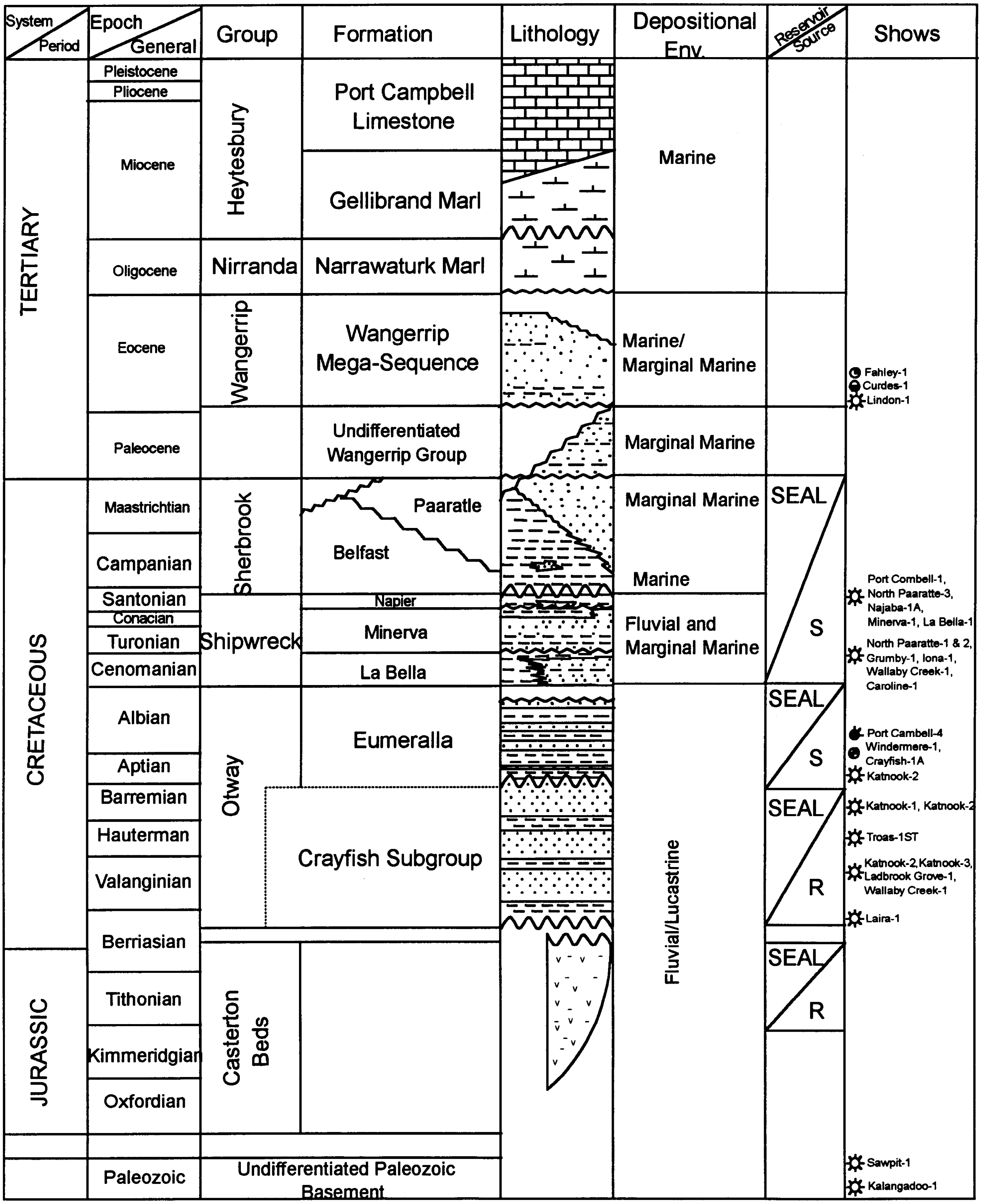

Figure 3

APPENDICES

MORGAN PALAEO ASSOCIATES

PALYNOLOGICAL/PETROLEUM GEOLOGICAL CONSULTANTS

POSTAL ADDRESS: Box 161, Maitland, South Australia 5573
DELIVERIES: 1 Shannon Tce, Maitland, South Australia 5573
Phone (088) 32 2795 Fax (088) 32 2798

PALYNOLOGY OF BHPP CONAN-1,

OFFSHORE OTWAY BASIN,

VICTORIA, AUSTRALIA

BY

ROGER MORGAN

for **BHP PETROLEUM**

September 1995

REF:OTW.RPCONAN1

PALYNOLOGY OF BHPP CONAN-1

OFFSHORE OTWAY BASIN,

VICTORIA, AUSTRALIA

BY

ROGER MORGAN

CONTENTS **PAGE**

I SUMMARY

1250m(cutts) : *lillei* Zone (*korojonense* Dino Zone) : Campanian : very nearshore marine : immature : usually Sherbrook Group

1300m(cutts) - 1450m(cutts) : upper *senectus* Zone (1300-1350m upper *australis* Dino Zone, 1450m lower *australis* Dino Zone) : Campanian : nearshore to brackish: immature ; usually Sherbrook Group

1500m(cutts) - 1575.5m(swc) : middle *senectus* Zone (upper *aceras* Dino Zone) : Campanian : nearshore : immature : usually Sherbrook Group

1601.5m(swcs) - 1640m(cutts) : lower *senectus* Zone (middle *aceras* Dino Zone) : Campanian : nearshore marine : immature : usually lower Belfast Mudstone of the Sherbrook Group

1649.0m(swc) - 1704.0m(swc) : upper *apoxyexinus* Zone (1649.0m lower *aceras* Dino Zone, 1678.0-1700m upper *cretacea* Dino Zone, 1704.0m lower *cretacea* Dino Zone) : Santonian : nearshore marine : immature : usually basal Belfast Mudstone of the Sherbrook Group

1715.0m(swc) : middle *apoxyexinus* Zone : Santonian : nearshore marine : immature : usually Napier Formation

lower *apoxyexinus* and upper *mawsonii* Zone not seen

1719.0m(swc) : *mawsonii* Zone (?lower) : Turonian-Coniacian : nearshore marine : marginally mature : usually Minerva Formation

1770m(cutts) - 1800m(cutts) : lower *mawsonii* Zone : (1775.0-1800m *infusorioides* Dino Zone) : Turonian : nearshore marine : marginally mature : usually Minerva Formation

1805.0m(swc) - 1830m(cutts) : *distocarinatus* Zone (1824.0m swc and ?1830m cutts *infusorioides* Dino Zone) : non-marine to marginal marine : marginally mature : usually La Bella Formation

1861.0m(swc) - 1867.0m(swc) : indeterminate barren

1872.0m(swc) - 1875.0m(swc) : *paradoxa* Zone : Albian : non-marine to brackish : marginally mature :usually Eumeralla Formation

1965m(cutts) : indeterminate caved material.

Depth (m)	Sample	Spore-Pollen Zone	Dinoflagellate Zone	Dino %	Environment
1250	cutts	lillei	korojonense	(3)	very nearshore
1300	cutts	upper senectus	upper australis	(<1)	marginal marine
1350	cutts	upper senectus	upper australis	(<1)	brackish
1400	cutts	upper senectus	lower australis	2	very nearshore
1450	cutts	upper senectus	lower australis	(13)	nearshore
1500	cutts	middle senectus	upper aceras	(8)	nearshore
1539.0	swc	middle senectus	upper aceras	8	nearshore
1575.5	swc	middle senectus	upper aceras	9	nearshore
1601.5	swc	lower senectus	middle aceras	6	nearshore
1610	cutts	lower senectus	middle aceras	(6%)	nearshore
1640	cutts	lower senectus	middle aceras	(25%)	nearshore
1649.0	swc	upper apoxyexinus	lower aceras	22	nearshore
1678.0	swc	upper apoxyexinus	upper cretacea	20	nearshore
1700	cutts	upper apoxyexinus	upper cretacea	(26)	nearshore
1704.0	swc	upper apoxyexinus	lower cretacea	15	nearshore
1715.0	swc	middle apoxyexinus	-	7	nearshore
1719.0	swc	?lower mawsonii	-	5	nearshore
1770	cutts	lower mawsonii	-	(28)	nearshore
1775.0	swc	lower mawsonii	infusorioides	11	nearshore
1790	cutts	lower mawsonii	infusorioides	(23)	nearshore
1795.0	swc	lower mawsonii	infusorioides	6	nearshore
1800	cutts	lower mawsonii	infusorioides	(14)	nearshore
1805.0	swc	distocarinatus	-	3	very nearshore
1824.0	swc	distocarinatus	infusorioides	2	marginal marine
1829.0	swc	distocarinatus	-	0	non-marine
1830	cutts	distocarinatus	(?infusorioides)	(7)	?non-marine
1861.0	swc	indeterminate	-	-	-
1867.0	swc	indeterminate	-	-	-
1872.0	swc	paradoxa	-	0	non-marine
1875.0	swc	paradoxa	-	1	brackish
1965	cutts	indeterminate	-	-	-

TABLE 1 : INDIVIDUAL SAMPLE SUMMARY : CONAN-1

II INTRODUCTION

Twelve cuttings samples were studied during drilling on an urgent basis, and reported by fax, at the request of Jim Preston. After well completion, two batches of samples were submitted for detailed study. The first comprised twelve sidewall cores. The second comprised six cuttings and five swcs. All these results are summarised herein.

Palynomorph occurrence data are shown as Appendix I and form the basis for the assignment of the samples to nine spore-pollen and nine dinoflagellate units of Campanian to Albian age.

Specimen counts were made on all assemblages and expressed in the raw data as percentages. In the summary table, percentages from cuttings are bracketed (5%) to show that they may be inaccurate due to caving.

The Cretaceous spore-pollen zonation is essentially that of Dettmann and Playford (1969), but has been significantly modified and improved by various authors since, and most recently discussed in Helby et al (1987), as shown on Figure 1. The Late Cretaceous zonation has been modified by Morgan (1992) in project work for BHPP (Figure 2).

Maturity data was generated in the form of Spore Colour Index, and is plotted on Figure 3 Maturity Profile of Conan-1. The oil and gas windows on Figure 3 follow the general consensus of geochemical literature. The oil window corresponds to spore colours of light-mid brown (Staplin Spore Colour Index of 2.7) to dark brown (3.6). These correspond to vitrinite reflectance values of 0.6% to 1.3%. Geochemists argue variations on kerogen type, basin type and basin history. The maturity interpretation is thus open to reinterpretation using the basic colour observations as raw data. However, the range of interpretation philosophies is not great, and probably would not move the oil window by more than 200 metres.

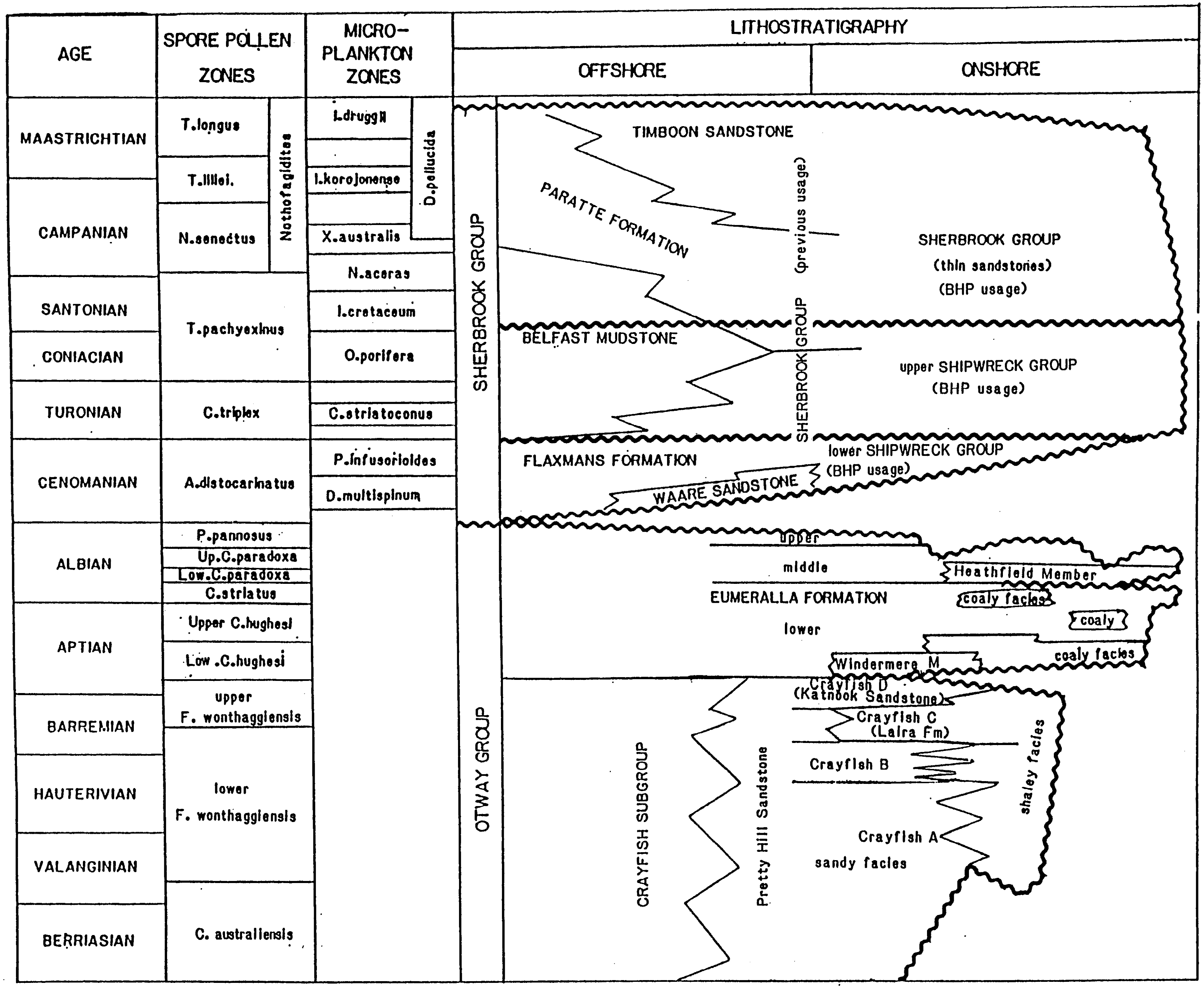

FIGURE 1. CRETACEOUS REGIONAL FRAMEWORK, OTWAY BASIN

SPORE-POLLEN ZONES		SPORE-POLLEN HORIZONS
LONGUS	upper	T. confessus / T. sectilis 1
		G. rudata ● 1b
	lower	N. senectus ● 1d
		T. sabulosus 2a
		T. longus 2b
LILLEI	upper	
		T. sectilis 3a
	lower	T. lillei 3b
SENECTUS	upper	
		G. rudata 7a
	middle	T. sabulosus 7e
	lower	N. senectus 9a
APOXYEXINUS	upper	A. cruciformis 1%
	middle	A. cruciformis 1-4% 11
		12
	lower	A. cruciformis 10%+
		12a A. cruciformis 10%+
MAWSONII		A. distocarinatus12c
		consistent 13 A. distocarinatus
		P. mawsonii 15a
DISTOCARINATUS		common saccates A. cruciformis

DINOFLAGELLATE ZONES		DINOFLAGELLATE HORIZONS
DRUGGII		M. conorata 1a
		M. conorata 1c
		M. druggii 1e
		I. pellucida 2
KOROJONENSE		I. korojonense 3 / I. cretacea
		I. korojonense 3c / I. pellucida
AUSTRALIS	upper	X. australis 4 / X. ceratoides / A. wisemaniae
		A. suggestium 4a
	lower	N. aceras 5 / N. semireticulata / X. australis ● 6
ACERAS	upper	N. tuberculata 7
		X. australis 7b
		N. tuberculata 7c / N. semireticulata
		O. obesa 7d
	middle	T. suspectum / Heterosphaeridium 10%+ 8
	lower	Heterosphaeridium 20%+ 9
		N. aceras 9b
CRETACEA	upper	I. belfastense 10 / A. denticulata
		Heterosphaeridium 20%+ 10a
		I. belfastense / A. denticulata 11a
	lower	I. cretacea 11b
PORIFERA		O. porifera 12b
STRIATOCONUS		
INFUSORIOIDES		C. edwardsii 14
		C. edwardsii ● 15
— — — —		C. edwardsii ● 15b
		dinoflagellates

FIGURE 2 ZONATION USED HEREIN SHOWING THE NUMBERED HORIZONS AGAINST THE EXISTING FORMAL ZONATION.

● =frequent (4-10%) ⬤=common (11-30%)

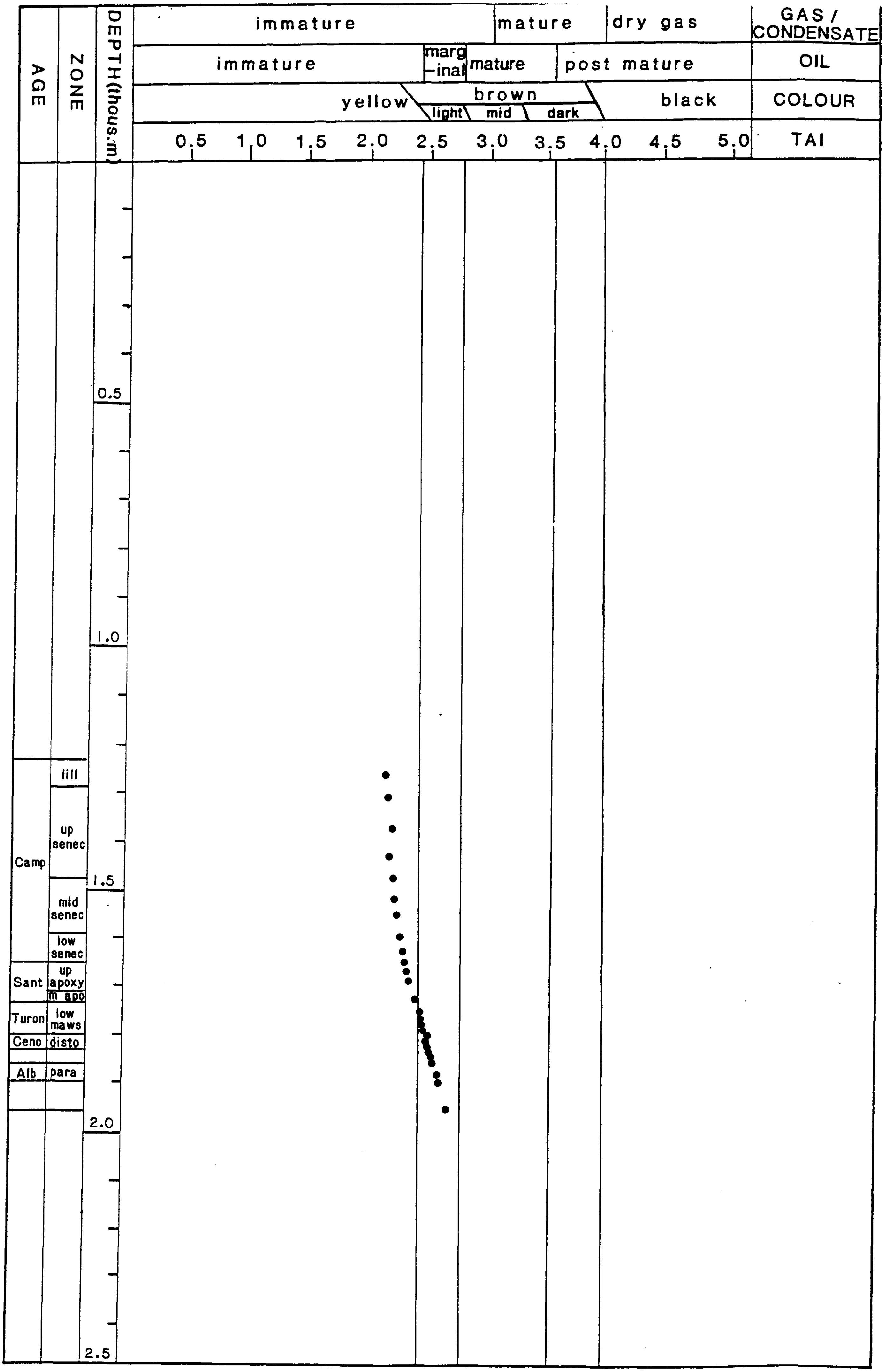

FIGURE 3 MATURITY PROFILE : CONAN-1

III PALYNOSTRATIGRAPHY

A 1250m(cutts) : *lillei* Zone (*korojonense* Dino Zone)

Assignment to the *Tricolporites lillei* Zone of Campanian age is indicated by the absence of younger markers at the top, and oldest *Triporopollenites sectilis* at the base, and is confirmed by the dinoflagellates. *Proteacidites* is common with *Cyathidites minor*, *Nothofagidites endurus* and *Vitreisporites pallidus* frequent. Rare elements include *Gambierina rudata*, *Lygistepollenites balmei*, *Tricolpites confessus*, *Tricolporites apoxyexinus* and *T. sectilis*. Rare Permian reworking was seen.

Amongst the scarce dinoflagellates, youngest *Isabelidinium cretacea* without older markers indicates the *Isabelidinium korojonense* Dino Zone, correlative with the *lillei* Spore-Pollen Zone.

Very nearshore marine environments are indicated by the scarce dinoflagellates and their low diversity, the abundant and diverse spores and pollen, and common freshwater algae (*Botryococcus*).

Yellow spore colours indicate immaturity for hydrocarbons.

These features are usually seen in the Sherbrook Group.

B 1300m(cutts) - 1450m(cutts) : upper *senectus* Zone (upper and lower *australis* Dino Zones)

Assignment to the upper *Nothofagidites senectus* Zone of Campanian age is indicated at the top by the absence of younger markers and confirmed by the dinoflagellates and at the base by oldest *Gambierina rudata*. Within the interval, *Falcisporites similis*, *Proteacidites* and *Vitreisporites pallidus* are common, with *C. minor*, *N. endurus*, *Microcachryidites antarcticus* and *Phyllocladidites mawsonii* frequent. Rare elements include *G. rudata*, *L. balmei*, *T. confessus* and *T. sabulosus*. Rare Permian and Triassic reworking were seen.

Amongst the dinoflagellates, *Xenikoon australis* without older markers indicates the upper *australis* Dino Zone at 1300-1350m, where all taxa are extremely rare. *Nelsoniella semireticulata* and *N. aceras* without older markers indicate the lower *australis* Dino Zone at 1400-1450m, where dinoflagellates are more frequent, with *X. australis* the most persistent, and frequent (8%) at 1450m. *Areosphaeridium suggestium* and the *Nelsoniella* spp are rare throughout.

Environments shallow uphole from nearshore at the base (with 13% low diversity dinoflagellates) to brackish marine at the top (with <1% very low diversity dinoflagellates). Pollen and spores are abundant and diverse throughout, with freshwater algae (*Botryococcus*) frequent throughout around 5%.

Yellow spore colours indicate immaturity for hydrocarbons.

These features are normally seen in the Sherbrook Group.

C 1500m(cutts) - 1575.5m(swc) : middle *senectus* Zone (upper *aceras* Dino Zone)

Assignment to the middle *N. senectus* Zone of Campanian age is indicated at the top by the absence of younger markers and confirmed by the dinoflagellates, and at the base by oldest *T. sabulosus*. Within the interval, *F. similis* is common, with *Proteacidites* very frequent (less than above), *Dilwynites granulatus* frequent (more than above), and C. minor, *M. antarcticus*, *P. microsaccatus* and *V. pallidus* frequent (as above). Rare elements are *Australopollis obscurus*, *N. endurus* (less than above), *T. confessus* and *T. gilli* (both to 1539.0m) and *T. sabulosus*. Very rare Permian reworking was seen.

Amongst the rare dinoflagellates, *Nelsoniella tuberculata* throughout and oldest *X. australis* at 1539.0m indicate the upper *Nelsoniella aceras* Dino Zone. *X. australis* is frequent at 1500m and 1539.0m with all other dinoflagellates rare. *Canningia giant*, *N. aceras* and *Heterosphaeridium heterocanthum* are rare but consistent. *Eucladinium madurense*, *Isabelidinium cretacea*, *Odontochitina porifera* and *O. triangularis* are rare and inconsistent.

Nearshore marine environments are indicated by the low dinoflagellate content and diversity, with pollen and spores abundant and diverse. Freshwater algae are minor (3%) except at 1539.0m, where they are common (10%).

Yellow spore colours indicate immaturity for hydrocarbons.

These features are normally seen in the Sherbrook Group.

D 1601.5m(swc) - 1640m(cutts) : lower *senectus* Zone (middle *aceras* Dino Zone)

Assignment to the lower *Nothofagidites senectus* Spore-Pollen Zone is indicated by oldest *Nothofagidites endurus* at the base, in the absence of younger indicators, and confirmed by the dinoflagellates. Of the spore-pollen, *Dilwynites granulatus*, *Falcisporites similis*, *Proteacidites* spp and *Vitreisporites pallidus* are common, with rare but significant elements including *Australopollis obscurus*, *Amosopollis cruciformis*, *Clavifera triplex*, *Ornamentifera sentosa* and *Phyllocladidites mawsonii*. Caved is *Tetracolporites verrucosus*. Permian reworking is rare.

Of the dinoflagellates, *Heterosphaeridium* spp are the most frequent, increasing downhole (2%, 4% and 10%). Zonal assignment is on *Nelsoniella aceras* with moderate *Heterosphaeridium* spp without younger or older markers. Top ranges include *Trithyrodinium glabrum*, at 1601.5m, and *Odontochitina obesa* at 1640m. *Odontochitina porifera*, *O. cribropoda*, *G. hymenophora* and *Isabelidinium cretacea* are rare and inconsistent.

Nearshore marine environments are indicated by the low dinoflagellate content and diversity amongst dominant and diverse spores and pollen. At 1640m, diversity is moderate.

Yellow spore colours indicate immaturity for hydrocarbons.

These features are normally seen in the Sherbrook Group in the lower Belfast Mudstone in this area.

E 1649.0m(swc) - 1704.0m(swc) : upper *apoxyexinus* Zone (1649.0m lower *aceras* Dino Zone, 1678.0-1700m upper *cretacea* Dino Zone, 1704.0m lower *cretacea* Dino Zone)

Assignment to the upper *Tricolporites apoxyexinus* Spore-Pollen Zone of latest Santonian age is indicated by very rare *A. cruciformis* in the absence of younger or older markers. Common are *F. similis*, *Gleicheniidites* and

Microcachryidites antarcticus. Frequent are *Proteacidites* spp and *V. pallidus*. Rare but significant are *A. obscurus*, *A. cruciformis* and *P. mawsonii*. No caving was visible in the cuttings sample. Minor Permian and Triassic reworking were seen.

The lower *N. aceras* Dino Zone is indicated by the major downhole acme of *Heterosphaeridium* spp (19% at 1649.0m). Rare are *Areosphaeridium suggestium*, *N. aceras*, *O. obesa* and *O. cribropoda*.

The upper *Isabelidinium cretacea* Dino Zone is indicated by *Isabelidinium belfastense* at 1678.0m and 1700m, and by *Chatangiella victoriensis* at 1678.0(swc) and *Amphidiadema denticulata* at 1700m(cutts). *Heterosphaeridium* spp especially *H. solida* are the dominant dinoflagellate taxa, with others rare. *Botryococcus* is common at 1678.0m only.

At 1704m, the lower *I. cretacea* Dino Zone is indicated by *I. cretacea* without younger markers. *Spiniferites* spp are frequent with *Botryococcus* also frequent.

Nearshore marine environments are indicated by the low dinoflagellate content and moderate to low diversity. Spores and pollen are dominant and diverse.

Yellow spore colours indicate immaturity for hydrocarbons.

These features are normally seen in the basal Belfast Mudstone of the Sherbrook Group.

F 1715.0m(swc) : middle *apoxyexinus* Zone

Assignment to the middle *T. apoxyexinus* Spore-Pollen Zone of Santonian age is indicated by the downhole influx of frequent *A. cruciformis* (4%) without older markers. A single *Appendicisporites distocarinatus* is considered reworked. Amongst the spore-pollen, *F. similis* and *M. antarcticus* are common, with *A. cruciformis*, *Dilwynites granulatus*, *Gleicheniidites* and *P. microsaccatus* frequent. *P. mawsonii* is rare and *Proteacidites* spp were not seen.

Amongst the dinoflagellates, no zone diagnostic taxa were seen. However, youngest *Circulodinium deflandrei* is consistent with the middle *apoxyexinus* Spore-Pollen Zone.

Nearshore marine environments are indicated by the low dinoflagellate content and diversity. Spores and pollen are dominant and diverse, and there is abundant cuticle.

Yellow spore colours indicate immaturity for hydrocarbons.

These features are normally seen in the Napier Formation, which may be present in the higher resistivity log interval 1707-18m.

G 1719.0m(swc) : *mawsonii* Zone (?lower)

Assignment to the *P. mawsonii* Spore-Pollen Zone of Coniacian-Turonian age is indicated by *P. mawsonii* without younger markers. *F. similis*, *D. granulatus*, *M. antarcticus* and *P. microsaccatus* are common, with *Cyathidites* and *Gleicheniidites* frequent. Rare are *P. mawsonii* and *Phimopollenites pannosus*. A single *Gambierina rudata* is considered caved as mud contamination. The lower *mawsonii* Zone is implied by the absence of *A. cruciformis*.

Dinoflagellates are rare and not age diagnostic.

Environments are very nearshore marine with low dinoflagellate content and very low diversity. Significant lake influence is shown with freshwater algae (*Botryococcus*) frequent. Pollen and spores are dominant and diverse.

Light brown spore colours indicate marginal maturity for hydrocarbons.

These features are normally seen in the Minerva Formation.

H 1770m(cutts) - 1800m(cutts) : lower *mawsonii* Zone (1775.0-1800m *infusorioides* Dino Zone)

Assignment to the lower *P. mawsonii* Zone of Turonian age is indicated by youngest *A. distocarinatus* without *A. cruciformis* at the top, and oldest *in situ* *P. mawsonii* at the base. This is confirmed by the swc at 1795.0m. Frequent to common are *Cyathidites minor*, *F. similis*, *Gleicheniidites* and *M. antarcticus*. Rare but significant are *A. distocarinatus*, *P. mawsonii* and *Trilobosporites trioreticulosus*. Significant caving is seen in the cuttings, marked especially by frequent *Proteacidites* and the dinoflagellates.

Amongst the dinoflagellates, *Heterosphaeridium* spp are the most frequent. Youngest *Cribroperidinium edwardsii* at 1775.0m indicates the *Palaeohystrichophora infusorioides* Dinoflagellate Zone of early Turonian to Cenomanian age. *P. infusorioides* is rare but consistent in the swcs. Other taxa are not zone diagnostic. The two cuttings samples show caving from the Campanian *X. australis* and *N. aceras* Dinoflagellate Zones.

Nearshore marine environments are indicated by the low dinoflagellate content and diversity especially in the swcs. Dinoflagellate content in the cuttings is considered unreliable due to caving. Pollen and spores are dominant and diverse.

Light brown spore colours indicate marginal maturity for hydrocarbons.

These features are normally seen in the Minerva Formation in this area.

I 1805.0m(swc) - 1830m(cutts) : *distocarinatus* Zone (1824.0m swc and ?1830m cutts *infusorioides* Dino Zone)

Assignment to the *A. distocarinatus* Spore-Pollen Zone of Cenomanian age is indicated by *A. distocarinatus* without younger or older markers. Common are *F. similis*, *M. antarcticus* and *P. microsaccatus*. Frequent are *Cyathidites* and *V. pallidus*. *A. distocarinatus* and *Triporoletes* spp are rare but consistent. *P. mawsonii* occurs in the cuttings only and is considered caved. *Phyllocladidites eunuchus* occurs in swcs and cuttings and is considered in place. Rare Permian and Early Cretaceous reworking was noted.

Environments are marginal marine to non-marine, with the swcs yielding extremely few (1824.0m) to no (1829.0m) dinoflagellates. The cuttings are contaminated by caving. The *P. infusorioides* Zone is indicated at 1824.0m swc and suggested at 1830m cutts by the presence of *C. edwardsii*. At 1830m(cutts), it could be caved. Significant lake influence is indicated by frequent freshwater algae (*Botryococcus*). Spores and pollen are abundant and diverse.

These features are usually seen in the La Bella Formation in this area.

Light brown spore colours indicate marginal maturity for oil and immaturity for gas/condensate.

J 1861.0m(swc) - 1867.0m(swc) : indeterminate

These two samples were almost barren of palynomorphs due to their sandy lithologies. The few taxa recovered were mostly long ranging spores and pollen. A single dinoflagellate (*Maduradinium pentagonum* at 1867.0m) is clearly mud contamination from the Sherbrook Group.

K 1872.0m(swc) - 1875.0m(swc) : *paradoxa* Zone

Assignment to the *Copt*ospora paradoxa Zone of Albian age is indicated by youngest *in situ C. paradoxa* (1875.0m), *Crybelosporites striatus* (1872.0m) and the downhole influx of *Cicatricosisporites australiensis* and *Foraminisporis asymmetricus*. Abundant to very common is *F. similis*, with common *Cyathidites* and frequent *C. australiensis*, *M. antarcticus* and *Retitriletes austroclavatidites*.

Extremely rare dinoflagellates are clearly caved and present as mud contamination. Extremely rare spiny acritarchs at 1875.0m are considered in place and indicate brackish environments. Significant lake influence is indicated by the freshwater algae (*Botryococcus* and *Schizosporis*).

Light brown spore colours indicate marginal maturity for oil, and immaturity for gas/condensate.

These features are normally seen in the Eumeralla Formation.

L 1965m(cutts) : indeterminate

This assemblage is clearly caved with spores and pollen most similar to the Santonian upper *apoxyexinus* Zone, and the dinoflagellates most similar to the Campanian *australis* and *aceras* Dino Zones. Very few taxa could be regarded as in place, suggesting caved Sherbrook Group into barren Eumeralla Formation.

IV CONCLUSIONS

Palynology suggests a normal Belfast Mudstone, complete to the base in upper *apoxyexinus* Zone. Beneath this, a thin and incomplete Napier Formation appears to be present and includes only the middle *apoxyexinus* Zone with the lower *apoxyexinus* Zone lost by unconformity. Beneath, the Minerva Formation may be truncated, as no upper *mawsonii* Zone was seen. Alternatively, it may be barren, as the Minerva Sand is exceptionally clean and so lacks claystone interbeds for swcs. Beneath, the La Bella Formation is present but yields are variable as usual in this interval. At the base, the Eumeralla Formation is indicated on swc data although some swcs and the cuttings are inconclusive.

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CONAN-1

PETROPHYSICAL INTERPRETATION REPORT

PREPARED BY: Anne Locke
Petrophysicist

CON-1/PP/S01/R

DATE: 5th October, 1995

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

Executive Summary

Conan-1 was drilled by BHP Petroleum during July, 1995, in the Otway Basin approximately 23 km southwest of the Minerva gas discovery and 17 km northeast of the La Bella gas discovery. Conan-1 reached a total depth of 1985mRT, and was plugged and abandoned without intersecting any significant hydrocarbons.

The Late Cretaceous primary objective, Minerva Formation was intersected at 1718mRT. The formation consists of 37.5m of clean quartzose sandstone, over a 90.5m interval giving a net to gross of 41% and an average porosity of 18.9%.

The La Bella Formation (1808-1869.5mRT) consists of argillaceous quartz sandstones with abundant lithic fragments. In general the porosities are low (less than 10%) due to the high argillaceous content, however significant porosity is interpreted over the interval 1840-1859.5mRT, with 12.4m of net sand having an average porosity of 14.5%.

The Early Cretaceous Eumeralla Formation was intersected at 1869mRT and consists of argillaceous lithic sandstones. The sands contain up to 50% lithics, with the high argillaceous content resulting in low porosities (average porosity 8%) and low permeability.

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1. INTRODUCTION

Conan-1 was drilled by BHP Petroleum in the Otway Basin, to a total depth of 1985mRT in the Early Cretaceous sediments of the Eumeralla Formation. The well is located approximately 23 km southwest of the Minerva gas discovery and 17 km northeast of the La Bella gas discovery.

No significant hydrocarbon indications were recorded during drilling.

All depths used in this report are referenced to the rotary table (RT) of the Ocean Bounty which is 25m above sea level.

2. HOLE CONDITIONS

2.1 Hole Size

The reservoir section was drilled with a 12-1/4" bit and hole conditions are generally good, with mudcake buildup across permeable sands. Minor washouts and rugose hole are apparent throughout the shalier sections, however the interpretation is not significantly affected by the hole conditions.

2.2 Borehole Fluids

The 12-1/4" hole was drilled with a KCl Newdrill mud containing 1.8% barite. Table 1 is a summary of the mud properties used in this open hole section.

Table 1: Borehole Fluids

Mud Type	KCL-NEWDRILL
Mud Weight	1.20 g/cm^3
Estimated Salinity	95,000 ppm NaCl eq.
R_{mf}	0.102 ohmm @ 12°C
R_{mc}	0.140 ohmm @ 11°C
R_m	0.125 ohmm @ 12°C
Barite	1.8%

2.3 Temperature

An extrapolated bottom hole formation temperature of 85°C at 1960m was used in the interpretation. The current geothermal gradient is estimated to be 3.42°C/100m assuming a surface temperature of 18°C and a surface elevation of 0m.

Table 2: Maximum Recorded Temperatures

BHT (°C)	Depth (mRT)	Tool	Time Since Last Circ. (hrs.)
70	1957.0	DLL-MSFL	8.20
75	1960.0	CSI	14.75
80	1940.0	LDL-CNL	23.15
80	1960.0	CST	28.00

3. AVAILABLE DATA

3.1 Wireline Logs

One suite of wireline logs was acquired in Conan-1. The data were obtained from four runs in the 12-1/4" open hole. Refer to Table 3 for details.

Table 3: Wireline Logs (Suite-1)

Date & Time	Tool String	Interval (mRT)
01/08/95 @ 11:55 hrs	AS-DLL-MSFL-GR-SP-CAL-AMS	1200.0 - 1957.0 (GR to seabed)
01/08/95 @ 18:22 hrs	CSI Checkshot Survey [54 levels]	600.0 - 1955.0
02/08/95 @ 02:49 hrs	LDL-CNL-GR-FMI-AMS	1675.0 - 1940.0
02/08/95 @ 07:30 hrs	CST-GR [30 shots]	1539.1 - 1949.9

3.2 MWD Data

A Baker-Hughes INTEQ Dual Propagation Resistivity (DPR) MWD tool was used to record phase difference (RPDM) and amplitude ratio (RADM) resistivities in combination with a natural gamma ray (GRAM) measurement.

3.3 Conventional Cores

No conventional cores were cut.

3.4 Sidewall Cores

One CST run of 30 shots was made in the Conan-1 well. Of the 30 shots attempted, 29 sidewall cores were recovered, 1 core was lost.

3.5 RFT Data

No RFT's were attempted.

3.6 Drillstem Tests

No DST's were performed.

4. INTERPRETATION PROCEDURE

4.1 Data Preparation

The interval 1700-1930m was evaluated quantitatively using the Well Data System (WDS), a log storage, manipulation, interpretation and presentation package developed by Western Atlas International Inc.

The wireline logs were checked for depth matching and environmentally corrected using algorithms which emulate the appropriate chart book corrections.

4.2 Interpretation Model

Log analysis was carried out using BLISS, which is a shaly sand model, developed by BHPP. The shale vloume was calculated using both the gamma ray and neutron/density crossplot. As the shale volume derived from the neutron/density was higher than that derived from the gamma ray (due to the presence of lithic fragments), the gamma ray was used in the interpretation. Below 1808m the sands contain significant quantities of lithic fragments. The percentage of lithics was therefore calculated below 1808m, and the logs corrected. With the absence of petrology the lithics have been determined to have properties similar to that of shales. Porosity was derived using the neutron/density crossplot. The water saturations were determined using the Juhasz Equation, which is a derivative of the Waxman-Smits model and uses the concept of a 'normalised Q_v' which enables all parameters to be obtained directly from logs.

4.3 Input Parameters

Input parameters used for the log analysis are summarised in Table 4.

Table 4: Input Parameters (BLISS Interpretation Model)

Zoned Parameter Interval		Shale Parameters					
Name	Range (mRT)	Density (g/cm^3)	Neutron (Lst pu)	Sonic (usec/ft)	GRmin (api)	GRmax (api)	Resist'ty (ohmm)
Minerva	1700 - 1808	2.52	0.31	85.0	35	110	8
La Bella	1808 - 1869	2.55	0.27	88.0	35	130	10
Eumeralla	1869 - 1930	2.45	0.30	92.0	35	130	10

4.4 Water Salinity

A Pickett Plot over the clean sands of the Minerva Formation (1718-1760m) was used to determine the water salinity (refer to Figure 1). An Rw of 0.110 ohm-m at 85°C was selected as representative of the interval. This corresponds to a formation water salinity of 23,000 ppm NaCl equivalent.

4.5 Formation Electrical Properties

Pickett Plot was also used to determine the appropriate porosity exponent "m". In the Minerva sand the slope of the selected line indicates m=1.85. The coefficient "a" is assumed to be 1.0.

In the lower lithic sandstones of the La Bella and Eumeralla Formations, the Pickett Plot Figure 2) suggests that m has increased to 2.15.

5. INTERPRETATION RESULTS

A depth plot of the results is displayed at 1:200 scale in Enclosure 1. A tabulated reservoir summary is given as Table 5.

5.1 Minerva Formation

The Minerva Formation (1718-1808m) consists largely of clean quartzose sandstones. Porosities are generally good ranging from 15% to 24%, however some intervals (1748-1751m, 1756-1758m) are completely cemented. A total of 37.5m of net sand is interpreted in this 90.5m gross interval, giving a net to gross of 41%. No hydrocarbons are interpreted within this interval.

5.2 La Bella Formation

The La Bella Formation (1808-1869.5m) consists of argillaceous lithic/quartz sandstones interbedded with claystones. The PEF reads anonamously high (6-8) over this interval due to the presence of 1.8% barite in the mud.

In the interval 1808-1822m the sand also contains carbonaceous material which results in higher resistivities and hence some minor interpreted residual hydrocarbon saturations that are spurious. Porosities calculated over this sand range from 5% to 14%, and the sand is therefore considered non net.

Porosities are generally low within the La Bella Formation ranging from 5% to 15%, due to the high argillaceous content of the sands. In the interval 1840 to 1859.5m however, 12.4m of net sand is interpreted over a 19.4m gross interval, with an average porosity of 14.5%. Permeability is also inferred over this interval by the mudcake buildup and the separation of the resistivity curves.

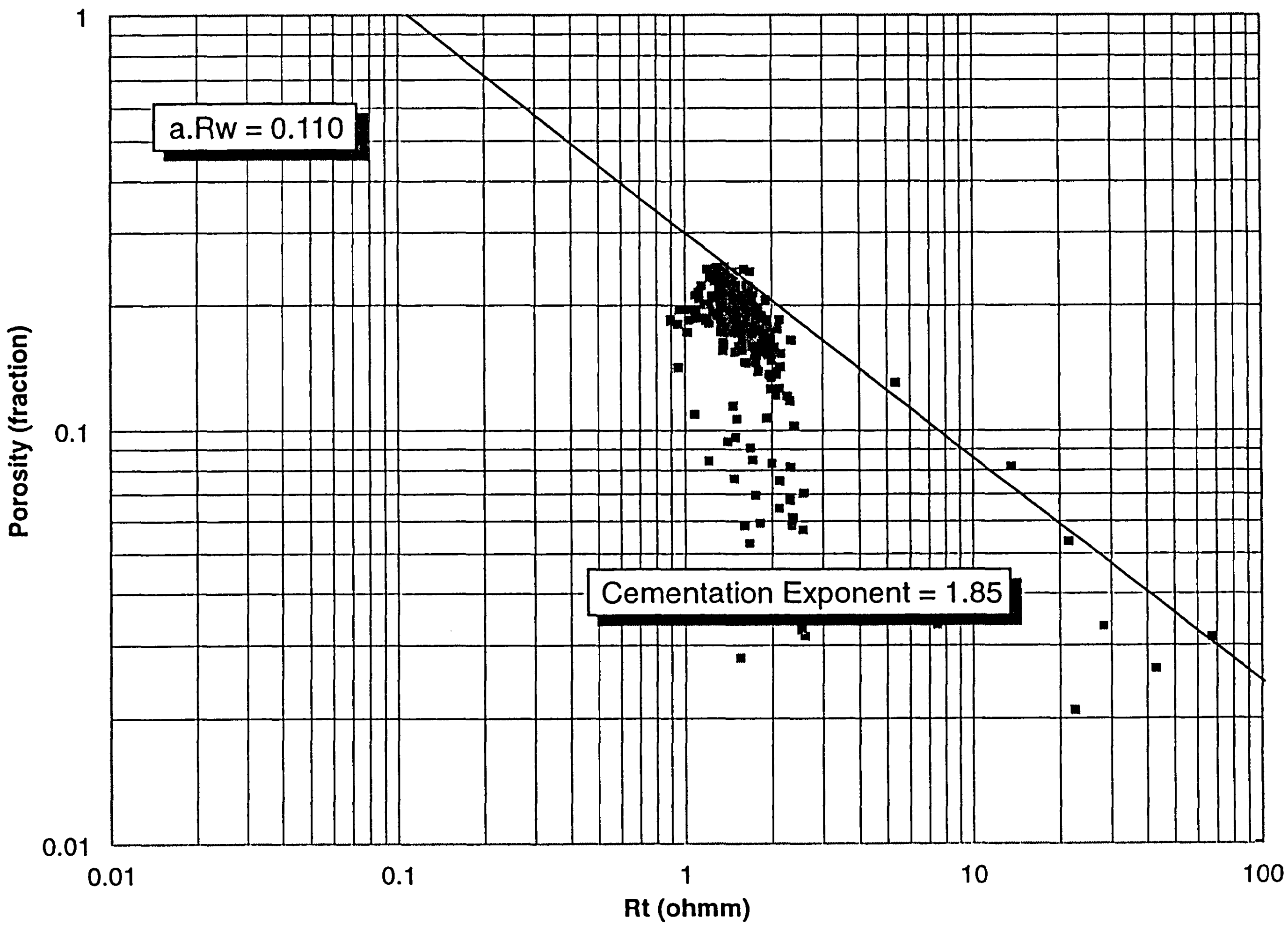
5.3 Eumeralla Formation

The Eumeralla Formation (1869.5m-TD) consists of argillaceous lithic sandstones. The interpretation indicates that up to 50% of the sand consists of lithic fragments, which is consistent with sidewall core descriptions. Porosities within these sands are poor, ranging from 2-12%. Permeabilities are also poor, which is indicated by the lack of separation on the resistivity curves and the lack of mudcake buildup.

Table 5: Reservoir Summary

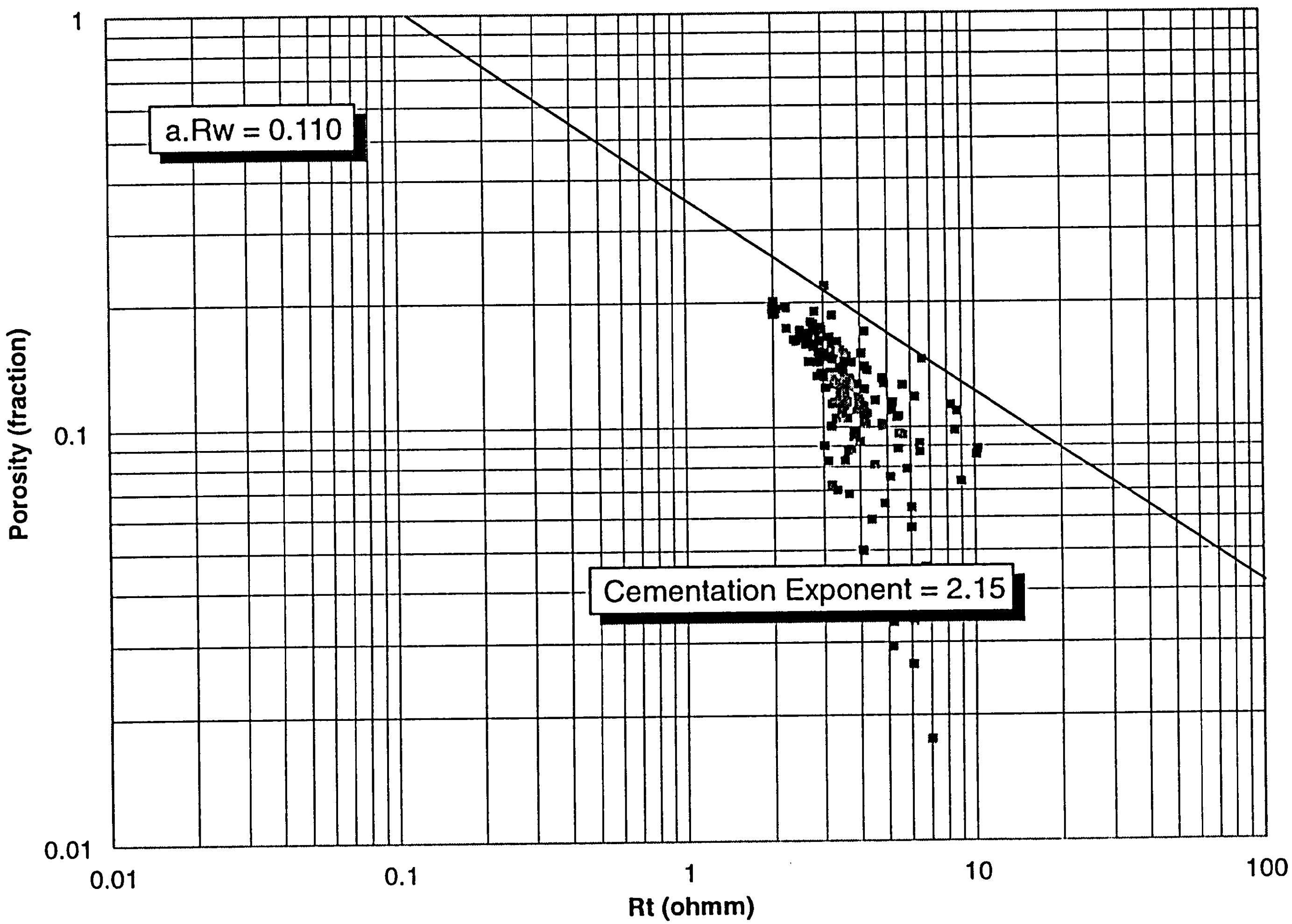
Minerva Formation							
Cut-offs	Porosity (%)	none	2.0	4.0	6.0	8.0	10.0
	Sw (%)	none	100	100	100	100	100
	Vsh (%)	none	100	50	50	50	50
Variables	Thickness (m)	108.0	50.6	39.3	38.5	38.5	37.5
	Avg Por (%)	7.2	15.3	18.4	18.7	18.7	18.9
	Avg Sw (%)	100	100	100	100	100	100
La Bella Formation							
Cut-offs	Porosity (%)	none	2.0	4.0	6.0	8.0	10.0
	Sw (%)	none	100	100	100	100	100
	Vsh (%)	none	100	50	50	50	50
Variables	Thickness (m)	61.0	51.9	19.9	19.4	18.3	16.3
	Avg Por (%)	8.7	10.2	12.9	13.1	13.5	14.0
	Avg Sw (%)	94	94	96	96	96	96
Eumeralla Formation							
Cut-offs	Porosity (%)	none	2.0	4.0	6.0	8.0	10.0
	Sw (%)	none	100	100	100	100	100
	Vsh (%)	none	100	50	50	50	50
Variables	Thickness (m)	61.0	55.4	1.0	0.6	0.1	0.0
	Avg Por (%)	7.5	8.2	6.4	7.3	9.0	-
	Avg Sw (%)	94	94	100	100	100	-

Figure 1: Conan-1 Pickett Plot (1718-1760m)



Only points with GR < 100 are plotted

Figure 2: Conan-1 Pickett Plot (1840-1860m)



Only points with GR < 100 are plotted

PE602843

This is an enclosure indicator page.
The enclosure PE602843 is enclosed within the container PE900663 at this location in this document.

The enclosure PE602843 has the following characteristics:

ITEM_BARCODE	= PE602843
CONTAINER_BARCODE	= PE900663
NAME	= Conan 1 Appendix 1, Enclosure 1- Log Interpretation
BASIN	= Otway
PERMIT	= VIC/P31
TYPE	= WELL
SUBTYPE	= WELL_LOG
DESCRIPTION	= Conan 1 Appendix 1, Enclosure 1- Log Interpretation
REMARKS	=
DATE_CREATED	= 30/08/95
DATE_RECEIVED	= 1/08/99
W_NO	= W1140
WELL_NAME	= Conan 1
CONTRACTOR	= BHP Petroleum
CLIENT_OP_CO	= BHP Petroleum

(Inserted by DNRE - Vic Govt Mines Dept)

PE600560

This is an enclosure indicator page.
The enclosure PE600560 is enclosed within the container PE900663 at this location in this document.

The enclosure PE600560 has the following characteristics:

ITEM_BARCODE = PE600560
CONTAINER_BARCODE = PE900663
NAME = Conan 1 Well Summary
BASIN = Otway
PERMIT = VIC/P31
TYPE = WELL
SUBTYPE = COMPOSITE_LOG
DESCRIPTION = Conan 1 Well Summary/Wireline Summary Log
REMARKS =
DATE_CREATED =
DATE_RECEIVED =
W_NO = W1140
WELL_NAME = CONAN-1
CONTRACTOR = BHP
CLIENT_OP_CO = BHP

(Inserted by DNRE - Vic Govt Mines Dept)