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SANTOS LIMITED

(A.B.N. 80 007 550 923)

HENRY-1 and HENRY-1 ST1

INTERPRETED DATA REPORT

(Combined)

PREPARED BY:
R. Subramanian
(Consultant)
January 2006

HENRY-1 and HENRY-1 ST1

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LOCATION MAP

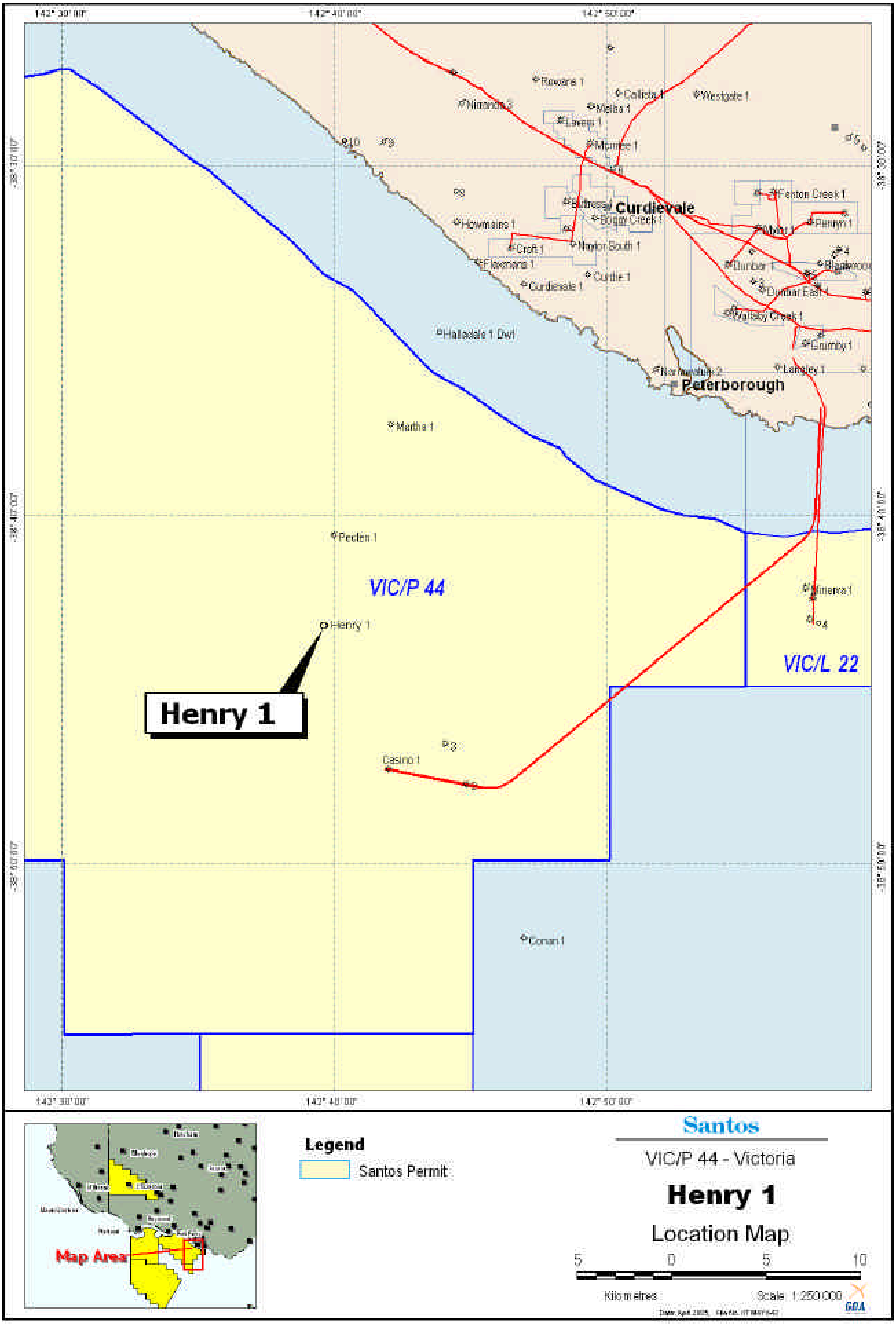


Figure 1: Henry-1 Location Map

WELL CARD

HENRY-1

WELL: HENRY-1	**WELL CATEGORY**: Offshore Gas Exploration Well **WELL INTENT:** Gas	**SPUD:** 10-07-05 **TD REACHED:** 17-07-05 **RIG RELEASED**: 18-07-05 **CMPLT**: -
		RIG: Diamond Offshore Ocean Patriot
SURFACE LOCATION: (GDA94) **LAT:** 38° 43' 11.63" S **LONG:** 142° 39' 39.78" E **NORTHING:** 5712996.4m **EASTING:** 644403.2m		**STATUS**: Plugged back & Sidetracked to Henry-1 ST1 @ 1095m
SEISMIC SURVEY: 01CAS 3D Survey Inline 3214 Xline 6520 **ELEVATION SEA FLOOR**: -67.5m LAT **RT** +21.5m LAT **BLOCK/LICENCE**: Victoria – Otway Basin VIC/P44		**REMARKS**: Henry-1 was sidetracked to Henry-1 ST1 from 1095m, around a 162m fish with top at 1166m. Drill collars and LWD tools were left in hole.
TD - m (Logr Extrap) 2100 m (Drlr)		

	HOLE SIZE	CASING SIZE	SHOE DEPTH	TYPE
PBTD m (Logr) 1095 m (Drlr)	**HOLE SIZE**	**CASING SIZE**	**SHOE DEPTH**	**TYPE**
TYPE STRUCTURE: TILTED FAULT BLOCK	914mm	762mm	122.5m	460 kg/m X56
TYPE COMPLETION: NIL	311mm	244mm	711.5m	70 kg/m L80 BTC
ZONE(S): -				

AGE	FORMATION OR ZONE TOPS	DEPTH (M) Loggers RT (m)	DEPTH (M) Subsea (m)	THICK-NESS (m)	HIGH (H) LOW (L)
	See Well Card for Henry-1 ST1				

TYPE OF LOG	FROM (m)	TO (m)	REPEAT SECTION	TIME SINCE LAST CIRC	BHT
MWD 216mm (8.5") Gamma Ray, Resistivity, Surveys (1 run)	720	2100			

LOG INTERPRETATION					
INTERVAL (m)	**Ø %**	**SW %**	**INTERVAL(m)**	**Ø %**	**SW %**
NO LOG ANALYSIS DONE					

PERFORATIONS	
FORMATION	**INTERVAL**

CORES			
NO.	**INTERVAL**	**CUT**	**REC**

PRODUCTION TEST RESULTS

No production tests were conducted at Henry-1

SUMMARY:

Henry-1 was proposed as an offshore Otway Basin gas exploration wildcat well in the VIC/P44 License. The proposed location is approximately 31 km west of Port Campbell, 8.5 km northwest of the Casino gas field and 26km west of the Minerva gas field. The well is 20 km from the Victorian coastline. The Surface Location for Henry-1 is Latitude: 38° 43' 11.63" South, Longitude: 142° 39' 39.78" East (GDA94), Northing: 5712996.4m, Easting: 644403.2m (MGA-94). The Seismic Reference is the 2001 Casino 3D Survey Inline 3214 Xline 6520. The nearest wells are Pecten-1A (4.9 km N) and Casino-1 (8.4 km SE). The prospect is situated on the Pecten High and the western flank of the Shipwreck Trough. The water depth at the well location was 67.5m LAT.

Henry-1 was spudded at 16:30 hrs on 10-07-05. The 914mm (36") section was drilled to 122.5m and cased with 762mm (30") casing with the shoe at 122.5m. The 311mm (12.25") section was drilled riserless to 720m and cased with 244mm (9.625") casing with the shoe at 711.5m. The blowout preventers were run with the marine riser and installed. The 216mm (8.5") was then drilled and simultaneously logged with MWD tools to a total depth of 2100m which was reached at 20:00hrs on 17-07-05. While tripping out of the hole at total depth, the drillstring became stuck. After several attempts to free the stuck pipe, the drillstring was backed off with the top of fish at 1166m. The 162m long fish consisted of BHA and MWD tools.

Thereafter a kick-off plug was set in the interval 1160m-1030m. A tricone bit was run in hole and used to initiate the sidetrack to Henry-1 ST1 from 1095m. Activities ceased on Henry-1 at 18:00 hrs on 23-07-05.

AUTHOR: R. Subramanian	**DATE**: January 2006

WELL CARD

HENRY-1 ST1

<table>
<tr><td>WELL: HENRY-1 ST1</td><td>WELL CATEGORY:
Offshore Gas Exploration Well
WELL INTENT: Gas</td><td colspan="4">SPUD: 18-07-05 TD REACHED: 30-07-05
RIG RELEASED: 06-08-05 CMPLT: -</td></tr>
<tr><td colspan="2"></td><td colspan="4">RIG: Diamond Offshore Ocean Patriot</td></tr>
<tr><td colspan="2">SURFACE LOCATION: (GDA94)
LAT: 38° 43’ 11.63” S LONG: 142° 39’ 39.78” E
NORTHING: 5712996.4m EASTING: 644403.2m</td><td colspan="4">STATUS: Plugged and Abandoned (GAB)</td></tr>
<tr><td colspan="2">SEISMIC SURVEY: 01CAS 3D Survey Inline 3214 Xline 6520
ELEVATION SEA FLOOR: -67.5m LAT RT +21.5m LAT
BLOCK/LICENCE: Victoria – Otway Basin VIC/P44</td><td colspan="4">REMARKS:
21.8m Net Pay identified in the Waarre Formation</td></tr>
<tr><td colspan="2">TD - m (Logr Extrap) 2032 m (Drlr)</td><td colspan="4"></td></tr>
<tr><td colspan="2">PBTD m (Logr) 1095 m (Drlr)</td><td>HOLE SIZE</td><td>CASING SIZE</td><td>SHOE DEPTH</td><td>TYPE</td></tr>
<tr><td colspan="2">TYPE STRUCTURE: TILTED FAULT BLOCK</td><td>914mm
(in Henry-1)</td><td>762mm</td><td>122.5m</td><td>460 kg/m
X56</td></tr>
<tr><td colspan="2">TYPE COMPLETION: NIL</td><td>311mm
(in Henry-1)</td><td>244mm</td><td>711.5m</td><td>70 kg/m
L80 BTC</td></tr>
<tr><td colspan="2">ZONE(S): WAARRE SANDSTONE</td><td></td><td></td><td></td><td></td></tr>
</table>

AGE	**FORMATION OR ZONE TOPS**	**DEPTH (m)**		**THICK-NESS - TVD (m)**	**HIGH (H) LOW (L)**
		Loggers RT (m)	**Subsea (m)**		
	Sea Level	21.5	0.0	67.5	0.0
Mid-Late Miocene	Sea Bed	89.0	67.5	687.8	0.5m High
Eocene	Mepunga Fm	776.8	755.3	96.2	26.3m Low
Eocene	Wangerrip: Dilwyn Fm	873.0	851.5	246.0	54.5m Low
Eocene	Pember Mudstone	1119.0	1097.5	25.4	NP
Palaeocene	Pebble Point Fm	1144.4	1122.9	64.0	NP
Palaeocene	Massacre Shale	1208.4	1186.9	11.7	154.9m Low
Late Cretaceous	Timboon Formation	1220.1	1198.6	199.9	150.6m Low
Late Cretaceous	Paaratte Formation	1420.0	1398.5	242.5	171.5m Low
Late Cretaceous	Skull Creek Mudstone	1662.5	1641.0	156.0	9m Low
Early - Late Cretaceous	Waarre B Formation	1818.5	1797.0	4.6	80m Low
Early - Late Cretaceous	Waarre A Formation	1823.1	1801.6	29.9	42.6m Low
Early Cretaceous	Eumeralla Formation	1853.0	1831.5	197.8	48.5m Low
	TD	2032.0	2029.3		

TYPE OF LOG	FROM (m)	TO (m)	REPEAT SECTION	TIME SINCE LAST CIRC	BHT
LWD 216mm (8.5") Mud Motor, Gamma Ray, Resistivity, Surveys (4 run)	1095	1464	**Note**: LWD failed below 1464m.		
WIRELINE LOGGING					
Run 1: DLL-MLL-ZDL-CN-GR-SP-CAL					
GR	1990	65		11.0	76°C
GR (Spectral)	1990	711			
DLL	2020	711			
MLL	2025	711			
ZDL	1997	711			
CN	1992	711			
SP	1979	711			
MAC	2008	711			
CAL	1998	711			
Run 2: RCI-GR	Failed				
Run 2: RCI-GR (repeat) (19 Pretests – 14 Good Tests, 5 Tight. 2 samples were collected from 1838m	1802	1957		24.25	82°C
Run 3: STAR-R	2015	1725		36.33	83°C
Run 4: MREX-GR	1900	1810		40.6	83.3°C
Run 5: VSP	2015	275		-	
Run 6: SWC-GR	1966.6	1811.3		55.17	85°C

LOG INTERPRETATION						PERFORATIONS	
INTERVAL(m)	**Ø %**	**SW %**	**INTERVAL(m)**	**Ø %**	**SW %**	**FORMATION**	**INTERVAL**
Waarre A Formation:							
1822.5m-1856m (TVD)						**CORES**	
Net Pay: 21.8m	20.6	47.8					
(Net Sand: 24.9m)							

CORES			
NO.	**INTERVAL**	**CUT**	**REC**

PRODUCTION TEST RESULTS

No Production tests were conducted at Henry-1 ST1.

SUMMARY:

Henry-1 (the parent hole for Henry-1 ST1) was proposed as an offshore Otway Basin gas exploration wildcat well in the VIC/P44 License. The proposed location is approximately 31 km west of Port Campbell, 8.5 km northwest of the Casino gas field and 26km west of the Minerva gas field. The well is 20 km from the Victorian coastline. The Surface Location for Henry-1 is Latitude: 38° 43' 11.63" South, Longitude: 142° 39' 39.78" East (GDA94), Northing: 5712996.4m, Easting: 644403.2m (MGA-94). The Seismic Reference is the 2001 Casino 3D Survey Inline 3214 Xline 6520. The nearest wells are Pecten-1A (4.9 km N) and Casino-1 (8.4 km SE). The prospect is situated on the Pecten High and the western flank of the Shipwreck Trough. The water depth at the well location was 67.5m LAT.

The primary target of Henry-1 is the Late Cretaceous Waarre Formation, Waarre A unit. It is a proven petroleum play in the vicinity of the Shipwreck Trough as evidenced by the discovery at Casino in 2002, and more recently at Martha-1 in 2004. The top Waarre A (K76) seismic reflector exhibits strong acoustic amplitude and AVO anomalies, which has proven a good indicator of gas accumulations within Waarre reservoirs throughout the Otway Basin.

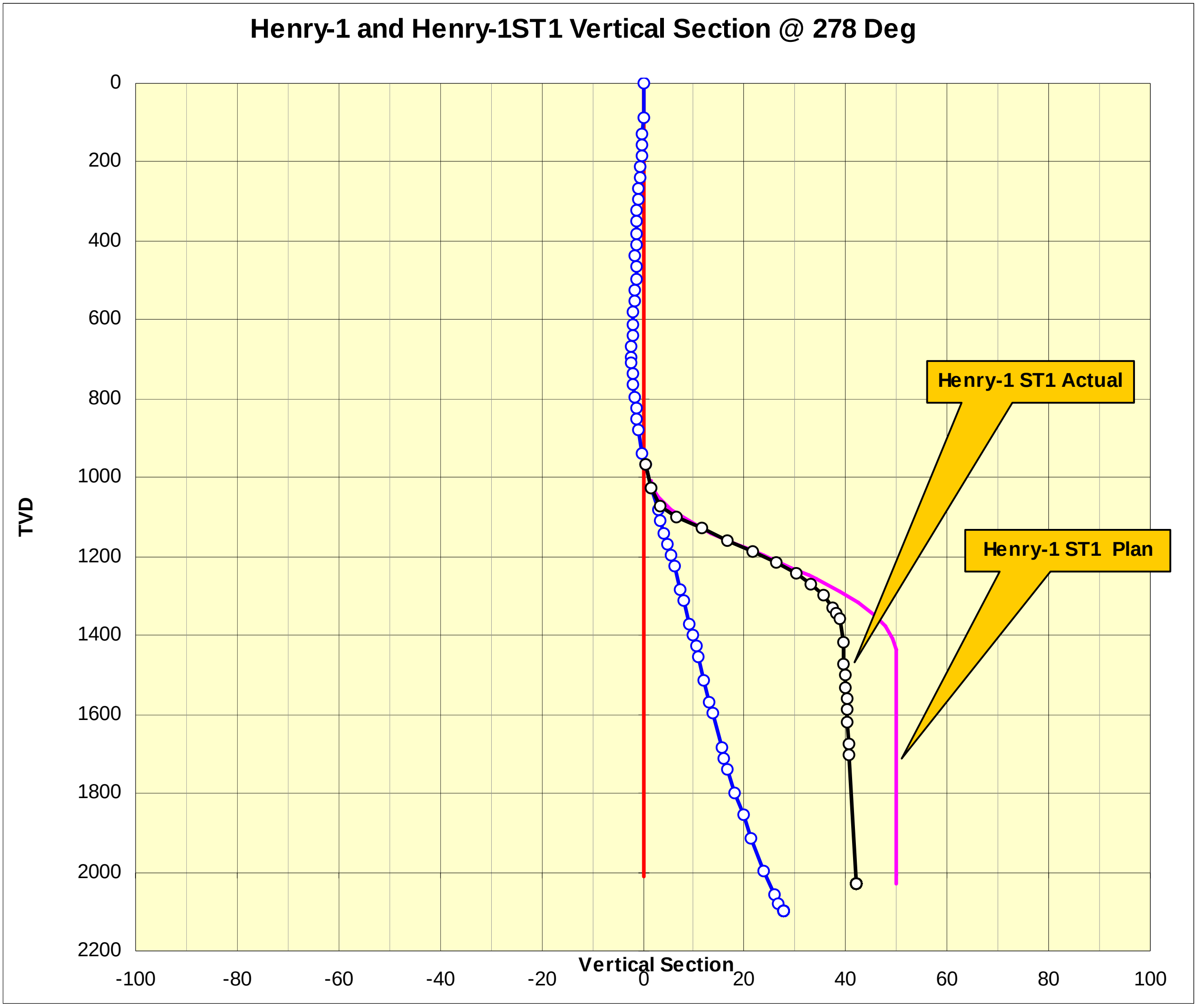
The Henry structure is a complex tilted fault graben, confined by several bounding faults. Structural dip is to the NE, with a proposed spill point at the tip of a NW-SE trending fault. At top reservoir, the Henry structure has vertical relief and proposed gas column of approximately 250 to 260m, from a crest (-1540mSS) to an interpreted GWC from amplitude shut-off (-1795mSS). The proposed Henry-1 location was not crestal, rather it was located to prove up a sufficient commercial volume and test the seismic anomalies of the primary Waarre A objective. A secondary Eumeralla objective was also prognosed to be intersected. The Eumeralla objective is generally not conducive to good reservoir development, however a similar amplitude anomaly with structural conformance was observed.

Henry-1 ST1 was kicked of from a cement plug from 1095m. Activities on the well commenced at 18:00 hrs on 23-07-05 after 80% formation was seen in the cuttings. A 216mm (8.5") TCI bit along with MWD tools and mud-motor (1.15° bend) was used to kick-off and initiate the sidetrack from 1095m to 1370m where a trip was performed to layout the motor and change the bit. A PDC bit was then run in hole with MWD tools and drilled directional hole from 1370m to 1394m where the bit was balled-up bit, resulting in slow penetration rates. The bit was pulled to surface, cleaned up and run back in hole and used to drill ahead from 1394m to 1464m where it was pulled out due to slow drilling. A TCI bit was then run in hole and used to drill from 1464m to 1748m. A washout in the drillpipe required the bit to be pulled to surface. A PDC bit was used to drill from 1748m to the core point at 1827m. A coring assembly was run in hole and used to core the interval 1827m to 1854.8m with a 27.8m recovery (100%). A re-run PDC bit was used to drill to the total depth of 2032m which was reached at 00:30 hours on 31-07-05. Wireline logs were run and abandonment plugs were placed as follows : Plug 1: 2032m-1906m, Plug 2: 1906m - 1780m, Plug 3: 760m – 660m (across 9-5/8" casing shoe), Plug 4: 169m - 119m. The rig was released at 04:30 hours on 06-08-05.

While drilling Henry-1 ST1, the penetrated depths of most formations were low to their respective prognosed depths as can been seen in the table in the Well Card. Henry-1 ST1 encountered the top of the Waarre A Formation at 1823.1m RT (-1801.6m SS) which was 42.6m low to prognosis. The well penetrated some 29.9m of Waarre A Formation in the 216mm (8.5") section. While drilling the Waarre Formation, total gas ranged from 50 to 170 units with a composition which was typically 99/1/trace/trace/trace %. Log analysis of the Waarre "A" Formation indicates a total of 24.9m Gross Sand with 21.8m Net Pay of Porosity 20.6% with mobilities up to 3650 md/cp.

AUTHOR: R. Subramanian | **DATE**: January 2006

WELL PATH SCHEMATIC


Henry-1 and Henry-1ST1 Vertical Section @ 278 Deg
TVD
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
-100
-80
-60
-40
-20
0
20
40
60
80
100
Vertical Section
Henry-1 ST1 Actual
Henry-1 ST1 Plan

1. GEOLOGY

1.1 INTRODUCTION

Henry-1 was proposed as an offshore Otway Basin gas exploration wildcat well in the VIC/P44 License. The proposed location is approximately 31 km west of Port Campbell, 8.5 km northwest of the Casino gas field and 26km west of the Minerva gas field. The well is 20 km from the Victorian coastline in 67.5m of water. The Surface Location for Henry-1 is Latitude: 38° 43’ 11.63” South, Longitude: 142° 39’ 39.78” East (GDA94), Northing: 5712996.4m, Easting: 644403.2m (MGA-94). The Seismic Reference is the 2001 Casino 3D Survey Inline 3214 Xline 6520. The nearest wells are Pecten-1A (4.9 km N) and Casino-1 (8.4 km SE). The prospect is situated on the Pecten High and the western flank of the Shipwreck Trough.

The permit holders are: Santos Limited (50%) Operator, Peedamullah Petroleum Pty Ltd (AWE) (25%), Mittwell Energy Resources Pty Limited (Mitsui) (25%)

The objectives of Henry-1 were to:

- Discover a new hydrocarbon resource within the Waarre Formation “A” unit.
- Prove a commercial volume of hydrocarbons.
- Confirm the amplitude supported Waarre A play.
- Enable accelerated production from Casino start-up.

The risks on Henry-1 were:

- Poorer than expected reservoir development; either thin or absent, or poor porosity and permeability.
- False seismic attributes - amplitude anomaly, amplitude conformance & AVO observed in the Waarre A is a function of residual gas saturations, fault seal breach or not related to hydrocarbons.

1.2 FIELD DESCRIPTION

The Henry structure is a complex tilted fault graben, confined by several bounding faults. Structural dip is to the NE, with a proposed spill point at the tip of a NW-SE trending fault. At top reservoir the Henry structure has vertical relief and proposed gas column of approximately 250-260m, from a crest (-1540mSS) to an interpreted GWC from amplitude shut-off (-1795mSS). The main amplitude anomaly covers an area of 9.5 km^2 with an upside area of 27.9 $km^{2.}$ The proposed Henry-1 location is not crestal, rather it has been located to prove up a sufficient commercial volume and test the seismic anomalies of the primary Waarre A objective. A secondary Eumeralla objective is also prognosed to be intersected. The Eumeralla objective is generally not conducive to good reservoir development, however a similar amplitude anomaly with structural conformance is observed.

The primary target of Henry-1 is the Late Cretaceous Waarre Formation, Waarre A unit. It is a proven petroleum play in the vicinity of the Shipwreck Trough by the discovery at Casino in 2002, and more recently at Martha-1 in 2004. The top Waarre A (K76) seismic reflector exhibits strong acoustic amplitude and AVO anomalies, which has proven a good indicator of gas accumulations within Waarre reservoirs throughout the Otway Basin.

1.3 WELL LOCATION

Henry-1 was proposed as an offshore Otway Basin gas exploration wildcat well in the VIC/P44 License. The proposed location is approximately 31 km west of Port Campbell, 8.5 km northwest of the Casino gas field and 26km west of the Minerva gas field. The well is 20 km from the Victorian coastline in 67.5m of water..

The Surface Surveyed Location (GDA94) for Henry-1 / Henry-1 ST1 is :

Latitude: 38° 43’ 11.63” South
Longitude: 142° 39’ 39.78” East
Easting**:** 644403.2m
Northing**:** 5712996.4m

The Seismic Location for Henry-1 / Henry-1 ST1 is:

01CAS3D Survey Inline 3214 Xline 6520

2. RESULTS OF DRILLING

2.1 STRATIGRAPHY & GEOPHYSICAL PROGNOSIS

As can be seen in the table in the Well Card, the penetrated depths of many formations varied significantly from their respective prognosed depths.

The Waarre A Formation, which constitutes the main reservoir, is a prominent and generally reliable seismic reflector. However due to the extremely complex post-depositional faulting in the area, the reflector is very broken-up in a regional sense. During the drilling of Henry-1 ST1 the primary objective Waarre Formation was penetrated 42.6m low to the prognosed depth possibly due to seismic anomaly.

2.2 STRATIGRAPHY & DEPOSITIONAL ENVIRONMENT (Drillers MDRT Depths)

The well cards at the front of this report tables the subsea elevations and thickness of formations penetrated in Henry-1 and Henry-1 ST1. A brief description of lithology and interpreted environments of deposition follows. More detailed descriptions can be found in Section 2.1 of the Basic Data Report.

Since Henry-1 was plugged back and sidetracked to Henry-1 ST1, a single continuous wellbore is considered for the following discussion. This consists essentially of Henry-1 from seafloor to the kick-off point and Henry-1 ST1 below the kick-off point. The two wells are reasonably close to one another for stratigraphic purposes.

Total depth for Henry-1 ST1 was reached at 2032m (D) after penetrating 197.8m (TVD) of the Early Cretaceous **Eumeralla Formation,** of the **Otway Group**. The formation top was intersected at 1853m. The formation consists of interbedded argillaceous sandstone and siltstone, with very minor coal. The sandstones are off-white to light and medium greenish-grey, and range in size from very fine to coarse, but are dominantly medium-grained. They are angular to subangular, poorly to moderately well sorted, better sorted towards the base, contain weak to moderate silica and minor pyritic cements and have a common to abundant white argillaceous matrix in part the sandstone is matrix supported. The Eumeralla contains common grey, green and dark lithics. There are traces of black carbonaceous detritus, trace mica flakes in part and trace to common glauconite grains. The sandstone varies from friable to occasionally moderately hard but only exhibits a very poor to poor porosity. No oil fluorescence was observed. The Eumeralla was deposited in a high-energy fluviatile environment, probably in a major braided stream system where there was an abundant supply of sand-sized volcanic detritus. The source of the volcanic material is unknown, but due to results from age dating, it appears that volcanism was contemporaneous with sedimentation (Abele *et al*, 1995). In the eastern portion of the Otway Basin the Eumeralla has been dated to be Aptian to Albian.

Overlying the Eumeralla Formation is the target reservoir sands of the Waarre A Formation. The Waarre A Formation was penetrated at 1823.1m (D) with the base of the Waarre A Formation being encountered at 1853m and is 29.9m thick (TVD).

The Waarre Formation makes up the oldest formation of the Sherbrook Group and is dated to be Turonian in age (Partridge, 1997). The Waarre Formation was deposited as the initial post-rift sequence at the commencement of Turonian time. Microplankton at the base of the Waarre formation record the first evidence of wholesale marine incursion into the Otway Basin. The section is sub-divided into three sub-units – Waarre "A", "B" & "C".

Henry-1 ST1 penetrated the Waarre "A" unit which represents a basal transgressive systems tract (TST) characterised by flooding of an incised valley with sediments deposited under marginal marine/estuarine conditions. Lithologically, the unit is similar to the underlying Eumeralla Formation from which it is sourced. The unit is comprised of fine to coarse grained lithic sandstone, interbedded with thin beds of silty carbonaceous mudstone. Onshore the sandstones are dominantly fluvial, but offshore marine conditions are indicated by coarsening upward beds.

In the cuttings samples, the sandstone is translucent, off-white to light brownish-grey to light grey, very fine to medium in size, though becoming fine to coarse grained with depth. The grains are subangular to subrounded, poorly to moderately sorted, generally contain a weak to moderate silica cement and locally abundant calcareous cement. There is trace to common light grey argillaceous matrix throughout, clear to opaque quartz grains, and minor black carbonaceous detritus. The sandstone is moderately hard, has poor visible porosity without any hydrocarbon fluorescence. The sandstone packages are generally blocky in shape. The basal Waarre is interpreted to be shallow marine to marginal marine. After the transgression in the lower part of the Waarre, the formation became more regressive, depositing the best reservoir sands in the lower coastal and delta areas.

The Waarre Formation Unit "B" which overlies Unit "A" and is 4.6m thick, was deposited under estuarine conditions. Onshore, Unit "B" is comprised of carbonaceous mudstone with thin interbeds of coal. Glauconitic mudstone and siltstone, with thin interbeds of dolomitic and calcareous sandstone, is common. Offshore wells show greater marine influence with increasing glauconitic content and common occurrence of dinoflagellates and microplankton.

In the Otway Basin, the Waarre Formation was transgressed by another flooding event (conformably overlain) by the **Flaxmans Formation** which is commonly the seal for the Waarre reservoir. In the Henry-1 ST1 well the Flaxmans Formation was not present.

The **Skull Creek Mudstone,** (sometimes considered part of the Paaratte Formation), unconformably overlies the Waarre Formation in Henry-1 ST1. The Skull Creek Mudstone consists of a thick siltstone which affords an excellent seal for hydrocarbons. The Belfast Mudstone and Nullawarre Greensand were not evidenced at Henry-1 ST1. The formation was penetrated close to where it was expected. It comprises a medium to dark brown to brownish-grey siltstone which is argillaceous and grades to a silty claystone. The Skull Creek Mudstone commonly has dispersed fine to medium quartz grains, trace glauconite, trace carbonaceous specks and trace disseminated pyrite. It is soft to firm and occasional moderately hard and generally subblocky. A pro-delta environment of deposition and an age of Santonian has been attributed to the Skull Creek Mudstone.

The Skull Creek Mudstone is overlain by the late Cretaceous **Paaratte Formation,** the youngest formation of the Sherbrook Group. The top was intercepted at 1420m, 171.5m low to prognosis. The 242.5m thick formation is made up of thin to fairly thick, sandstone packages, interbedded with claystone and minor siltstone. The sandstone is very light brownish-grey to very light grey, and towards the base becomes off-white to light brown. Grain size is predominantly coarse to very coarse, though ranges from very fine to pebbly, and decreases in grain size to fine to very fine towards the base. The grains are angular to subrounded, are very poorly sorted, though improve to moderate at the base. There is weak pyrite, silica and calcareous cement throughout the section. A trace of argillaceous and silty matrix occurs at the top, and again at the base where it is common to abundant. Common, decreasing to trace, grey, green and red volcanogenic lithics are found and abundant altered feldspar grains were noted. Trace to common very fine carbonaceous material occurs throughout, in part associated with pyrite. The sandstone is dominantly friable and occasionally moderately hard in part. It has fair to occasionally good porosity, decreasing to very poor, visible porosity at the base. No fluorescence was noted.

The minor thinly interbedded claystone is medium to dark grey to medium brownish-grey, moderately to very silty, in part finely arenaceous, trace to common pyrite, trace to common black carbonaceous flecks and detritus, in part associated with pyrite, trace micromica, soft, in part very dispersive and slightly subfissile.

The Paaratte Formation was deposited in a deltaic environment, in this case, presumably delta plain, and has been dated to be Santonian to Maastrichtian in age in the Otway Basin.

Overlying the Paaratte Formation is the **Timboon Formation** with its top penetrated at 1220.1m. The formation is made up of thin to fairly thick sandstone packages, interbedded with siltstone. The sandstone is pale grey to grey, clear to translucent, predominantly medium grained to minor coarse grained. The sandstone is moderately well sorted and the grains are subrounded to subangular in part. The sandstone has a weak siliceous cement, has trace lithic fragments and traces of disseminated pyrite. The sandstone is friable to loose, and occasionally in moderately hard aggregates. No hydrocarbon fluorescence was observed. The interbedded siltstone is light to medium brown to brown grey, arenaceous, slightly calcareous with minor disseminated pyrite. The siltstone is firm to moderately hard and subblocky. The Timboon Sandstone was deposited in a deltaic environment, in this case, presumably delta plain, and has been dated to be Campanian to Maastrichtian in age in the Otway Basin.

The **Massacre Shale** overlies the Timboon Sandstone. It was penetrated at 1208.4m and is 11.7m thick. The formation consists of siltstone interbedded with minor sandstone. The siltstone is medium grey, medium to dark brown, arenaceous and grades to silty sandstone, carbonaceous in part, has rare white argillaceous laminations, has common disseminated pyrite and is moderately hard to occasionally very hard and generally subblocky. The interbedded sandstone are pale to medium grey, clear to translucent to off white, medium to coarse grained. There are occasional very coarse subrounded polished bit-fractured quartz fragments. The sandstone is moderately poorly sorted with subangular to minor angular grains. The sandstone has common moderate strong calcareous and dolomitic cement, minor white argillaceous matrix and occasional medium grey silty matrix. Disseminated pyrite is common and the aggregates are hard to occasionally very hard aggregates. There are loose grains in part and no hydrocarbon fluorescence was observed. The Massacre Shale forms the boundary between the Cretaceous and the Tertiary.

Overlying the Massacre Shale is the oldest unit in the **Wangerrip Group**, the **Pebble Point Formation** which is 64m thick and was intersected at 1144.4m. The formation is composed of interbedded claystone and sandstone. Sandstone is pale grey, clear to translucent, predominantly medium grained with minor coarse grained, becoming coarser with depth, moderately well sorted, with subangular to minor angular grains and occasionally subrounded grains. The sandstone has trace weak to moderately hard siliceous cement. It is partly friable to moderately hard, generally loose and has fair inferred porosity but no hydrocarbon fluorescence. The interbedded claystone is medium grey and medium to dark brown, slightly arenaceous, siliceous in part, partly silty, soft to firm, occasionally very hard, dispersive, amorphous to subblocky. The environment of deposition for the Pebble Point is interpreted to be shallow water, nearshore, restricted marine with periodic influxes of coarse detrital material. Various megafossils and microfossils have been identified in the formation that indicate an age ranging from Maastrichtian for the oldest strata, to Palaeocene, and even Late Palaeocene (Abele *et al*, 1995).

Conformably overlying the Pebble Point is the **Pember Mudstone**, which was penetrated at 1119m and is 25.4m thick. The formation consists mainly of claystone which is medium to dark brown, slightly arenaceous, silty, predominantly soft and minor firm, dispersive and amorphous to subblocky. The claystones are interbedded with minor sandstones which are pale brown, translucent, predominantly coarse grained, well sorted and with subrounded grains, with trace moderately strong to strong siliceous cement, with trace silty matrix. The aggregates are moderately hard to hard and loose in part with generally poor visual porosity and no hydrocarbon fluorescence. The Pember Mudstone was deposited in a marine environment where there was restricted circulation and low energy conditions, probably below or close to storm wave base. It has been given an age of Late Palaeocene to Early Eocene (Abele *et al*, 1995) based on a study of associated palynomorphs.

The **Dilwyn Formation** conformably overlies the Pember Mudstone and was penetrated at 873m and is 246m thick. The section consists predominantly of sandstone with minor interbedded silty claystone. The sandstone is pale to medium grey, also minor pale yellow, is medium to coarse grained, moderately well sorted, with predominantly subrounded to rounded grains and partly subangular grains, with trace pyrite cement, with trace lithic fragments and commonly loose. The sandstone has a fair inferred porosity but no hydrocarbon fluorescence. The claystone is medium to dark grey and dark brown, soft to firm, occasionally hard, with trace pyrite and is very soft, very dispersive and non fissile.

Both macrofossils and microfossils from the Dilwyn have been dated to be Early Eocene. The environment of deposition is interpreted to be shallow marine, with the cleaner sandy portions representing shoreface deposits of a coastal barrier system and the interbedded section possibly back beach lagoon sediments, with some breaching occurring. Another interpretation is that the Dilwyn could have formed in a lower delta plain area with the sands, distributary channels and mouth bars, and the clays, the interdistributary bay fills (Abele *et al*., 1995).

The Dilwyn Formation is the youngest unit of the Wangerrip Group, and is unconformably overlain by the **Mepunga Formation**, the oldest formation of the **Nirranda Group** and was intersected at 776.8m and is 96.2m thick. The massive sandstone is medium brown to occasionally dark brown, partly medium yellow brown, coarse to very coarse grained and minor medium grained, moderately well sorted, with grains that are subrounded to occasionally rounded and minor subangular. The sandstone has a weak siliceous cement and common Fe-staining. There are traces of glauconite and trace pyrite. The sandstone is poorly consolidated and loose in part and partly friable to moderately hard. The porosity is inferred to be fair with no hydrocarbon fluorescence being observed. There are trace of claystone which is medium brown, slightly to very silty in part, with abundant dispersed very fine to grit-sized brown-stained quartz grains in places. It is slightly calcareous in part, with a trace of glauconite, trace to common pyrite and is very soft, very dispersive and non fissile. According to dating of forams, molluscs and palynomorphs discovered within the Mepunga, an age of Middle Eocene to Early Oligocene has been given. The sandstones have been interpreted as being deposited in beach and nearshore locations as barrier islands, whereas the claystones regarded as estuarine and some as deep lagoonal in origin (Abele *et al*, 1995).

The **Narrawaturk Marl** overlies the Mepunga Formation with a conformable contact. The marl was encountered from below the casing shoe at 711.5m and hence only 65.3m of cuttings were examined installing the casing and riser. The Gamma Ray wireline log was run over this section, above the 340mm casing but the top was not picked. The formation is made up of a calcareous claystone/siltstone which is intergraded with and intergrading to marl. The calcareous claystone/siltstone is medium brown to medium brown grey, has common fossil fragments (commonly echinoid spines and bryozoan fragments). The claystone is firm to moderately hard, grades to marl and is blocky to subblocky. There are traces of pyrite and quartz grains. The Marl is light grey, occasionally light green grey, argillaceous in part, very calcareous and grading to calcareous claystone. It is soft to firm and subblocky. The fossil fragments have been dated to be Late Eocene to Early Oligocene, but no older than Oligocene in age. The marl was deposited in an open marine environment, mostly below storm wave base.

Formations younger than the Narrawaturk Marl are behind casing and were not studied. These include formations (typically limestones) of the **Heytesbury Group** like the Clifton Formation which grades into the **Gellibrand Marl** which is overlain, with a transitional contact, by the **Port Campbell Limestone**, the topmost formation of the Heytesbury Group. The Port Campbell Limestone is Middle to Late Miocene in age and was deposited in a moderate-energy, continental shelf environment, above fair weather wave base. It is uncertain if all these formations were penetrated in Henry-1 prior to installing the marine riser when all returns were to the seafloor.

2.3 HYDROCARBON SUMMARY

Ditch gas values were monitored and recorded in units (U) by Reserval Total Gas detector, where one unit is equivalent to 200 ppm (parts per million) of methane gas in air. The ditch gas was also monitored for hydrocarbon gas composition by the Reserval chromatograph. Gas composition refers to percent components of the hydrocarbon alkane series: (methane, ethane, propane, butane and pentane). Gas compositions are quoted as the percentage ratios of these five gases (i.e. 94/2/1/1/1 denotes 94% C1, 2% C2, 1% C3, 1% C4 and 1% C5). Ditch cuttings were tested for hydrocarbon fluorescence by using an ultra-violet fluoroscope.

While drilling Henry-1, gas was monitored realtime in the 216mm (8.5”) section from the surface casing shoe to the total depth of 2100m. The Timboon Formation had low levels of less than 1 unit total gas which was mainly consisting of C1. Within the Paaratte Formation the background gas increased marginally to a maximum of 36 units at 1613 m with a typical composition of 99/1 % with traces of C3, C4 and C5. In the Skull Creek Mudstone the total gas hovered around 20 units. In the Waarre Formation, which was the primary gas target for the well, total gas increased significantly to a maximum of 610 units with a composition of 97/2/1 with traces of C4 and C5. In the Eumeralla Formation the total gas dropped significantly and remained low around the 20-unit level with a maximum peak of 109 units at 1952m (D). The composition in the Eumeralla Formation was typically 99/1/trace/trace/trace %.

After Henry-1 was plugged back and sidetracked to Henry-1 ST1, total gas was monitored from the kick-off depth of 1095m, total gas readings were similar to Henry-1. While drilling the Waarre Formation, total gas ranged from 50 to 170 units with a composition which was typically 99/1/trace/trace/trace %.

2.4 SUMMARY

Henry-1 (the parent hole for Henry-1 ST1) was proposed as an offshore Otway Basin gas exploration wildcat well in the VIC/P44 License. The proposed location is approximately 31 km west of Port Campbell, 8.5 km northwest of the Casino gas field and 26km west of the Minerva gas field. The well is 20 km from the Victorian coastline. The Surface Location for Henry-1 is Latitude: 38° 43' 11.63" South, Longitude: 142° 39' 39.78" East (GDA94), Northing: 5712996.4m, Easting: 644403.2m (MGA-94). The Seismic Reference is the 2001 Casino 3D Survey Inline 3214 Xline 6520. The nearest wells are Pecten-1A (4.9 km N) and Casino-1 (8.4 km SE). The prospect is situated on the Pecten High and the western flank of the Shipwreck Trough. The water depth at the well location was 67.5m LAT.

The primary target of Henry-1 is the Late Cretaceous Waarre Formation, Waarre A unit. It is a proven petroleum play in the vicinity of the Shipwreck Trough by the discovery at Casino in 2002, and more recently at Martha-1 in 2004. The top Waarre A (K76) seismic reflector exhibits strong acoustic amplitude and AVO anomalies, which has proven a good indicator of gas accumulations within Waarre reservoirs throughout the Otway Basin.

The Henry structure is a complex tilted fault graben, confined by several bounding faults. Structural dip is to the NE, with a proposed spill point at the tip of a NW-SE trending fault. At top reservoir the Henry structure has vertical relief and proposed gas column of approximately 250-260m, from a crest (-1540mSS) to an interpreted GWC from amplitude shut-off (-1795mSS). The proposed Henry-1 location was not crestal, rather was located to prove up a sufficient commercial volume and test the seismic anomalies of the primary Waarre A objective. A secondary Eumeralla objective was also prognosed to be intersected. The Eumeralla objective is generally not conducive to good reservoir development, however a similar amplitude anomaly with structural conformance is observed.

Henry-1 ST1 was kicked of from a cement plug from 1095m. Activities on the well commenced at 18:00 hrs on 23-07-05 after 80% formation was seen in the cuttings. A 216mm (8.5") TCI bit along with MWD tools and mud-motor (1.15° bend) was used to kick-off and initiate the sidetrack from 1095m to 1370m where a trip was performed to layout the motor and change the bit. A PDC bit was then run in hole with MWD tools and drilled directional hole from 1370m to 1394m where the bit was balled-up bit resulting in slow penetration rates. The bit was pulled to surface, cleaned up and run back in hole and used to drill ahead from 1394m to 1464m where it was pulled out due to slow drilling. A TCI bit was then run in hole and used to drill from 1464m to 1748m. A washout in the drillpipe required the bit to be pulled to surface. A PDC bit was used to drill from 1748m to the core point at 1827m. A coring assembly was run in hole used to core the interval 1827m to 1854.8m with a 27.8m recovery (100%). A re-run PDC bit was used to drill to the total depth of 2032m which was reached at 00:30 hours on 31-07-05. Wireline logs were run and abandonment plugs were placed as follows : Plug 1: 2032m-1906m, Plug 2: 1906m - 1780m, Plug 3: 760m – 660m (across 9-5/8" casing shoe), Plug 4: 169m - 119m. The rig was released at 04:30 hours on 06-08-05.

While drilling Henry-1 ST1, the penetrated depths of most formations were low to their respective prognosed depths as can been seen in the table in the Well Card. Henry-1 ST1 encountered the top of the Waarre A Formation at 1823.1m RT (-1801.6m SS) which was 42.6m low to prognosis. The well penetrated some 29.9m of Waarre A Formation in the 216mm (8.5") section. While drilling the Waarre Formation, total gas ranged from 50 to 170 units with a composition which was typically 99/1/trace/trace/trace %. Log analysis of the Waarre "A" Formation indicates a total of 24.9m Gross Sand with 21.8m Net Pay of Porosity 20.6% with mobilities up to 3650 md/cp.

3. REFERENCES

SANTOS, 2005	HENRY-1 WELL PROPOSAL, PREPARED FOR SANTOS LTD, (UNPUBLISHED).
SUBRAMANIAN, R., 2005	HENRY-1 & HENRY-1 ST1 BASIC DATA REPORT, PREPARED FOR SANTOS LIMITED, (UNPUBLISHED).

APPENDIX I : LOG ANALYSIS

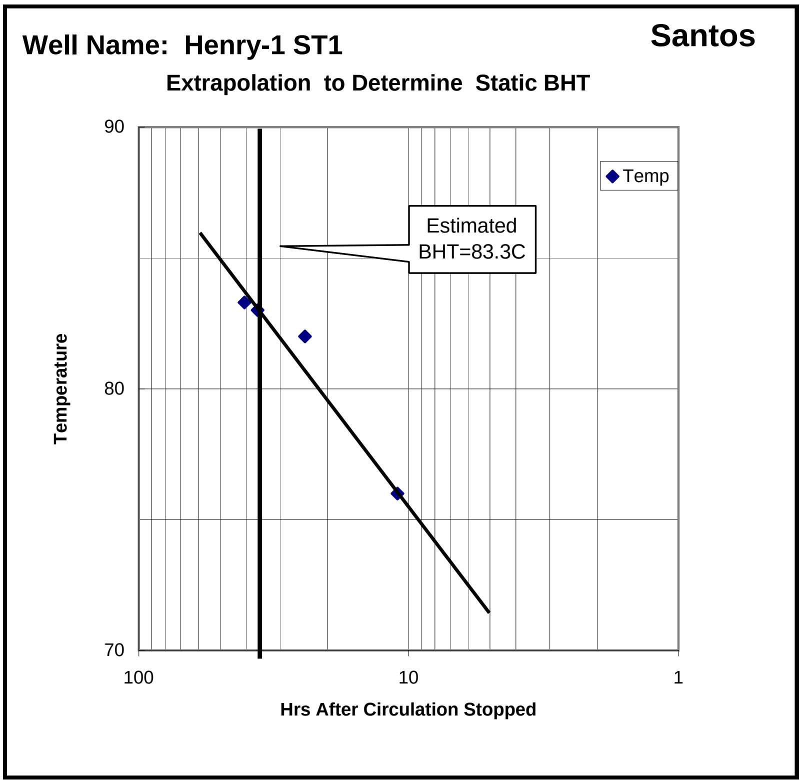
APPENDIX II: HYDROCARBON SHOW REPORT

No Hydrocarbon Fluorescence was observed in Henry-1 / Henry-1 ST1

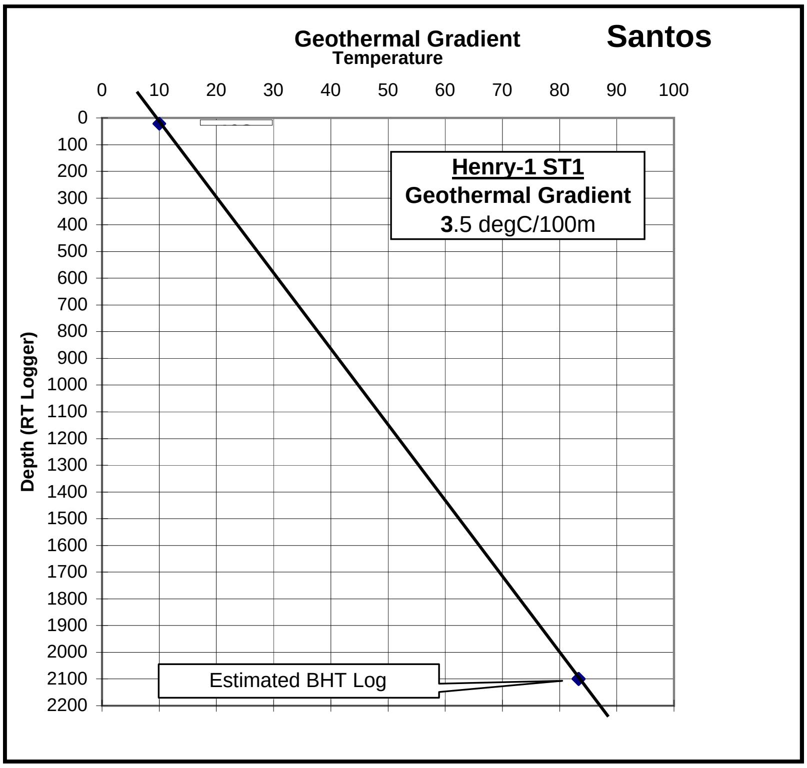
APPENDIX III: GEOTHERMAL GRADIENT

Temperature data acquired from wireline log data were used to determine the Bottom Hole Temperature. A Geothermal Gradient of 3.5°C/100m was calculated.

A graphical representation is presented overleaf.



Well Name: Henry-1 ST1
Santos
Extrapolation to Determine Static BHT
Temp
Estimated
BHT=83.3C
90
80
70
Temperature
100
10
1
Hrs After Circulation Stopped



Geothermal Gradient
Santos
Temperature
0
10
20
30
40
50
60
70
80
90
100
Henry-1 ST1
Geothermal Gradient
3.5 degC/100m
Estimated BHT Log
Depth (RT Logger)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200

APPENDIX IV: PRODUCTION TEST REPORT

Production testing was not conducted in Henry-1 ST1

APPENDIX V: PALYNOLOGY REPORT

The Palynology report as attached overleaf

SANTOS STRATIGRAPHIC SERVICES
EXPLORATION SERVICES DEPARTMENT

Palynology Report No. 2005/31

Author: G.R. WOOD
Approved by: G.R. WOOD
Date: 29th September, 2005

PALYNOLOGICAL REPORT NO. 2005/31
PALYNOSTRATIGRAPHICAL ANALYSIS
HENRY NO. 1 ST1

Santos Ltd
A.B.N. 80 007 550 923

Introduction

Eleven sidewall core and nine full-hole core samples from Henry No. 1ST1 located in VIC/P44 were examined palynologically so as to assess their palynostratigraphic position and palaeoenvironment.

A summary of the results of this study are presented on Table 1. The palynostratigraphic results are presented in more detail on Table 2. Figure 1 outlines the palynostratigraphic scheme adopted and the known relationships of the palynological zones to the lithostratigraphy. Assemblage data utilised in assessing the palaeoenvironments are shown in Table 3. Range charts of the palynomorphs identified in this study are presented in Appendix 1.

WELL NAME	SAMPLE	DEPTH	Sieve (μm)	Yield
HENRY-1ST1	SWC21	1815.7m	10	average
HENRY-1ST1	SWC20	1819.8m	10	average
HENRY-1ST1	SWC19	1821.0m	10	average
HENRY-1ST1	SWC18	1822.2m	10	average
HENRY-1ST1	SWC17	1823.0m	10	average
HENRY-1ST1	SWC15	1853.1m	10	poor
HENRY-1ST1	SWC14	1853.8m	10	poor
HENRY-1ST1	SWC13	1855.4m	10	average
HENRY-1ST1	SWC12	1856.3m	10	good
HENRY-1ST1	SWC4	1884.2m	10	average
HENRY-1ST1	SWC3	1930.2m	10	average
HENRY-1ST1	FHC	1827.2m	10	good
HENRY-1ST1	FHC	1830.9m	10	good
HENRY-1ST1	FHC	1833.8m	10	good
HENRY-1ST1	FHC	1848.5m	10	good
HENRY-1ST1	FHC	1843.9m	10	good
HENRY-1ST1	FHC	1844.4m	10	good
HENRY-1ST1	FHC	1845.6m	10	good
HENRY-1ST1	FHC	1845.95m	10	good
HENRY-1ST1	FHC	1846.15m	10	good

G.R Wood

Table 1

Well Name : Henry No.1ST1

Interval : 1800m - 1950m

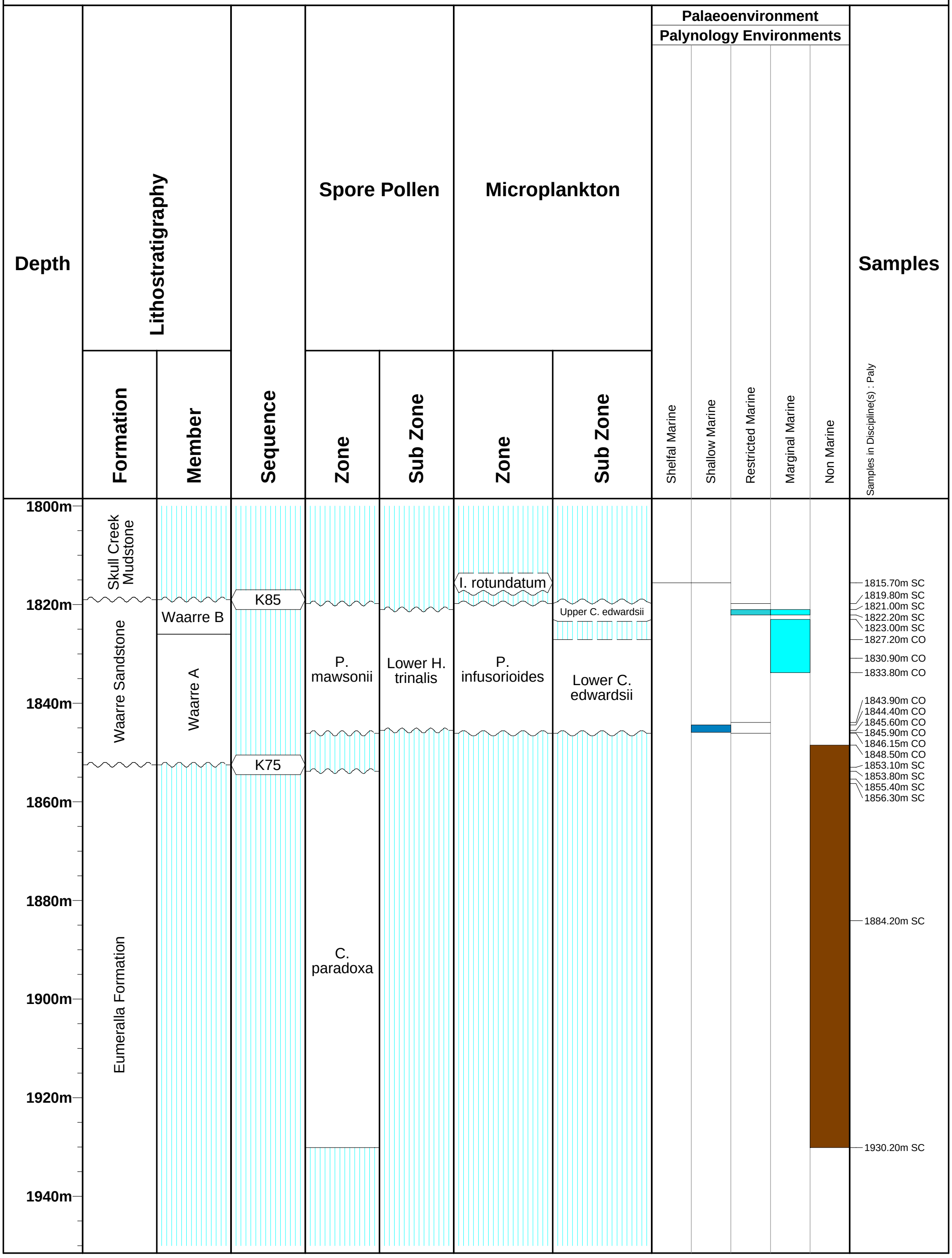
Scale : 1:1000

Chart date: 29 September 2005

Santos Ltd
Adelaide

Sampling
Cutting
Core
Sidewall core
Corrected core
Core corrections

Henry No.1ST1



POINTS OF SIGNIFICANCE – PALYNOSTRATIGRAPHY

1. There is a substantial unconformity (K75) present in the interval 1853.8 to 1846.15. Samples from 1930.2 to 1853.8m yielded Albian *C. paradoxa* assemblages typical of the Eumeralla Formation.

2. Samples from 1823 to 1819.8m yielded Turonian *P. infusioroides* assemblages typical of the Waarre Formation, Waarre B unit. Underlying core samples from 1827.2 to 1846.15 yielded assemblages typical of the Waarre A in this region.

3. The age of the sample from 1815.7m is late Santonian *I. rotundatum* Zone which suggests that it is assignable to the Skull Creek Mudstone (Sharp & Wood, 2003).There is a substantial unconformity (K85) below this shale. The missing sequence encompasses the mid and lower Belfast Mudstone, the Flaxman Formation and the mid-upper Waarre Formation, representing a period which may be as long as 5 million years.

POINTS OF SIGNIFICANCE – PALAEOENVIRONMENTAL DATA

1. Assemblages from 1930.2 to 1848.5 m contain only spores and pollen and considered non marine with the exception of some leiospherids and rare *Michrystridium spp* in the sample from 1855.4m which is non marine to brackish. Fern spores and gymnosperm pollen dominate these assemblages with only minor bryophyte and lycopod elements.

2. Core samples from the interval 1846.15 to 1843.9m yielded assemblages with low to moderate proportions (16 to 36%) of microplankton The assemblage from 1846.15m contains a low to moderate diversity microplankton component (36%) and foram liners. The dominance of *Cyclonephelium spp* together with a prominent *Palaeoperidinium cretaceum, Cribroperidinium cooksoniae & Chatangiella spp* component suggests restricted shallow marine conditions. The relatively high peridinioid component in this and the overlying sample from 1845.9m may be related to the increased supply of terrestrially derived nutrients during periods of low sea level (Pearce, 2003). The 1845.9m assemblage also contains prominent *Cyclonephelium spp & P. cretaceum* together with an increased *Oligosphaeridium spp & Odontochitina spp* component and this suggests less restricted shallow marine conditions. Similar microplankton constituents (but with less *P. cretaceum*) are found in the assemblages from 1845.6 and 1844.4m and are likewise considered as shallow marine. A return to more restricted shallow marine conditions is reflected in the assemblage from 1843.9m which contains higher proportions of *Kiokansium polypes & Oligosphaeridium pulcherrimum* together with foram liners.

3. The interval 1833.8 to 1823m yielded assemblages with only a very low yield (3 to 6%) and very low diversity microplankton components and an increase in the gymnosperm pollen component. These assemblages contain primarily *Cyclonepheliun compactum* and *Cribroperidinium edwardsii* and can only indicate a predominantly fluvial / terrestrial input to a very restricted marine environment.

4. Similarly low diversity dinocyst assemblages dominated by a high yield of *C. edwardsii* (19 – 26%) in the microplankton component were recovered from 1822.2 and 1821m and these indicate a very restricted marine environment.

5. A more diverse but similarly restricted marine assemblage containing prominent C. edwardsii, O. pulcherrimum and K. polypes components was recovered from 1819.8m.

6. The shallowest sample studied (1815.7m) contains a higher dinocyst component (76%) predominantly *Heterosphaeridium spp* (67%) in a moderately diverse (>20 species) shallow to shelfal marine assemblage.

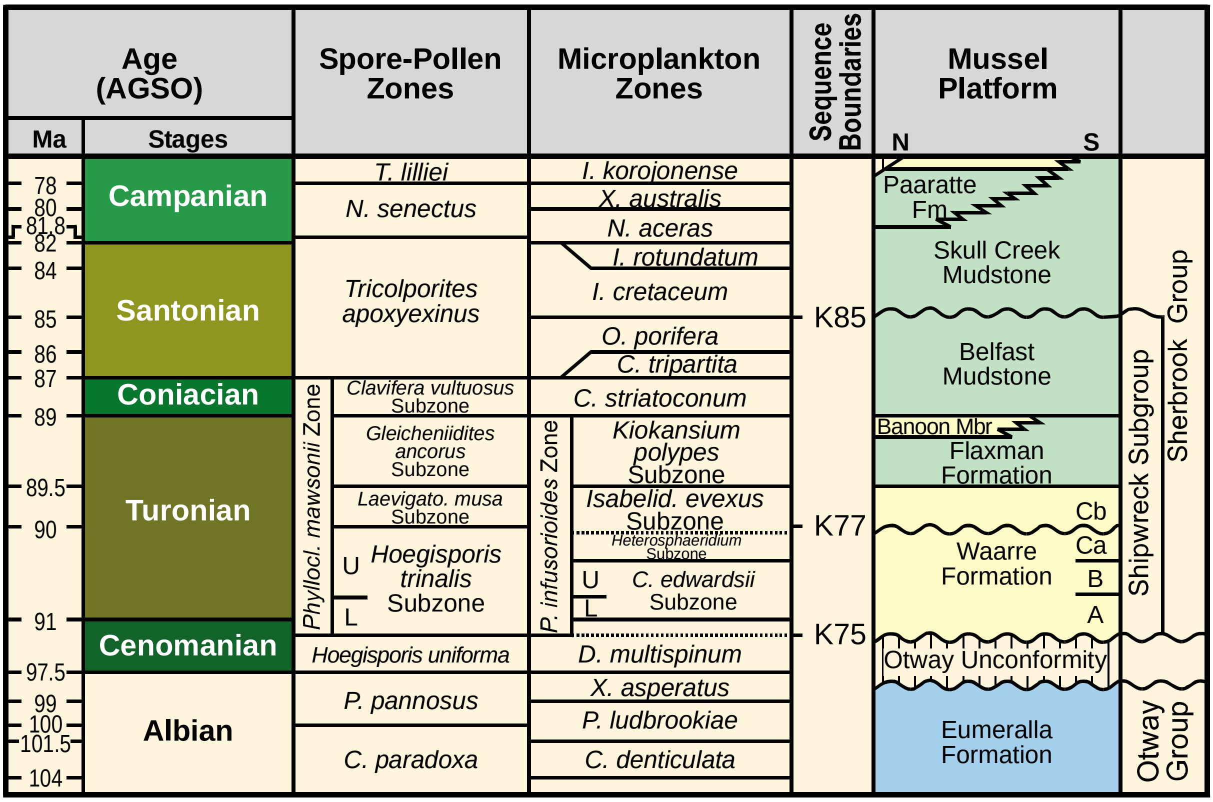


Figure 1: From Sharp & Wood, 2003.

Stratigraphy of the Eastern Mussel Platform.

The stratigraphic succession deposited and preserved over the Mussel Platform comprises sequences from the Early Cretaceous to present day. The stratigraphy herein will concentrate on the economically significant late Cenomanian to Campanian section. Three major sequence boundaries (informally termed K75, K77 and K85 in Santos reports) are responsible for the present day distribution of the reservoir targets across the Mussel Plateau. Stratigraphic discussion will focus on the following chronostratigraphically significant sequences:

Pre K75 :	Eumeralla formation
K75 – K77	Lower to mid Waarre Sandstone
K77 – K85	Upper Waarre to Belfast Mudstone
Post K85	Skull Creek Mudstone and younger

Relationship to the existing lithostratigraphic schemes is based when possible to nomenclature discussed in a revision of the stratigraphy of the Upper Cretaceous Sherbrook Group by Partridge (2001) and an earlier published informal subdivision of the Waarre Sandstone by Buffin (1989). Both of these earlier studies were based on the study of mostly onshore well sequences in the adjoining Port Campbell Embayment. Early Otway Basin stratigraphic frameworks (Bock & Glenie, 1965, Douglas & Ferguson, 1988, Tickell et al, 1992, Moreton et al, 1994) were characterised by markedly diachronous lithological units. Partridge (2001) through utility of improved palynological data for key onshore reference and type sections (Partridge, 1996), proposed a revision of the lithostratigraphic units to more closely represent time-rock units than in previously described schemes. These efforts have been continued in this study of the Casino Field and wells in the Shipwreck Trough and the Mussel Plateau (Fig.1).

The first attempt to subdivide the Waarre section into regional intra-formational units was by Buffin (1989) who described four informal units A, B & C based primarily on electric log character in onshore wells. The Waarre Sandstone is not represented in outcrop and facies interpretation is dependant on limited core and mostly cuttings information. Buffin (1989) described the distribution of facies within the context of a beach barrier-bar system with lagoonal, tidal channel, beach and tidal delta facies proposed in an overall regressive sequence. Maps of the extent of these units were based on the available well coverage in the Port Campbell Embayment. There was no attempt by Buffin (1989) to hypothesise about the extension of the Waarre depositional systems southwards as there was only very limited offshore exploration data available. Subsequent offshore wells drilled both within and on the flanks of the Shipwreck Trough with Waarre reservoirs as a primary target have provided sufficient coverage to trace the southerly extent of these units. Later work by Partridge (1994, 1999) and recent Santos operated wells in the Port Campbell Embayment have been instrumental in providing palynological criteria for greater resolution of this intra-formational sub-division.

Armed with the palynostratigraphic data from the Port Campbell Embayment for comparison, the Waarre data from the Mussel Platform and nearby Shipwreck Trough wells were similarly scrutinised for possible co-eval events. Because of the mostly marginal marine character of the Waarre sequences, spore pollen and dinoflagellate datasets were interrogated and both provided useful datums although in some wells data quality was hampered by sparse sampling of some intervals and the effect of depositional environment on some dinoflagellate taxa. A benefit of applying an adaptation of the Port Campbell Embayment schemes was the ability to then map depositional trends from the abundance of onshore reservoir intersections into the comparatively more sparse offshore datasets.

Biostratigraphic Framework

During the 1980's most of the palynology undertaken in the Otway Basin was expressed either in terms of the eastern Australian Mesozoic zonation developed by the Minad/APG group (Peter Price and co-workers) or the pan-Australian HMP scheme (Helby, Morgan & Partridge, 1987). Both of these schemes relied on classical interval zone concepts and lacked resolution in the predominantly non-marine to marginal marine Waarre Sandstone and to a certain extent the underlying Eumeralla Formation. By the mid 1990's the Morgan group had begun to develop an event stratigraphy (Morgan& Hooker *in* LaBella WCR) and Partridge (2001 Fig.2)

Published a review and substantial up-date of the Late Cretaceous part of the HMP scheme, introducing a number of subzones based on both interval zone criteria and event features (acmes). The Partridge (2001) Waarre subdivision was based primarily on Port Campbell Embayment on-shore sequences. We have adopted the Partridge scheme but require more precision to satisfactorily label the sands in and below the Waarre "Ca" interval (i.e. below the base of *I. evexus*) in the offshore Otway sequences with expanded Waarre A to Ca sections. Modifications and further subdivision of the Partridge subzones are outlined in Figure 2.

OTWAY BASIN ZONATION SCHEME FOR THE TURONIAN TO CONIACIAN			
Defining Events	**Spore Pollen Zones**	**Microplankton Zones**	Defining Events
	C. vultuosus	**Upper *C. striatoconus***	Top *C. striatoconus*
Base *C. vultuosus*			Base *C. striatoconus*
Top *A. distocarinatus*	***G. ancoras***	**Lower *C. striatoconus***	
			Base *G. hymenophora*
			Base *Trythyrodinium “marshalii”*
		K. polypes	Top consistent *V. griphus*
			Base *V. griphus, Spinidinium sp A*
Top consistent *L. musa*	***L. musa***	**Upper *I. evexus***	
			Base prominent *A. cruciformis*
Top consistent *H. trinalis*	**Upper *H. trinalis***	**Lower *I. evexus***	
Base *A. obscurus*			Consistent *I. evexus*
		***Heterosphaeridium* acme Zone**	Top prominent *Heterosphaeridium*
			Base prominent *Heterosphaeridium*
Base consistent *P. mawsonii*		**Upper *C. edwardsii***	Base *I. evexus / “waarriense”*
Base consistent *L. musa*	**Lower *H. trinalis***		Base consistent *K. polypes, Heterosphaeridium spp,* prominent *C. edwardsii*
		Lower *C. edwardsii*	
			Base dinoflagellates
Base *H. Trinalis, V. Admirabilis, L.musa, C. Triplex, P. Mawsonii / eunichus*			

Figure 2

Palaeoenvironmental Analysis

Definition of palaeoenvironments used in this study

Non-marine – No marine influence (nil or only monospecific proximal dinocyst component) - fluvial, swamp, lacustrine, coastal plain

Marginal Marine – paralic environments with an interaction of freshwater influx and marine influence (low yield, very low diversity microplankton assemblages) – upper delta plain, coastal lagoon, estuarine.

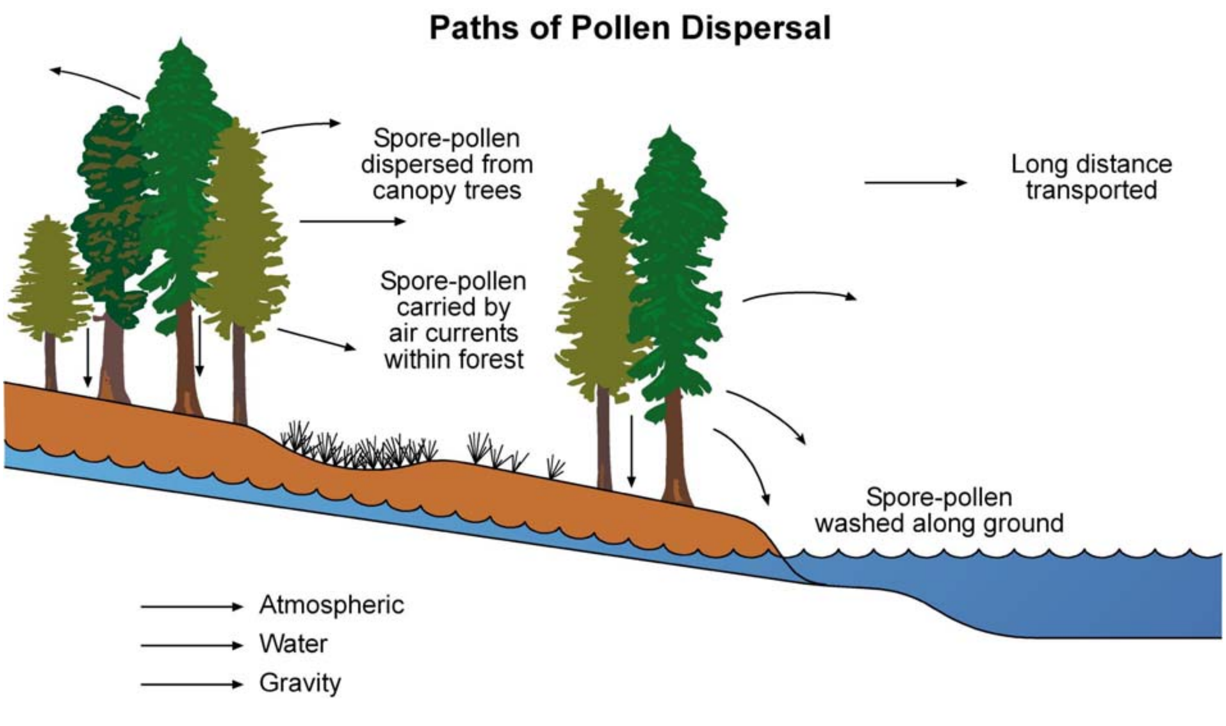
Restricted Marine –marine environment influenced by higher salinities, freshwater influx or turbidity (moderate yield, low diversity microplankton assemblages) – estuarine, lower delta plain, inner to middle neritic environments.

Shallow Marine – fully marine environment with minimum freshwater influence (low to moderate yields, moderate to high diversity assemblages) – inner to middle neritic environments.

Shelfal Marine - fully marine environment with minimum freshwater influence (moderate to high yields, moderate to high diversity assemblages) –middle to outer neritic environments.

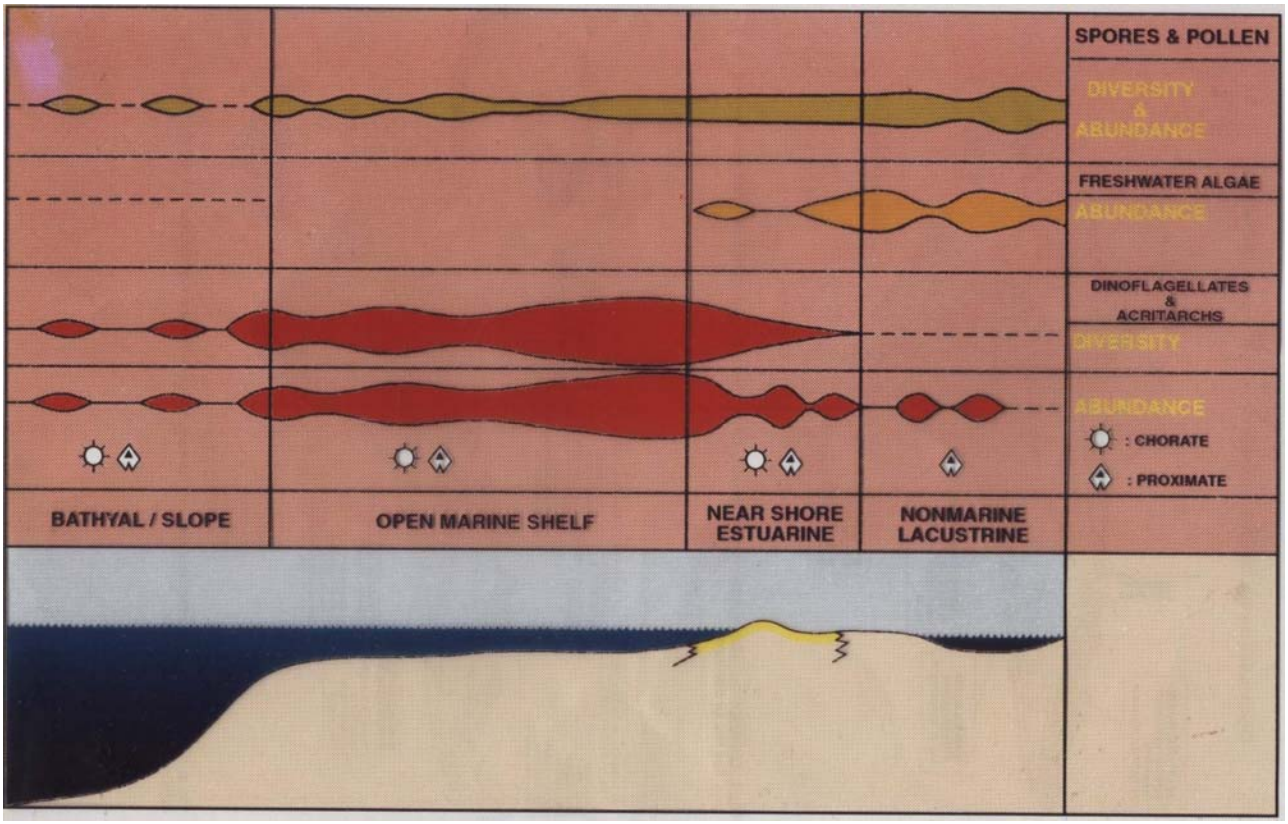
Palaeoenvironmental Analyses

The analysis of the relative abundances of spore and pollen grains, dinoflagellates and acritarchs in assemblages can provide useful palaeonenvironmental data.Plots of relative abundances of palynomorph groups can be related to transgressive-regressive phases and distances from the shoreline. The most commonly measured ratio is that of the marine (dinoflagellates + acritarchs) versus terrestrial (spores + pollen) palynomorphs.



Relative proportions of spores (ferns, lycopods & bryophytes), pollen (gymnosperm & angiosperm) in the terrestrial component can provide evidence of the floristic composition of the depocentre and its surrounding hinterland.

Organic-walled cyst producing dinoflagellates can provide evidence of the surface water physio-chemical conditions in marine influenced depositional settings. Modern and Quaternary dinocyst studies indicate that the cyst-forming dinoflagellates principally thrive in relatively shallow marine environments with their highest diversities reached along shelves and continental rises (Dale, 1996). Studies on the distribution pattern of modern dinocysts have shown that apart from nutrient availability and water temperature, cyst diversity strongly depends on the relative stress (turbidity & salinity) in the ecosystem. As these stress elements are often related to shoreline proximity, the dinocyst diversity signal is a useful palaeoenvironmental indicator (Pross & Brinkhuis, 2005).



The proximal / distal signal is expressed by changes in the assemblage composition, assemblage diversity and cyst abundances.

Actuopalaeontological and Quaternary studies as well as more recently dinocyst ecobiostratigraphic studies in Tertiary basins (Pross & Brinkhuis, 2005; Sluijs, et al, 2005) have refined existing and furnished new concepts of palaeoenvironmental reconstructions utilising dinocysts. Analysis of Paleogene dinocyst assemblages have been integrated with models of sea-surface productivity, temperature, salinity and stratification (Sluijis et al, 2005).

Similar ecobiostratigraphic studies of Cretaceous dinocyst assemblages are rare. A high resolution, quantitative study of Late Cretaceous assemblages from the Western Interior Basin, USA by Harris & Tocher (2000) identified criteria for discerning salinity contrasts across the basin. There are some common elements in the Late Cretaceous assemblages in the Otway Basin.

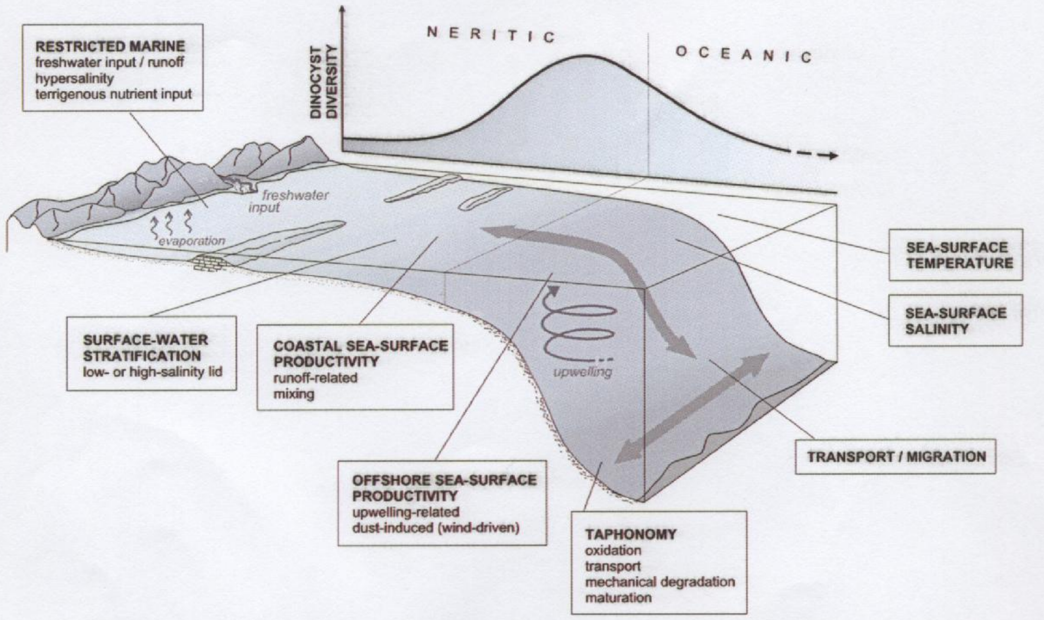


Fig. 1. Schematic illustration of main factors influencing the distribution of dinoflagellates and their organic-walled cysts.

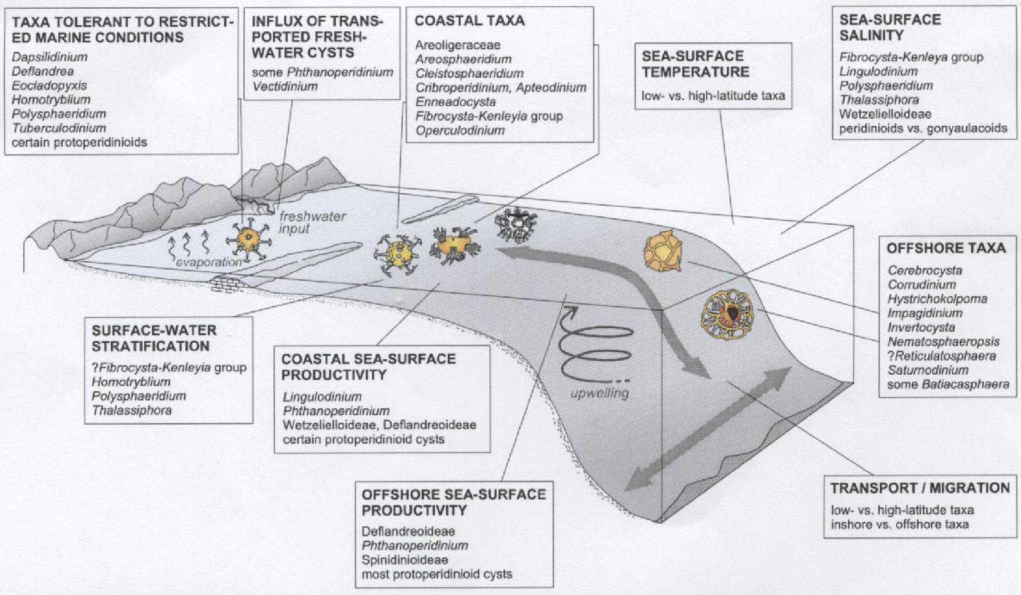


Fig. 2. Typical Paleogene dinoflagellate cysts indicative of specific environmental conditions. Compiled after various authors.

Example of a detailed Paleogene palaeoenvironmental transect. (from Pross & Brinkhuis, 2005)

SAMPLE	DEPTH (metres)	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS %	REWORKED ELEMENTS AGE	PRESER VATION	YIELD	DIVER SITY	REMARKS
SWC 21	1815.7	*I. rotundatum* to basal *N. aceras, ?I. rotundatum* Microplankton Zone (Late Santonian)	Skull Creek Mudstone	Tr	Permian	Fair	Mod.	Mod.	Assemblage dominated by microplankton (76%) predominantly *Heterosphaeridium spp* (67%) with prominent minor components including *Odontochitina spp & Isabelidinium spp. I. cretaceum, I. rotundatum, I. belfastense, A. denticulata & ??N. aceras* noted. The spore pollen component is dominated by *Dictyophyllidites, Cyathidites & Proteacidites spp* and includes *F. sabulosus & O. sentosa.*
SWC 20	1819.8	*P. infusorioides* Microplankton Zone, Upper *C. edwardsii* subzone (Turonian)	Waarre Formation Waarre B			Fair	Mod.	Low	Assemblage dominated by spore pollen predominantly *Cyathidites, Dictyophyllidites & Alisporites spp. A. distocarinatus* noted. Microplankton component (20%) includes prominent *C. edwardsii* (9%), *Oligosphaeridium spp & K. polypes.*
SWC 19	1821	*P. infusorioides* Microplankton Zone, Upper *C. edwardsii* subzone, *P. mawsonii* Spore pollen Zone, Lower *H. trinalis* subzone (Turonian)	Waarre Formation Waarre B			Fair	Mod.	Mod.	Assemblage dominated by spore pollen predominantly *Cyathidites, Dictyophyllidites & Alisporites spp. A. distocarinatus, H. trinalis & C. triplex* noted. Microplankton component (26%) includes prominent *C. edwardsii* (19%), *Spiniferites spp Oligosphaeridium spp & K. polypes.*
SWC 18	1822.2	*P. infusorioides* Microplankton Zone, ?Upper *C. edwardsii* subzone, *P. mawsonii* Spore pollen Zone, Lower *H. trinalis* subzone (Turonian)	Waarre Formation Waarre B	Tr	Permian	Fair	Low	Low	Assemblage dominated by spore pollen predominantly *Cyathidites, Dictyophyllidites, Cicatricosisporites & Alisporites spp. A. distocarinatus, H. trinalis & C. triplex* noted. Restricted microplankton component (28%) includes prominent *C. edwardsii* (26%), *C. compactum & Oligosphaeridium spp.*

SAMPLE	DEPTH (metres)	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESER VATION	YIELD	DIVER SITY	REMARKS
				%	AGE				
SWC 17	1823	*P. infusorioides* Microplankton Zone, Upper *C. edwardsii* subzone, *P. mawsonii* Spore pollen Zone, *H. trinalis* subzone (Turonian)	Waarre Formation Waarre B	1	Permian	Fair	Low	Low	Assemblage dominated by spore pollen predominantly *Cyathidites spp., M. antarcticus, Dictyophyllidites & Alisporites spp. L. "musa" & V. "admirabilis"*noted. Minor microplankton component (2%) includes *C. edwardsii, C. compactum & K. polypes.*
Core	1827.2	*P. infusorioides* Microplankton Zone, Lower *C. edwardsii* subzone, *P. mawsonii* Spore pollen Zone, Lower *H. trinalis* subzone (Turonian)	Waarre Formation Waarre A	1	Permian	Fair	Low	Low	Assemblage dominated by spore pollen predominantly *Cyathidites spp., A. australis, Gleicheniidites spp, M. antarcticus, Dictyophyllidites & Alisporites spp. A. distocarinatus, H. trinalis & P. mawsonii* noted. Minor microplankton component (2%) includes *C. edwardsii, C. compactum & Heterosphaeridium spp.*.
Core	1830.9	*P. infusorioides* Microplankton Zone, Lower *C. edwardsii* subzone, *P. mawsonii* Spore pollen Zone, Lower *H. trinalis* subzone (Turonian)	Waarre Formation Waarre A	2	Permian	Fair	Low	Low	Assemblage dominated by spore pollen predominantly *Cyathidites spp., A. australis, M. antarcticus & Alisporites spp. A. distocarinatus & H. trinalis* noted. Minor microplankton component (3%) includes *C. edwardsii & C. compactum*. Foram liners noted.
Core	1833.8	*P. infusorioides* Microplankton Zone, Lower *C. edwardsii* subzone, *P. mawsonii* Spore pollen Zone, Lower *H. trinalis* subzone (Turonian)	Waarre Formation Waarre A	3	Permian	Fair	Low	Low	Assemblage dominated by spore pollen predominantly *Cyathidites spp., Dictyophyllidites, & Alisporites spp. V. "admirabilis" & H. trinalis* noted. Prominent microplankton component (6%) *includes C. compactum (3%), P. cretaceum & C. edwardsii* noted.

SAMPLE	DEPTH (Metres)	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESER VATION	YIELD	DIVER SITY	REMARKS
				%	AGE				
Core	1843.9	*P. infusorioides* Microplankton Zone, Lower *C. edwardsii* subzone, *P. mawsonii* Spore pollen Zone (Turonian)	Waarre Formation Waarre A	1	Permian	Fair	Low	Low	Assemblage dominated by spore pollen predominantly *Cyathidites*, *Dictyophyllidites & Alisporites spp. C. triplex* noted. Moderately diverse microplankton component (22%) includes prominent *Oligosphaeridium spp. P. cretaceum, Spiniferites spp & K. polypes*.
Core	1844.4	*P. infusorioides* Microplankton Zone, Lower *C. edwardsii* subzone, *P. mawsonii* Spore pollen Zone, Lower *H. trinalis* subzone (Turonian)	Waarre Formation Waarre A			Fair	Mod.	Mod.	Assemblage dominated by spore pollen predominantly *Cyathidites*, *Dictyophyllidites, Alisporites spp. & M. antarcticus. H. trinalis & C. triplex* noted. Prominent, moderately diverse microplankton component (16%) includes prominent *Cyclonephelium spp, Oligosphaeridium spp., P. cretaceum, Spiniferites spp & K. polypes*.
Core	1845.6	*P. infusorioides* Microplankton Zone, Lower *C. edwardsii* subzone, *P. mawsonii* Spore pollen Zone, *H. trinalis* subzone (Turonian)	Waarre Formation Waarre A			Fair	Mod.	Mod.	Assemblage dominated by spore pollen predominantly *Cyathidites*, *Dictyophyllidites, Alisporites spp. & M. antarcticus. L. "musa", P. mawsonii & C. triplex* noted. Prominent, moderately diverse microplankton component (26%) includes prominent *Cyclonephelium spp, Oligosphaeridium spp. & Odontochitina spp. P. cretaceum, Spiniferites spp* present.
Core	1845.90	*P. infusorioides* Microplankton Zone, ?Lower *C. edwardsii* subzone, *P. mawsonii* Spore pollen Zone (Turonian)	Waarre Formation Waarre A	1	Permian	Fair	Mod.	Low	Assemblage dominated by spore pollen predominantly *Cyathidites*, *Osmundacidites spp, Alisporites spp. & M. antarcticus. C. triplex* noted. Prominent, moderately diverse microplankton component (28%) includes prominent *Cyclonephelium spp, Oligosphaeridium spp. & Odontochitina spp. P. cretaceum & Spiniferites spp.*

SAMPLE	DEPTH (Metres)	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESER VATION	YIELD	DIVER SITY	REMARKS
				%	AGE				
Core	1846.15	*P. infusorioides* Microplankton Zone, ?Lower *C. edwardsii* subzone, *P. mawsonii* Spore pollen Zone (Turonian)	Waarre Formation Waarre A			Fair	Mod.	Mod.	Assemblage dominated by spore pollen predominantly *Cyathidites, Alisporites spp. & M. antarcticus. C. triplex* noted. Prominent, moderately diverse microplankton component (36%) includes prominent *Cyclonephelium spp (18%), P. cretaceum (8%), Cribroperidinium spp. & Spiniferites spp.*
Core	1848.5	*C. paradoxa* or younger. (Cretaceous undifferentiated)	-			Fair	Ext. low	Ext. low	Extremely sparse assemblage dominated by spore pollen predominantly *Cyathidites, & Alisporites spp.. M. antarcticus, C. paradoxa & T. trioreticulosus* noted. No microplankton noted.
SWC	1853.1	-	-						No identifiable palynomorphs recovered.
SWC	1853.8	*?C. paradoxa*. (Albian)	?Eumeralla Formation			Fair	Low	Low	Restricted assemblage entirely spore pollen predominantly *Cicatricosisporites spp 42%), Cyathidites, & Araucariacites spp. T. trioreticulosus* noted. No microplankton noted.
SWC	1855.4	*C. paradoxa* (Albian)	Eumeralla Formation			Fair	Mod.	Mod.	Restricted assemblage entirely spore pollen predominantly *Cyathidites, M. antarcticus & Alisporites spp. C. paradoxa & T. trioreticulosus* noted. No microplankton recorded.
SWC	1856.3	*C. paradoxa* (Albian)	Eumeralla Formation			Fair	Mod.	Mod.	Assemblage entirely spore pollen predominantly *Cyathidites, M. antarcticus & Dictyophyllidites spp. A. acusus, C. paradoxa & T. trioreticulosus* noted. No microplankton recorded.
SWC	1884.2	*C. paradoxa* (Albian)	Eumeralla Formation			Fair	Mod.	Low	Assemblage entirely spore pollen predominantly *Cyathidites (50%), Retitriletes & Cicatricosisporites spp. C. paradoxa & T. trioreticulosus* noted. No microplankton recorded.

SAMPLE	DEPTH (metres)	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESERVATION	YIELD	DIVERSITY	REMARKS
				%	AGE				
SWC	1930.2	*C. paradoxa* (Albian)	Eumeralla Formation			Fair	Low	Low	Assemblage entirely spore pollen predominantly *Cyathidites, M. antarcticus & Araucariacites spp. A. problematicus & C. paradoxa* noted. No microplankton recorded.

Well Name : Henry No.1ST1

Interval : 1800m - 1950m

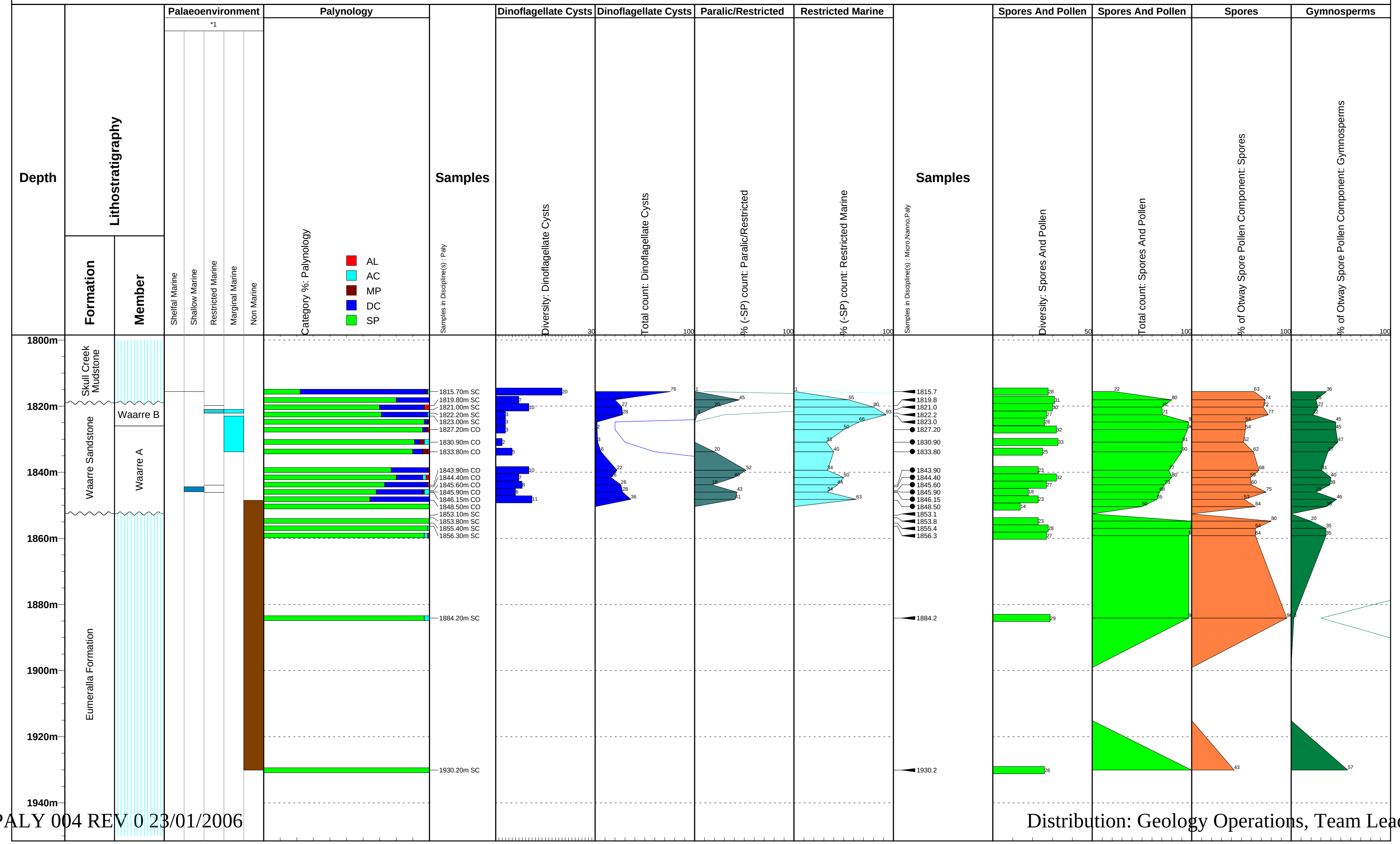
Scale : 1:1000

Chart date: 29 September 2005

Santos Ltd
Adelaide

Sampling
Cutting
Core
Sidewall core
Corrected core
Core corrections

Henry No.1ST1
Text Keys
*1 Palynology Environments



Well Name : Henry No.1ST1

Interval : 1800m - 1950m

Scale : 1:500

Chart date: 30 September 2005

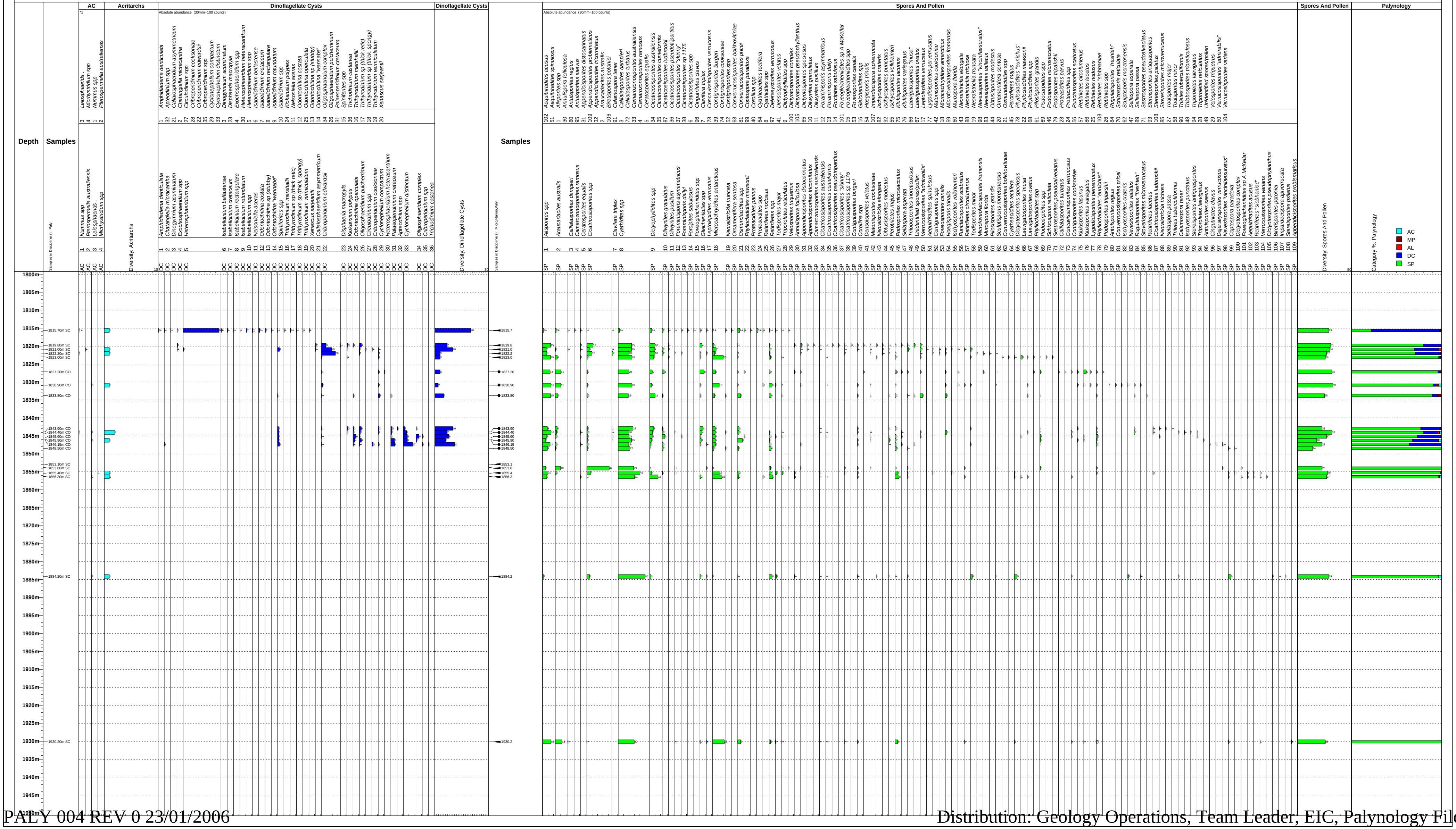
Santos Ltd
Adelaide

Sampling
Cutting
Core
Sidewall core
Corrected core
Core corrections

Henry No.1ST1

Text Keys

*1 Absolute abundance (30mm=300 counts)



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APPENDIX VI: SPECIAL CORE ANALYSIS

SCAL RESULTS WERE NOT COMPLETE AT THE TIME OF THIS REPORT.

ENCLOSURE I: COMPOSITE LOG

ENCLOSURE II: STRUCTURE MAP

ENCLOSURE III: STRATIGRAPHIC CROSS SECTION

ENCLOSURE IV: LOG INTERPRETATION PLOT