SANTOS – INPEX - MITTWELL

COMPILED FOR

SANTOS LIMITED

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

CALLISTER-1

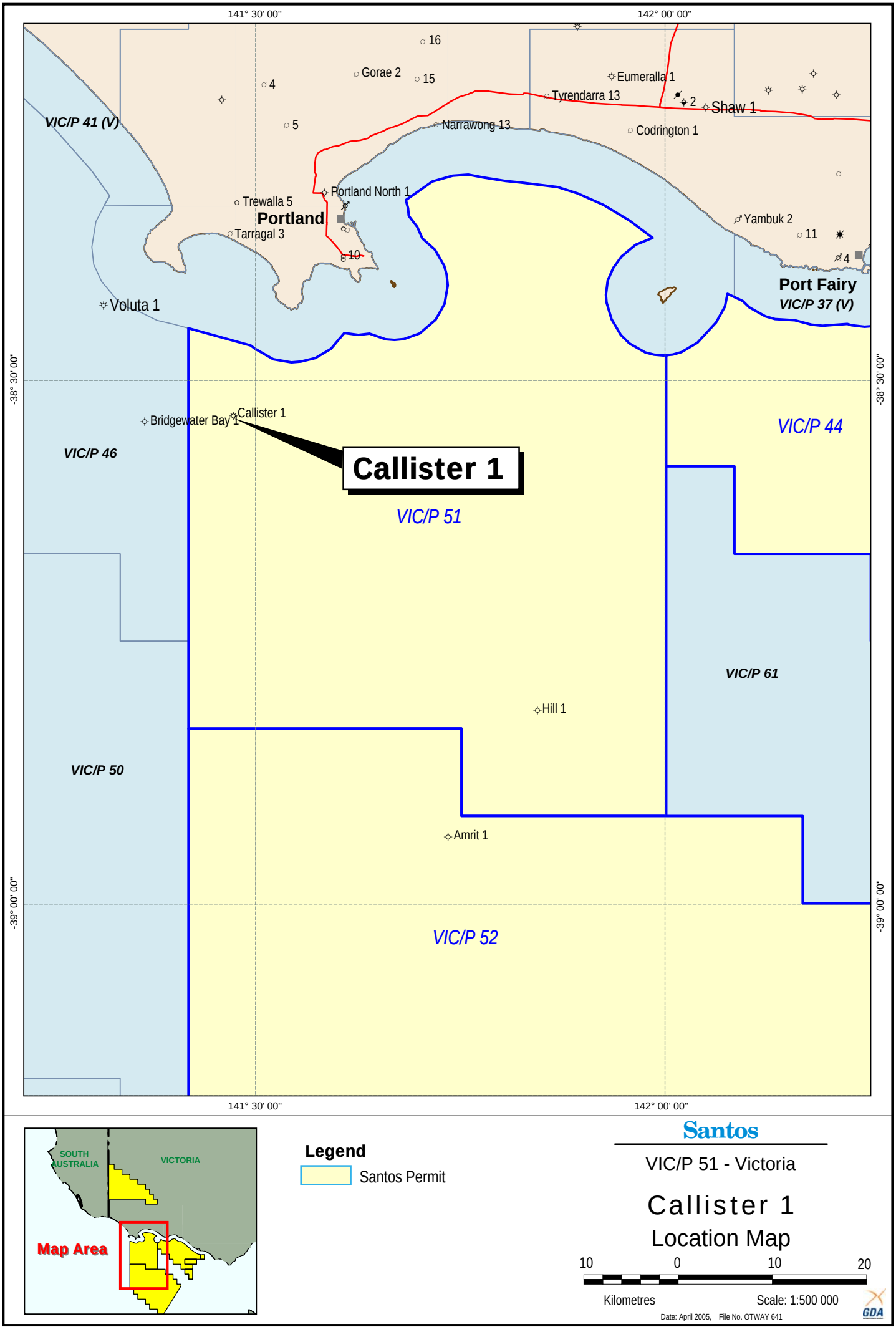
INTERPRETED DATA REPORT

PREPARED BY:
R. Subramanian
(Consultant)
April 2005

CALLISTER-1

TABLE OF CONTENTS

LOCATION MAP


141° 30' 00"
142° 00' 00"
-38° 30' 00"
-39° 00' 00"
16
Gorae 2
15
4
5
Eumeralla 1
Tyrendarra 13
2
Shaw 1
Narrawong 13
Codrington 1
VIC/P 41 (V)
Portland North 1
Trewalla 5
Portland
Tarragal 3
10
Yambuk 2
11
4
Port Fairy
VIC/P 37 (V)
Voluta 1
Bridgewater Bay 1
Callister 1
VIC/P 44
VIC/P 46
Callister 1
VIC/P 51
VIC/P 61
Hill 1
VIC/P 50
Amrit 1
VIC/P 52
SOUTH AUSTRALIA
VICTORIA
Map Area
Legend
Santos Permit
Santos
VIC/P 51 - Victoria
Callister 1
Location Map
10
0
10
20
Kilometres
Scale: 1:500 000
Date: April 2005, File No. OTWAY 641
GDA

WELL CARD

WELL: CALLISTER-1	**WELL CATEGORY**: Offshore Gas Exploration Well **WELL INTENT:** Gas	**SPUD:** 13-10-04 **TD REACHED:** 04-11-04			
		RIG RELEASED: 17-11-04 **CMPLT**: -			
		RIG: JACK BATES			
SURFACE LOCATION: (GDA94) **LAT:** 38° 31' 59.690" S **LONG:** 141° 28' 23.462" E **NORTHING:** 5734911.3m **EASTING:** 541241.7m		**STATUS**: Plugged and Abandoned			
SEISMIC STATION: OP80A-49 2D Survey SP 1514		**REMARKS**:			
ELEVATION SEA FLOOR: -129.4m LAT **RT** +29.0m LAT					
BLOCK/LICENCE: Victoria – Otway Basin VIC/P51					
TD 3917 m (Logr Extrap) 3914 m (Drlr)					
PBTD - m (Logr) - m(Drlr)		**HOLE SIZE**	**CASING SIZE**	**SHOE DEPTH**	**TYPE**
TYPE STRUCTURE: FAULTED HORST BLOCK CLOSURE		914mm	762mm	192m	460 kg/m X56
TYPE COMPLETION: NIL		445mm	340mm	778m	101 kg/m L80 BTC
ZONE(S): -		311mm	244mm	2538m	70 kg/m L80

AGE	FORMATION OR ZONE TOPS	DEPTH (M)		THICK-NESS (m)	HIGH (H) LOW (L)
		Drillers RT (m)	Subsea (m)		
Miocene-Eocene	Seabed to Top Dilwyn Formation	158	129	695	-
Eocene	Wangerrip Group: Dilwyn Formation	853	824	249	10m H
Palaeocene	Massacre Shale	1102	1073	14.5	NP
Late Cretaceous	Timboon Sandstone	1116.5	1088	409.5	49m H
Late Cretaceous	Paaratte Formation	1526	1497	731	-
Late Cretaceous	Nullawarre Greensand	2257	2228	89	27m H
Late Cretaceous	Belfast Mudstone	2346	2317	796	NP
Late Cretaceous	Flaxmans Formation	3142	3113	286	NP
Early - Late Cretaceous	Waarre "C"	3428	3399	25	168m L
Early - Late Cretaceous	Waarre "B"	3453	3424	15	-
Early - Late Cretaceous	Waarre "A"	3468	3439	-	-
	Total Depth (Logger Extrap)	3917	3888	-	-

LOG INTERPRETATION						PERFORATIONS	
INTERVAL (m)	Ø %	SW %	INTERVAL(m)	Ø %	SW %	FORMATION	INTERVAL
No Net Pay identified in this well.						Nil	
						CORES	
						FORM / NO. / INTERVAL / CUT / REC	

TYPE OF LOG	FROM (m)	TO (m)	REPEAT SECTION	TIME SINCE LAST CIRC	BHT
MWD 311mm (12.25") Gamma Ray, Resistivity, Annular Pressure, Vibration, Surveys (2 runs)	787.5	2550			
MWD 216mm (8.5") Gamma Ray, Resistivity, Annular Pressure, Vibration, Surveys (2 runs)	2550	3914			
WIRELINE SUITE 1 :					
PEX-DLT-DSI GR Resistivity SP Caliper Dt (Full waveforms) Neutron-Density	 2550 2550 2550 2550 2550 2550	 100 778 778 778 778 778	 Down log	 21.30 hrs	 87°C
WIRELINE SUITE 2 :					
Triple-Combo GR Spectral GR Resistivity SP HCAL Sonic (Upper Dipole & WFT) Neutron-Density	 3877 3877 3917 3870 3867 3908 3885	 2442 2442 2442 2442 2442 2469 2446	 Down log	 19.30 hrs	 131°C
MDT-GR (TOTAL : 26, 5 tight, 21 Lost Seals, No samples collected)	3400	3812	Run 1	26:40 hrs	132°C
CMR	3375	3917	Run 1	36:45 hrs	135°C
MSCT-GR (TOTAL : 26 Cores cut, 11 good, 3 partial,12 missing, 53.8% recovery)	3158m	3865m	Run 1	11:45 hrs	137°C
CSI CHECKSHOT	600m	3903m	Run 1	24:15 hrs	138°C

PRODUCTION TEST RESULTS

No production test conducted.

SUMMARY:

Callister-1 was drilled as an Otway Basin gas exploration well in the Victoria Offshore VIC/P51 licence. The Surface Location is Latitude: 38° 31' 59.690" South, Longitude: 141° 28' 23.462" East (GDA94), Northing: 5734911.3m, Easting: 541241.7m (MGA-94). The Seismic Reference is OP80A-49 2D Survey SP 1514. The location lies approximately 24 km southwest of the town of Portland, 10 km east of Bridgewater Bay-1, 18 km southeast of Voluta-1 and 45 km northwest of Hill-1. Callister-1 is located in 129.4m of water and was drilled by the semi-submersible drilling rig "Jack Bates".

The Callister-1 exploration wildcat well was designed to test one of three adjacent structural culminations that form the Callister Prospect, within the VIC/P51 Permit. The well plan was to drill to a total depth of 3629mRT. The Callister Prospect was a test of a new and as yet unproven Belfast-Paaratte gas play and the proven Eumeralla–Waarre gas play. The well would test two objectives within the Callister A Culmination, the largest of three, adjacent, horst block closures defined primarily on the 2003 OS03 2D seismic dataset. Success was dependent on the presence of cross fault seal for both objectives.

Callister-1 was planned to test the fault-bound structural potential of the primary target Intra-Paaratte K91 and K90 Nullawarre-equivalent deltaic sections, with up to 180m of structural relief over an area of 41 km^2. The deeper Waarre Formation secondary target has up to 400m of structural relief over an area of 36 km^2 . It was likely that significant overpressure will be encountered below the primary target, and the secondary objective would only be reached if operationally feasible.

Callister-1 was spudded at 12:00 hrs on the 13th of October 2004 by the semi-submersible drilling facility "Jack Bates". The 914mm (36") phase was drilled from seafloor at 158.4m to section total depth at 192m with all returns to the seafloor and cased with a string of 762mm (30") conductor casing which was set at 192m. The 445mm (17.5") hole section was drilled from 192m to 787.5m and cased with a string of 340mm (13.375") casing which was set at 778m. The 311 mm (12.25") section was drilled in 2 bit runs from 787.5m to 2550m, the TD for the 311mm section. The 311mm (12 ¼") section was logged while drilling with Anadrill Schlumberger MWD CDR-Powerpulse tools to record Gamma Ray, Resistivity, Vibration/Shock, Annular Pressure and Deviation Survey data. At 2550m, intermediate wireline logs were run. A string of 244mm (9.625") casing was run and cemented with the shoe at 2538m. The 216mm (8.5") section was drilled with 2 bit runs from 2550m to the Total Depth of 3914m which was reached at 09:00hrs on the 4th of November 2004. In the section from 2553m to 3914m, Mud Weight was increased in stages from MW 1.14SG (9.5ppg) to 1.69SG (14.1ppg) to combat high gas readings. The 216mm (8.5") section was logged while drilling with Anadrill Schlumberger MWD CDR-Powerpulse tools to record Gamma Ray, Resistivity, Vibration/Shock, Annular Pressure and Deviation Survey data. At Total Depth, wireline logs were run as summarised above.

Callister-1 was drilled as a vertical hole. At the Total Depth of 3914mRT (D), the estimated displacement was 36m towards 286.7°T direction. At total depth it is estimated that the TVD would be 3913.2m and the well was drilled within the Target tolerances specified in the program.

The penetrated depths of most formations in Callister-1 were between 14m and 49m high to their respective prognosed depths as can been seen in the Well Card. The exceptions were the Intra-paaratte K91 horizon which was penetrated 53m low to prognosis while the Nullawarre Equivalent K90 horizon was penetrated 27m high to prognosis. The Intra-Paaratte K91 and Nullawarre Equivalent K90 sands did not indicate any hydrocarbon shows.

The Top of the target Waarre Formation was intersected 168m low to prognosis. This corresponds to a deeper seismic reflector than what was originally mapped. During drilling the overlying Flaxmans Formation was penetrated where the Waarre Formation was mapped. In the target Waarre "C" Formation, no net pay was identified by log analysis in the sand interval 3430m to 3455m. Gas readings ranged from 15 to 58 units with a composition of 92/4/3/trace %. In the Waarre "A" Formation, no net pay was identified in the interval 3469m to 3861m. Gas readings in the interval ranged between 43 and 292 units with an average composition of 96/3/1/trace/trace %. While drilling, the CO^2 readings were typically in the 400-700 ppm range.

Callister-1 was plugged and abandoned. Cement plugs were set as per program, Plug 1: 3914m-3714m, Plug 2: 3714m-3514m, Plug 3: 3514m-3314m, Plug 4: 2568m-2510m, Plug 5: 2510m-2455m and Plug 6: 253m-185m. The rig was released at 04:00 hours on November 17, 2004.

AUTHOR: R. SUBRAMANIAN | **DATE**: April 2005

1. GEOLOGY

1.1 INTRODUCTION

Callister-1 was drilled as an Otway Basin gas exploration well in the Victoria Offshore VIC/P51 license. The Surface Location is Latitude: 38° 31' 59.690" South, Longitude: 141° 28' 23.462" East (GDA94), Northing: 5734911.3m, Easting: 541241.7m (MGA-94). The Seismic Reference is OP80A-49 2D Survey SP 1514. The location lies approximately 24 km southwest of the town of Portland, 10 km east of Bridgewater Bay-1, 18 km southeast of Voluta-1 and 45 km northwest of Hill-1.

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1.2 FIELD DESCRIPTION (after Callister-1 Well Proposal)

Geological/Geophysical Summary

The Callister Prospect is located on the crest of a faulted, east-west trending horst block, which is well-defined by recent 2D seismic. The Callister horst is situated at the south-eastern extent of the plunging Bridgewater Bay high, within a probable relay ramp between offset major rift-related faults.

An effective petroleum system has yet to be proven in the offshore Otway Basin west of the Shipwreck Trough area, and also within the Upper Cretaceous Sherbrook Group. However, the possibility of an active Upper Cretaceous liquids-prone source in the offshore Otway Basin is encouraged by geochemical studies that indicate the potential for multiple charge events into existing gas-accumulations. These studies suggested an early gas-prone charge from a likely Eumeralla source was followed by a more recent liquids-prone charge event from a Waarre/Flaxman or Belfast source. The Callister horst is well situated to receive charge from the potential source kitchens of the adjacent Voluta and Portland troughs throughout its structural history, as the relay ramp is likely to form a focal point for petroleum migration. Based on regional mapping, the Voluta Trough is a major Belfast Shale depocentre, improving

the possibility of charge from a liquids-prone source for the Callister Prospect. A probable gas chimney to the northeast of the Callister location provides further evidence for hydrocarbon charge in the area.

The primary target of the Callister Prospect was the Intra-Paaratte (K91)/Nullawarre (K90) deltaic section. This section consists of interbedded, transgressive/regressive shallow marine to deltaic sandstone/siltstone sequences with intervening shales/mudstones, and has been intersected by Bridgewater Bay-1 and Hill-1, 10 and 45 km away. In these wells, the gross Paaratte stratigraphic interval range from 730m to 475m in thickness.

The secondary target of the Callister Prospect was the deeper fluvio-deltaic to marginal marine sandstones of the Waarre Formation. This section has been intersected by the Bridgewater Bay-1 and Normanby-1 wells, 10km and 47km away, and is the primary objective in the proven petroleum system in the Shipwreck Trough area, 100km to the east. However, due to depth of burial and resultant uncertainty in the potential for porosity preservation in the Callister area, this section was regarded as a secondary target.

The primary risk for the K91/K90 objective was seal capability due to uncertainty in the possible cross-fault juxtaposition of Intra-Paaratte K91 and Nullawarre K90 sandstones. Variations in cross-fault sandstone juxtaposition and hence seal capacity along the strike of the horst block could also limit the size of any potential accumulation. At the deeper Waarre (K77) secondary objective level, the primary risk lay in the distribution of sandstone reservoirs at this location, and also in the preservation of porosity and permeability at this depth.

Quicklook AVO analysis was carried out over the Callister Prospect Paaratte Objective using offset gathers from the OS03 2D survey. Generally the gathers showed signs of anisotropy and noise from out of plane reflectors producing some ambiguous results. The areal distribution of potential seismic attribute anomalies was investigated using both Far*(Far-Near) offset stack analysis and Amplitude over Background (A/B) maps. The resultant anomalous responses from both methods appear restricted to a semi-circular, channel-form geometry but as with the full stack data, no amplitude conformance with structure was visible within the Paaratte interval. Due to the great depth of the Waarre Formation (limited offset range) and expected lower porosities, AVO modelling was not carried out over this secondary objective

The Callister Prospect location has been chosen based on the following criteria:

- to test a thick, higher amplitude section of the Intra-Paaratte K91/Nullawarre K90 deltaic sandstones
- to test the extent of the Waarre Formation Play Fairway located at a focus for hydrocarbon migration with the best chance of reservoir preservation.

In satisfying these criteria the proposed location lies within the small three way fault closure identified at the Waarre level and beyond the limit of the P90 closure area ($2km^2$) at the K91 horizon. Consequently, the well was located approximately 70m downdip of the crest of the Intra-Paaratte delta (K91) and 110m downdip of the crest of the Waarre Formation sandstones. In the event of failure, the updip potential at both reservoir objectives would be uneconomic.

Play

The Callister Prospect lies within the Paaratte Play Fairway which relies upon either the unproven Belfast Paaratte Petroleum System, or an alternate liquids source from the Waarre/Flaxmans sequence for oil success. Whilst in the nearshore and onshore sections of the Otway Basin, the Belfast Formation is a generally poor to gas-prone source, it is postulated that source quality will improve basinwards in the Voluta and Portland trough depocentres, where the Belfast Formation is currently within the active oil-window. As the Paaratte Play is unproven for both oil and gas, a high play risk was assigned in the charge category. The deeper Waarre Formation objective lies within the proven gas-prone Eumeralla-Waarre Petroleum System that works in the onshore and nearshore parts of the Otway Basin

Closure

The Callister Prospect is an east-west trending, fault-bound horst block feature which was mapped on a 1-2 km grid of 2D seismic data (including 2003 acquired and 2002 reprocessed surveys). The proposed well location is just beyond the limit of the small three way dip closure of the Intra-Paaratte K91 section on the crest of the horst. The preferred (likely) model for the Callister extent is that the resource potential is limited to the northwest and southeast by structural spill. Some uncertainty exists with closure at the western end of the prospect due to shallow Tertiary channels and the resultant uncertainty in the seismic interpretation and velocities beneath this poor data zone. Various mapping scenarios (depth conversion methods, gridding without a) faults, b) low-confidence picks) confirmed the presence of this structural high within the VICP51 permit, though uncertainty still remains as to the P10 areal closure extent.

Reservoir

Reservoir was highly likely to occur in the Paaratte Formation is very well developed in the nearby Bridgewater Bay/Discovery Bay area, as well as in Hill 1, 45 km to the southeast. The presence of strong amplitude events within the section, its polarity and an amplitude character that is consistent with the presence of sandstone provide a high confidence that some potential reservoir quality section will be present at the Callister location. The Paaratte Formation was prognosed to be approximately 650m thick and consist of a stack of interbedded sandstones, siltstones and shales of fluvial to deltaic depositional environment. Net:Gross ratios decrease from the main Paaratte depocentre, in the vicinity of Argonaut-1 (123 km WNW) to Bridgewater Bay-1, but in Callister-1 the Net:Gross of the upper Paaratte was expected to be moderate to high. In the lower Paaratte/Nullawarre (K91/K90) correlation to Bridgewater Bay-1 predicts the presence of several thick, massive sandstones with intervening shales become much thicker (in excess of 150m).

The top of the Paaratte package was mapped as the K93 horizon. At Hill-1 this section has 46m of reservoir quality sandstones underlying Timboon-equivalent mudstone. At the more proximal Callister-1 location, it was expected that the Timboon mudstone would not be well developed (similar to Bridgewater Bay-1 and Discovery Bay-1) and the K93 interval would consist of thin, interbedded sandstones and shales as opposed to thick delta lobes.

Seal

Seal was considered a higher risk element for the Callister Prospect, Paaratte Formation. At the Hill-1 location the Paaratte (K93) section is overlain by distal Timboon-equivalent mudstone facies providing a good reservoir/seal couplet. At the Callister location, seismic data support the presence of interbedded sands and shales within the Timboon Formation and no thick, well-developed, sealing mudstones. Without a thick, regionally extensive mudstone, sealing of Upper Paaratte sandstones would require unlikely cross-fault sand/shale juxtapositions or an effective shale-smear seal along the fault plane. It was possible that one or more Upper Paaratte sandstones could prove gas-bearing, but it was unlikely and was regarded as upside to the distribution.

In the lower Paaratte/Nullawarre (K91/K90), correlation to Bridgewater Bay-1 and the seismic character, support the presence of well-developed, thicker, intra-formational mudstones associated with regional flooding events. These are more likely to top-seal and also provide a cross-fault seal and are seen as the primary objective level. Seismic mapping tied to Bridgewater Bay-1 supports the presence of a possible regional sealing section (~150m at the well location) overlying the primary targets.

Charge

Hydrocarbon charge had significant uncertainty due to the unproven existence of an active petroleum system. The Callister Prospect was targeted primarily for potential gas but some potential for oil could also exist. Total chance of hydrocarbon charge is considered to be approximately 57%.

The existence of an active liquids-prone source on the southern margins is supported by the presence of bitumen strandings on the coast-line, and sampling of sea-floor seeps with liquids signatures. Geochemical studies also indicate the potential for dual-charge events into structures in the Shipwreck Trough, from an early dry-gas source (Eumeralla) and a later, more liquids-prone source (Waarre/Flaxmans or Belfast?).

Maturity modelling showed potential for charge in the Late Cretaceous and Tertiary from sediments in the Portland Trough. The modelling indicated that the Eumeralla Formation was matured and generated in the mid-Cretaceous but that it retained some generative potential that could be reactivated by further burial in the Late Cretaceous and Tertiary despite the lower heat-flow at this time. Further generative potential was seen from strata of Waarre to Belfast age, which are in the recent to current-day hydrocarbon window. Charge from these strata was dependent on their quality as source rocks.

The early formed Callister Structure is situated at the focal-point of a structural nose with access to a large generative hydrocarbon-kitchen and as such is ideally suited to receive hydrocarbon charge throughout its existence as a trap.

The presence of an apparent gas chimney defined on several seismic lines to the north-east of the Callister Prospect, above a second offset culmination, provided good evidence for a working charge system in the area.

1.3 WELL LOCATION

Callister-1 was drilled as an Otway Basin gas exploration well in the Victoria Offshore VIC/P51 license. The Surface Location is Latitude: 38° 31' 59.690" South, Longitude: 141° 28' 23.462" East (GDA94), Northing: 5734911.3m, Easting: 541241.7m (MGA-94). The Seismic Reference is OP80A-49 2D Survey SP 1514. The location lies approximately 24 km southwest of the town of Portland, 10 km east of Bridgewater Bay-1, 18 km southeast of Voluta-1 and 45 km northwest of Hill-1. Callister-1 is located in 129.4m of water.

The Surface Surveyed Location for Callister-1 is :

Latitude: 38° 31' 59.690" South
Longitude: 141° 28' 23.462" East (GDA-94).
Easting: 541241.7m
Northing: 5734911.3m (MGA-94)

The Seismic Location for Callister-1 is:

OP80A-49 2D Survey SP 1514
Multi-vintage 2D Surveys (1980-1993), OS03-2D (2003)

2. RESULTS OF DRILLING

2.1 STRATIGRAPHY & GEOPHYSICAL PROGNOSIS

While drilling Callister-1, the penetrated depths of most formations were between 10m and 49m high to their respective prognosed depths. However the exception was the primary target Waarre Formation which was intersected 168m low to its predicted depths.

2.2 STRATIGRAPHY (Drillers MDRT Depths)

The following table outlines the elevations and thicknesses of formations penetrated in Callister-1. Detailed descriptions can be found in Section 2.1 of the Basic Data Report.

AGE	FORMATION OR ZONE TOPS	DEPTH (M)		THICK-NESS (m)	HIGH (H) LOW (L)
		Drillers RT (m)	Subsea (m)		
Miocene-Eocene	Seabed to Top Dilwyn Formation	158	129	695	-
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Early - Late Cretaceous	Waarre "A"	3468	3439	-	-
	Total Depth (Logger Extrap)	3917	3888	-	-

2.3 HYDROCARBON SUMMARY (Logger's MDRT Depths)

Ditch gas values were monitored and recorded in units (U) by F.I.D (flame ionisation detector) 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 a F.I.D. 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. 95/2/1/1/1 denotes 95% C1, 2% C2, 1% C3, 1% C4 and 1% C5). Ditch cuttings were tested for hydrocarbon fluorescence by using an ultra-violet fluoroscope.

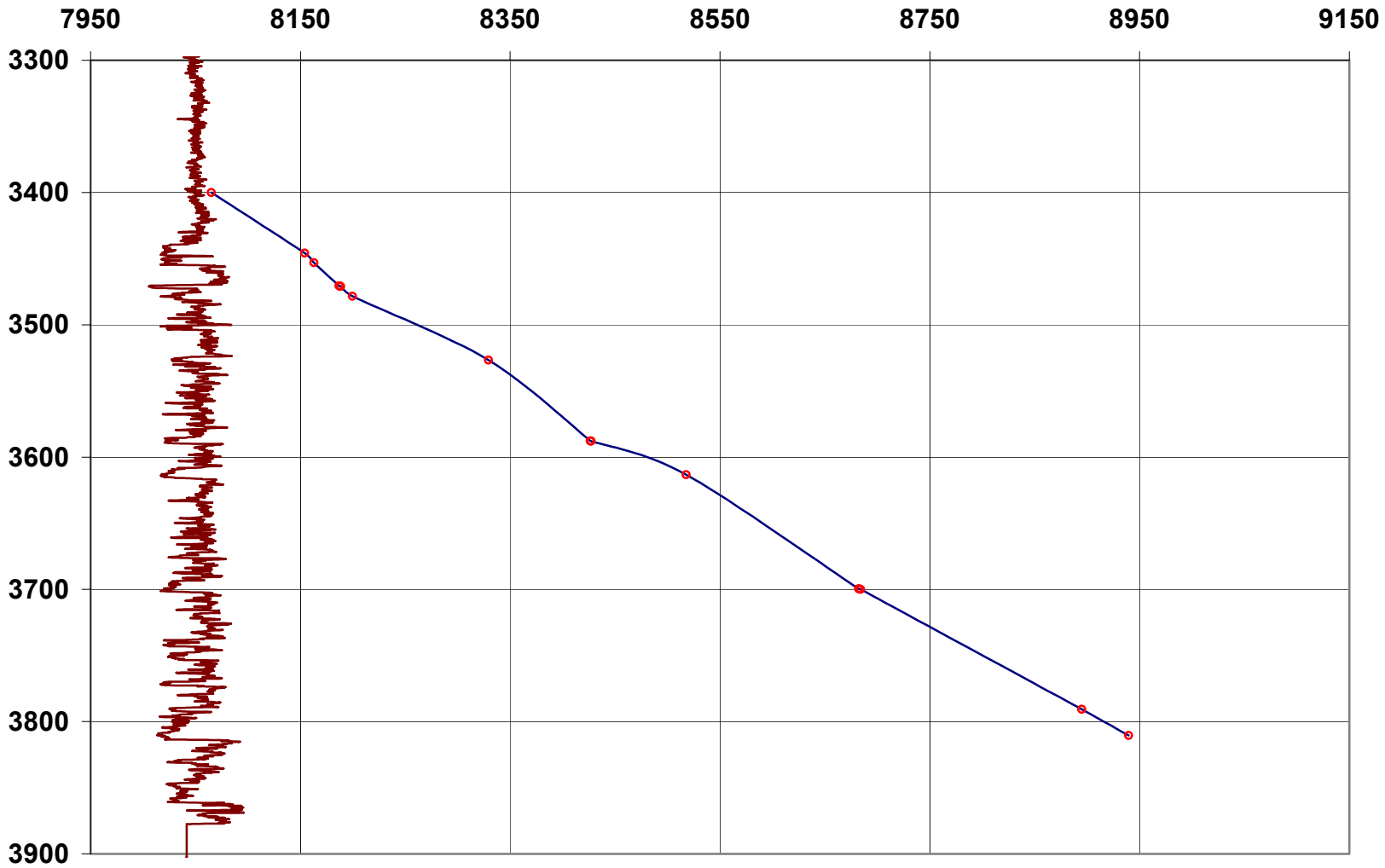
Since drilling was riser-less and returns were to the seafloor in the 914mm (36") and 445mm (17.5") sections, gas readings are not available. After drilling out the 340mm (13-3/8") casing shoe at 778m returns were to the surface and realtime gas monitoring was possible. From the casing shoe at 778m to 1425m, Total Gas in trace quantities (typically <1%) was recorded and consisted of 100% C1. From 1425m to the top of the Belfast Mudstone at 2346m, background gas ranging from 2 to 28 units was recorded and consisted of 98/2/trace 0%. In the Belfast Mudstone and Flaxmans Formation, the background gas increased marginally to range between 1 and 66 units and comprised of varying gas ratios ranging from 97/3/trace % to 87/5/5/2/1 %. In the target Waarre "C" Formation, 1.5m of pay with Average ∅=11.8% and Sw=50% was identified by log analysis in the sand interval 3430m to 3455m. Gas readings ranged from 15 to 58 units with a composition of 92/4/3/trace %. In the Waarre "A" Formation, 3.5m of Net Pay with Average ∅=11.0% and Sw=43% was identified in the interval 3469m to 3861m. Gas readings in the interval ranged between 43 and 292 units with an average composition of 96/3/1/trace/trace %.

In the interval from 3833m to Total Depth, connection gas readings were recorded in the 400 to 700 unit range requiring an increase in Mud Weight from 1.54 sg (12.8 ppg) to 1.69 sg (14.1 ppg).

2.4 WATER INFLUX

While on a wiper trip after recording wireline logging Run 4: CMR-GR, a gain in the trip tank was recorded. The logging runs were abandoned and the bit was run in hole to control the influx and condition the mud and hole. It was estimated that an influx of approximately 40 bbls was recorded while logging. A plot of the hydrostatic pressures recorded during the MDT Pressure Survey indicates a non-uniform column with perturbations on the hydrostatic plot (see below) suggesting an influx of water from 3700m, 3590m & 3470m. The deepest pressure indicates an equivalent Mud Weight of 1.645 sg (13.7 ppg) and the shallowest pressure indicated an equivalent Mud Weight of 1.669 sg (13.9 ppg). Assuming a fresh water influx, pressures indicate an influx of between 38 & 53 bbls of water which agrees with the reported influx of 40bbls when the Mud Weight was cut back to 1.513sg (12.6 ppg) and chlorides cut from 52000 ppm to 33000 ppm.

MDT Hydrostatic Pressure v/s Depth



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The Callister-1 exploration wildcat well was designed to test one of three adjacent structural culminations that form the Callister Prospect, within the VIC/P51 Permit. The well plan was to drill to a total depth of 3629mRT. The Callister Prospect was a test of a new and as yet unproven Belfast-Paaratte gas play and the proven Eumeralla–Waarre gas play. The well would test two objectives within the Callister A Culmination, the largest of three, adjacent, horst block closures defined primarily on the 2003 OS03 2D seismic dataset. Success was dependent on the presence of cross fault seal for both objectives.

Callister-1 was planned to test the fault-bound structural potential of the primary target Intra-Paaratte K91 and K90 Nullawarre-equivalent deltaic sections, with up to 180m of structural relief over an area of 41 km^2. The deeper Waarre Formation secondary target has up to 400m of structural relief over an area of 36 km^2. It was likely that significant overpressure will be encountered below the primary target, and the secondary objective would only be reached if operationally feasible.

Callister-1 was spudded at 12:00 hrs on the 13th of October 2004 by the semi-submersible drilling facility "Jack Bates". The 914mm (36") phase was drilled from seafloor at 158.4m to section total depth at 192m with all returns to the seafloor and cased with a string of 762mm (30") conductor casing which was set at 192m. The 445mm (17.5") hole section was drilled from 192m to 787.5m and cased with a string of 340mm (13.375") casing which was set at 778m. The 311 mm (12.25") section was drilled in 2 bit runs from 787.5m to 2550m, the TD for the 311mm section. The 311mm (12 ¼") section was logged while drilling with Anadrill Schlumberger MWD CDR-Powerpulse tools to record Gamma Ray, Resistivity, Vibration/Shock, Annular Pressure and Deviation Survey data. At 2550m, intermediate wireline logs were run. A string of 244mm (9.625") casing was run and cemented with the shoe at 2538m. The 216mm (8.5") section was drilled with 2 bit runs from 2550m to the Total Depth of 3914m which was reached at 09:00hrs on the 4th of November 2004. In the section from 2553m to 3914m, Mud Weight was increased in stages from MW 1.14SG (9.5ppg) to 1.69SG (14.1ppg) to combat high gas readings. The 216mm (8.5") section was logged while drilling with Anadrill Schlumberger MWD CDR-Powerpulse tools to record Gamma Ray, Resistivity, Vibration/Shock, Annular Pressure and Deviation Survey data. At Total Depth, wireline logs were run as summarised in the Well Card.

Callister-1 was drilled as a vertical hole. At the Total Depth of 3914mRT (D), the estimated displacement was 36m towards 286.7°T direction. At total depth it is estimated that the TVD would be 3913.2m and the well was drilled within the Target tolerances specified in the program.

The penetrated depths of most formations in Callister-1 were between 14m and 49m high to their respective prognosed depths as can been seen in the Well Card. The exceptions were the Intra-paaratte K91 horizon which was penetrated 53m low to prognosis while the Nullawarre Equivalent K90 horizon was penetrated 27m high to prognosis. The Intra-Paaratte K91 and Nullawarre Equivalent K90 sands did not indicate any hydrocarbon shows.

The Top of the target Waarre Formation was intersected 168m low to prognosis. This corresponds to a deeper seismic reflector than what was originally mapped. During drilling the overlying Flaxmans Formation was penetrated where the Waarre Formation was mapped. In the target Waarre "C" Formation, no net pay was identified by log analysis in the sand interval 3430m to 3455m. Gas readings ranged from 15 to 58 units with a composition of 92/4/3/trace %. In the Waarre "A" Formation, no net pay was identified in the interval 3469m to 3861m. Gas readings in the interval ranged between 43 and 292 units with an average composition of 96/3/1/trace/trace %. While drilling, the CO^2 readings were typically in the 400-700 ppm range.

Callister-1 was plugged and abandoned. Cement plugs were set as per program, Plug 1: 3914m-3714m, Plug 2: 3714m-3514m, Plug 3: 3514m-3314m, Plug 4: 2568m-2510m, Plug 5: 2510m-2455m and Plug 6: 253m-185m. The rig was released at 04:00 hours on November 17, 2004.

3. REFERENCES

SANTOS, 2004	CALLISTER-1 WELL PROPOSAL, PREPARED FOR SANTOS LTD, (UNPUBLISHED).
SUBRAMANIAN, R., 2004	CALLISTER-1 BASIC DATA REPORT, PREPARED FOR SANTOS LIMITED, (UNPUBLISHED).
SANTOS, 2004	CALLISTER-1 PRELIMINARY LOOKBACK, PREPARED FOR SANTOS LIMITED, (UNPUBLISHED).

APPENDIX I: ELECTRIC LOG EVALUATION RESULTS

Log analysis identified no net pay in Callister 1.

CALLISTER 1
LOG ANALYSIS

CALLISTER 1 - LOG ANALYSIS

Callister 1 wireline logs were analysed from 3143 m to 3917 m(L). No gas pay was identified in the well, although elevated background gas readings were observed on the mudlogs over the Waarre A Formations, but this has been interpreted to be mainly low saturation gas as the MWD and wireline logs do not indicate conventional pay. Callister 1 was subsequently plugged and abandoned as with gas shows.

The seabed was tagged at 158.42m (D, tide corrected). A 660mm hole was drilled from 158m (D) to 192m and opened to 914mm. 762mm casing was set at 191m. (D). A 444mm hole was then drilled to 787.5m (D) and 340 mm casing set at 778m (D). A 311mm hole was drilled with KCL-PHPA Polymer to a depth of 2522m (D) using MWD (Navigation, Resistivity and Gamma Ray) prior to running intermediate wireline logs. 244mm casing was set at 2538m (D). A 216mm hole was drilled with KCl-PHPA to a total depth of 3914mm (D) with MWD (Navigation, Resistivity and Gamma Ray). Wireline logging was carried out as described below.

Unless otherwise specified, all depths mentioned below are logger's depths referenced to the drill floor.

Conventional Pay Summary ***(ϕ_e>10% & Swt<70%)***

FORMATION	SAND INTERVAL	GROSS SAND (m)	NET SAND (m)	AVG PHIs (%)	NET PAY (m)	AVG PHIp (%)	WT.AVG SW (%)
FLAXMANS FORMATION	3144-3430	0	0	-	0	-	-
WAARRE C	3430-3455	9.1	1.5	11.8	0	-	-
WAARRE B	3455-3469	0	0	-	0	-	-
WAARRE A	3469-3861	68.9	3.5	11	0	-	-

Logs Acquired (wireline)

Run 1	GR	3877m – 2442 m	
	SGR	3877m – 2442m	
	HALS	3917m – 2442m	
	HCAL	3867m – 2442m	
	SP	3870m – 2442m	
	DT	3908m – 2442m	Upper dipole and waveforms
	RHOB	3885m – 2446m	
	TNPH	3885m – 2446m	
	PE	3885m – 2446m	
Run 2	MDT-GR	3812m – 3400m	26 pts (5 curtailed, 21 lost seals)
Run 3	CMR	3917m – 3375m	
Run 4	MSCT-GR	3865m – 3158m	26 cut (11 good, 3 partial, 12 missing)
Run 5	CSI-Checkshot	3903m – 600m	

Mud Parameters

Mud Type	KCl Polymer
KCl Content	8.0%
Mud Density	1560 K/M3
Rm	0.130 ohmm @ 26 DEGC
Rmf	0.083 ohmm @ 25 DEGC
Rmc	0.322 ohmm @ 24 DEGC
MRT	131 DEGC from run 2, 19.3 hrs since last circulation

Log Processing and Remarks

COMMENTS:

Run 1: Triple Combo

- 244mm Casing shoe at 2538m (L), 2538m (D)
- Total Depth: 3917m (L), 3914m (D)
- Replaced faulty HNGS (Spectral GR)
- Tools hanging up between 2700m and 3700m while running in the hole. While logging up, experienced overpull of 5000 to 8500kls between 3700m and 2700m.
- The Calipers were closed at 2994m due to excess amounts of overpull. Calipers were re-opened at 2641m.
- Wiper trip was performed after Run 1 due to tight hole conditions which were encountered during run 1.
- Due to tight hole, GR was jerky affecting correlation of subsequent logs to the 1st run

Run 2 & 3: MDT-GR

- Run 2 was aborted after conducting 3 consecutive "No Seals".
- One Shale test was okay, while another was again a "No Seal"
- Seal inside casing was okay.
- The packer was examined at surface for damage – none found.
- Replaced packer with larger hole diameter packer.
- While tool on surface, noticed power module between the pump out module & MRSC (1 gallon) sample chamber was not working.
- Lost 1:45 hrs while replacing the power module between the pump out module & MRSC (1 gallon) sample chamber.
- In total conducted 26 pre-test with 6 tight test, 20 no seat. Of the 26 pre-test 3 test conducted in shale (2 confirmed seat, 1 no seat) and 1 test conducted in the casing to confirm packer integrity in the casing while pulling out of the hole on run 2.

Run 4: CMR

- Tools too light-floating in mud while running in hole, also magnet catching on to casing.
- Added DLT tools to weigh up tool string.
- Bottom hole temperature recorded at 134.7degC.

Run 5: MSCT-GR

- Run aborted at 3117m after a observing a gain in the trip tank.
- A wiper trip was conducted to condition the well before attempting to conduct MSCT's.
- MSCT was re-run following the wiper trip.
- Of the 26 cores cut, 11 were good, 3 were partial recovery, 12 were lost
- Marker disks were found blocking the core catcher tube
- Photographs of the undisturbed core were taken after retrieval from the tool and are attached
- Despite missing marker disks (failed to be deployed), the only uncertainity remains regarding sample from depth 3464m. This is probably from a deeper depth.

Interpretation Procedures and Parameters

A deterministic approach was used to evaluate Callister due to the poor quality of the wireline logs. Due to the excessive tool stick and 'jerky' logs, the logs were depth matched individually and referenced to the MWD GR. The resistivity logs were not used in the interpretation (apart from MSFL) due to excessive tool sticking. The MWD ATR and PSR resistivity readings were used in place of the wireline logs as they are more robust and not affected by the adverse hole conditions seen on the wireline logs.

The Spectral gamma ray log was not used due to the high concentrations of potassium in the well bore (8%). Standard Gamma ray logs were used. As a result spectral clay typing could not be used in the analysis. Elevated barite also affected the PEF logs and this could not be used in the interpretation. Poor borehole conditions and tool stick-slip affects all pad device tools, particularly density and the MSFL. Where possible, elastic depth matching has removed some of the effects of tool sticking, but washouts affect the response of pad tools and these have not been corrected. As a result, badhole processing switches the primary porosity from the nuclear logs to the sonic logs. Due to badhole, the density log was synthetically replaced so as to compensate for bad hole. The following parameters were used in the analysis-

- **Volume Of Shale**

The shale volume (Vsh) was calculated using the Density-Neutron xplot technique. The equations are:

$$V_{SH}DN = \frac{(a-b)}{(c-d)}$$

where:

$$a = (\rho ma - \rho fl) * (nphi_{fl} - nphi)$$
$$b = (\rho - \rho fl) * (nphi_{fl} - nphi_{ma})$$
$$c = (\rho ma - \rho fl) * (nphi_{fl} - nphi_{sh})$$
$$d = (\rho sh - \rho fl) * (nphi_{fl} - nphi_{ms})$$

ρ = density (K/M3)
fl = fluid properties
sh = shale properties
ma = matrix properties
nphi = neutron log (environmentally corrected)

- **Porosity**

Total Porosity, PHIT (ϕ_t**)** was using the following relationships:

$$sphi = \frac{(DT - 55.5)}{DT} * 0.45,$$

$$dphi = \frac{\rho ma - \rho}{\rho ma - \rho fl},$$

$$nphi = nphi_{ss},$$

$$phix = \frac{(dphi + nphi_{ss})}{2},$$

$$dphix = \min(dphi, phix) \quad \textbf{\&}$$

$$phit = badhole > 0.1, sphi, dphix$$

Effective Porosity, PHIE (ϕ_e) is calculated as follows:

$$phie = phit - (phi_{sh} * Vsh)$$

where;

$phi_{sh} = 0.18$

- **Water Saturation**.

The water saturation was derived using the Psuedo-Archie Equation as defined below:

$$Sw = \sqrt[n]{\frac{aRw}{\phi^m RT}}$$

Southern Margin Cut-off values

The following cut-off values were used in defining pay,

ϕ_e >10% & Swt <70%

Conclusions

1. No Net pay was identified. Residual gas shows occur in the Waarre A Formation, but these quite small.
2. Poor log quality made proper evaluation difficult.
3. Callister 1 was plugged and abandoned with gas shows.

Attached is the well evaluation summary (WES) plot for Callister 1.

/data/wes_ot/callister1_04129.cgm

APPENDIX II: HYDROCARBON SHOW REPORT

Only trace fluorescence was observed in Callister-1.

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OIL SHOW EVALUATION REPORT

WELL: Callister-1 **GEOLOGIST:** R. Subramanian
INTERVAL: 3426'-3435'
FORMATION: Waarre Formation

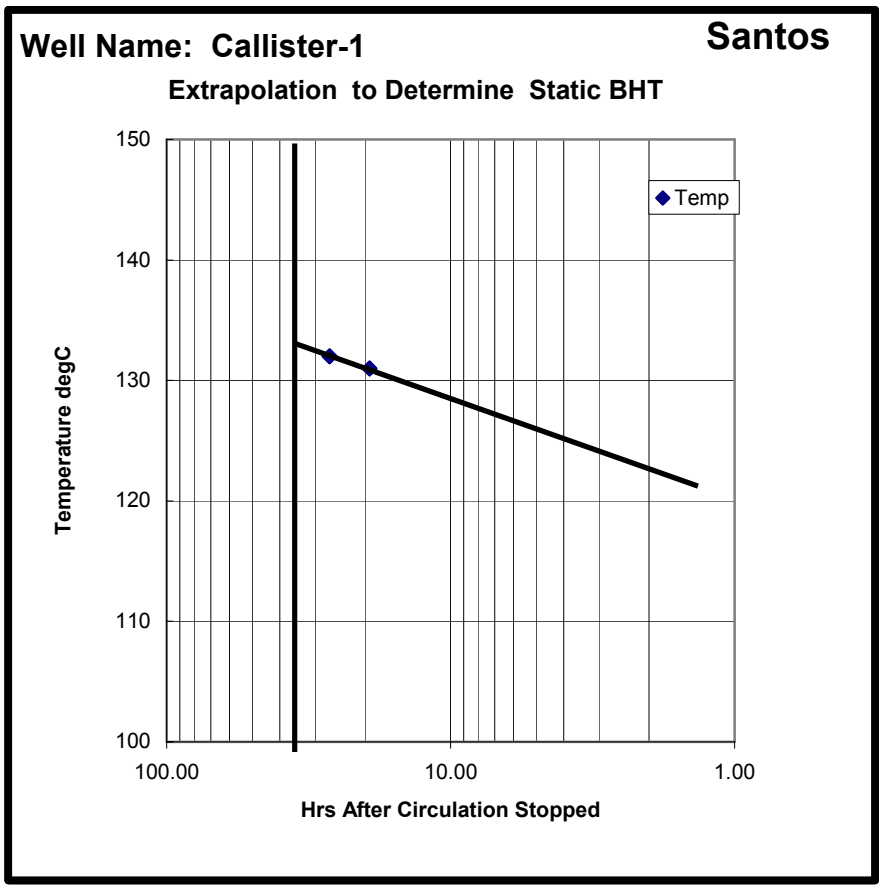
C1 ppm	<5k	10k	20k	30k	40k	50k	100k	150k	200k	>250k
C2+ ppm	<500	750	1k	2k	3k	4k	5k	7.5k	10k	>15k
Porosity Ø	Tight			poor		fair		good		
% with fluorescence	Trace	10	20	30	40	50	60	70	80	>90
Fluorescence appearance	Trace		spotted			streaked		patchy		solid
Brightness of fluorescence	v. dull		dull		dim			mod bright	v. bright	glowing
Type of cut	Trace	v. slow crush cut	Weak crush cut	instant crush cut	v. slow streaming cut	slow stream	moderate streaming	streaming	Fast Streaming	instant
Residue on spot plate	Trace	heavy trace	v. thin ring	thin ring	Moderately thick ring	v. thick ring	thin film	thin film	thick film	solid
Show rating	Trace		poor		fair		good			
Comments:	Yellow fluorescence.									

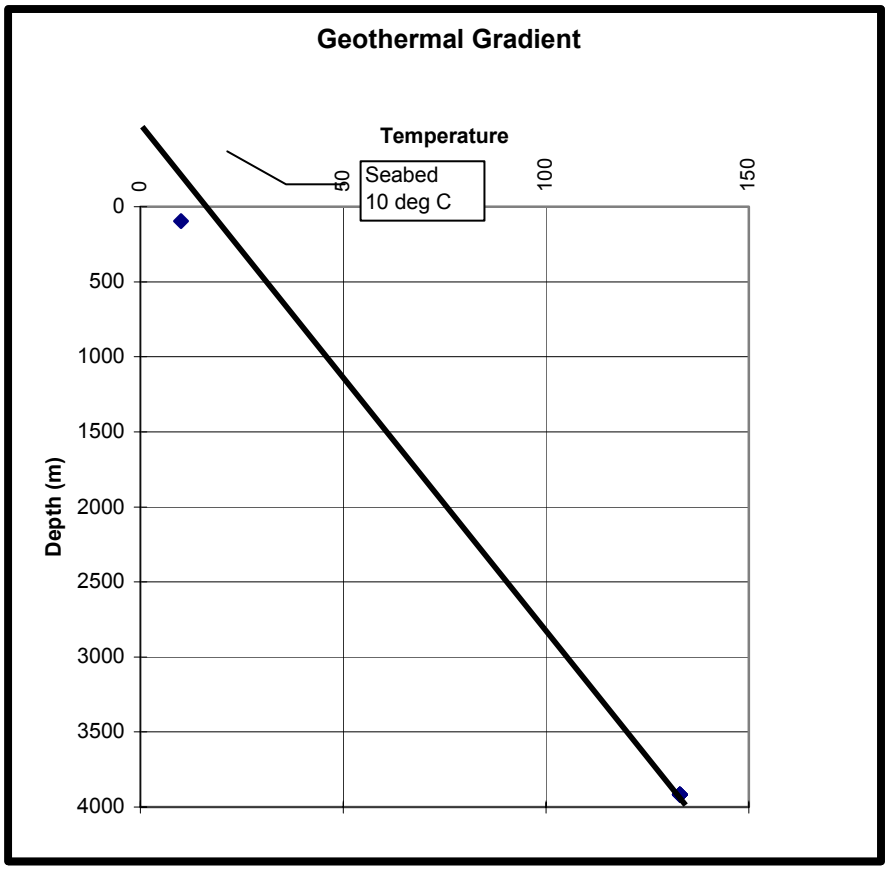
APPENDIX III : GEOTHERMAL GRADIENT

Data from Wireline Logs were used to estimate a Geothermal Gradient. An extrapolated static bottom hole temperature of 133°C at 3917m (total depth) and a geothermal gradient of 3.0°C/100m were calculated from downhole temperatures recorded during logging operations.

LOG	TEMP (°C)	DEPTH (m)	TIME SINCE LAST CIRCULATION
PEX	87	2550	21.5 hrs
Triple Combo	131	3917	19.3 hrs
MDT	132	3917	26.7 hrs
CMR	137	3865	11.75 hrs
CSI Checkshots	138	3903	24.25 hrs
Seabed	10	158	

The results are depicted graphically overleaf.


Well Name: Callister-1
Santos
Extrapolation to Determine Static BHT
Temp
Temperature degC
150
140
130
120
110
100
100.00
10.00
1.00
Hrs After Circulation Stopped


Geothermal Gradient
Temperature
0
50
100
150
Seabed
10 deg C
Depth (m)
0
500
1000
1500
2000
2500
3000
3500
4000

APPENDIX IV : PETROLOGY REPORT

No petrology work was done on Callister 1 samples.

APPENDIX V : PALYNOLOGY REPORT

Santos

INTERIM PALYNOLOGY REPORT - COMPOSITE

Study: **Callister No. 1**

Author: R. Helby

SAMPLE	DEPTH (metres)	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESERVATION	YIELD	DIVERSITY	REMARKS
				%	AGE				
CUTT	1460	*Isabelidinium pellucidum* (?) (Late Campanian)	Timboon Fm	R	Perm	Fair	Mod.	Mod.	Restricted palynomorph assemblage lacking both dinocyst and spore-pollen marker taxa. Tentatively assigned to *I. pellucidum* Zone on basis of apparent absence of *X. australis* and *T. lilliei*. Shallow marine.
CUTT	1505	Upper *Xenikoon australis* (Early Campanian)	Paaratte Fm	R	Perm	Fair	Mod.	Mod	Very restricted dinocyst assemblage with rare *X. australis* and *Areosphaeridium suggestium*. Near shore marine.
CUTT	1535	Upper *Xenikoon australis* (Early Campanian)	Paaratte Fm	R	Perm	Fair	V.low	Low	Fairly restricted dinocyst assemblage with frequent *X. australis* (3%). Near shore marine.
CUTT	1580	Upper *Xenikoon australis* (Early Campanian)	Paaratte Fm	R	Perm	Fair	V.low	Low	Restricted palynomorph assemblage with prominent (5/21) *Xenikoon australis* and single specimen of *Nelsoniella aceras* (not seen in other samples). Spore-pollen limited, not diagnostic. Near shore marine.
CUTT	1630	Upper *Xenikoon australis* (Early Campanian)	Paaratte Fm	F	Perm	Fair	Mod.	Mod.	Moderate palynomorph assemblage with frequent (7/83) *Xenikoon australis*. Spore-pollen suite includes *Nothofagidites* spp. Near shore marine.
CUTT	1655	Upper *Xenikoon australis* (Early Campanian)	Paaratte Fm	F	Perm	Fair	Mod.	Mod.	Moderate palynomorph assemblage with common (5/43) *Xenikoon australis*. Spore-pollen suite restricted – not diagnostic. Near shore marine.

SAMPLE	DEPTH (metres)	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESERVATION	YIELD	DIVERSITY	REMARKS
				%	AGE				
CUTT	1715	Upper *Xenikoon australis* (Early Campanian)	Paaratte Fm	F	Perm	Fair	Low	Low	Very restricted palynomorph assemblage with *Areosphaeridium suggestium* and tentative identification of *Xenikoon australis*. Spore-pollen suite restricted – not diagnostic. Near shore marine.
CUTT	1800	*Xenikoon australis* (?) (Early Campanian)	Paaratte Fm	F	Perm	Fair	Low	Low	Very restricted palynomorph assemblage with a single specimen of *Heterosphaeridium.* Spore-pollen suite restricted – not diagnostic. Near shore marine.
CUTT	1850	*Xenikoon australis* (?) (Early Campanian)	Paaratte Fm	R	Perm	Fair	Low	Low	Restricted dinocyst assemblage with prominent *Heterosphaeridium* spp. and tentatively identified specimen of *Xenikoon australis.* Spore-pollen suite restricted – not diagnostic. Near shore marine.
CUTT	1885	*Xenikoon australis* (Early Campanian)	Paaratte Fm	F	Perm	Fair	Low	Low	Restricted dinocyst assemblage with rare *Xenikoon australis* and prominent *Heterosphaeridium* spp. *Nelsoniella* and older taxa not observed. Near shore marine.
CUTT	1900	Indeterminate	Indeterminate	R	Perm	Fair	V. low	V. low	Almost barren
CUTT	1910	Indeterminate	Indeterminate	R	Perm	Fair	V. low	V. low	Very restricted palynomorph assemblage with a single specimen of *Heterosphaeridium.* Spore-pollen suite very restricted – not diagnostic. Near shore marine.

SAMPLE	DEPTH (metres)	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESERVATION	YIELD	DIVERSITY	REMARKS
				%	AGE				
CUTT	1985	*Xenikoon australis* (Early Campanian)	Paaratte Fm	F	Perm	Fair	Low	Low	Restricted dinocyst assemblage with prominent *Heterosphaeridium* spp. (22%), rare *Xenikoon australis* (2 specimens) and a questionable specimen of *Nelsoniella aceras.* Spore-pollen suite not diagnostic. Near shore marine.
CUTT	2100	*Nelsoniella aceras* (Early Campanian)	Skull Ck Mdst	-	-	Fair	Low	Mod.	Restricted dinocyst assemblage with rare *Nelsoniella aceras, Heterosphaeridium* spp. and frequent *Odontochitina porifera*. Spore-pollen suite possibly no older than *T. apoxyexinus* Zone on the basis of occurrence of *Latrobosporites amplus*. Near-shore marine.
CUTT	2165	*Nelsoniella aceras* (Early Campanian)	Skull Ck Mdst	R	Perm	Fair	Mod.	Mod.	Fairly rich, moderately diversity dinocyst suite with common *Nelsoniella aceras,* common *Heterosphaeridium* spp. and common *Odontochitina* spp. Spore-pollen suite possibly no older than *T. apoxyexinus* Zone on the basis of occurrence of *Latrobosporites amplus*. Shelfal marine.
CUTT	2255	*Isabelidinium rotundatum* (Santonian)	Nullawarre Grnsd	R	Perm	Fair	Mod.	Mod.	Moderate diversity dinocyst suite with common *Isabelidinium rotundatum,* frequent *Trithyrodinium vermiculatum* and *Amphidiadema denticulata*. Spore-pollen suite possibly no older than *T. apoxyexinus* Zone. Shelfal marine.

SAMPLE	DEPTH (metres)	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESERVATION	YIELD	DIVERSITY	REMARKS
				%	AGE				
CUTT	2270	*Isabelidinium rotundatum* (Santonian)	Nullawarre Grnsd	-	-	Fair	V. low	Low	Restricted dinocyst assemblage with rare *Isabelidinium rotundatum* and frequent *Heterosphaeridium* spp. Spore-pollen suite restricted – not diagnostic. Near shore marine.
CUTT	2270	*Isabelidinium rotundatum* (Santonian)	Nullawarre Grnsd	F	Perm	Fair	Low	Mod.	Rich, moderately diverse dinocyst suite with frequent *Isabelidinium rotundatum, frequent Trithyrodinium vermiculatum* and abundant *Heterosphaeridium* spp. Spore-pollen suite possibly no older than *T. apoxyexinus* Zone. Near-shore marine.
CUTT	2270	*Isabelidinium rotundatum* (Santonian)	Nullawarre Grnsd	R	Perm	Fair	Mod.	Mod.	Low diversity dinocyst suite with frequent *Isabelidinium rotundatum, Amphidiadema denticulata with abundant Heterosphaeridium* spp. and *frequent Trithyrodinium vermiculatum.* Shelfal marine.
CUTT	2310	*Isabelidinium rotundatum* (Santonian)	Nullawarre Grnsd	R	Perm	Fair	Mod.	Mod.	Low diversity dinocyst suite with frequent *Isabelidinium rotundatum, Amphidiadema denticulata with common Heterosphaeridium* spp. and *frequent Trithyrodinium vermiculatum.* Shelfal marine.
CUTT	2320	*Isabelidinium rotundatum* (Santonian)	Nullawarre Grnsd	R	Perm	Fair	Mod.	Mod.	Low diversity dinocyst suite with frequent *Isabelidinium rotundatum, Amphidiadema denticulata with common Heterosphaeridium* spp. and *frequent Trithyrodinium vermiculatum.* Shelfal marine.

SAMPLE	DEPTH (metres)	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESERVATION	YIELD	DIVERSITY	REMARKS
				%	AGE				
CUTT	2350	*Isabelidinium rotundatum to Isabelidinium cretaceum* (Santonian)	Nullawarre Grnsd to Belfast Mdst "C"	F	Perm	Fair	Low	Mod.	Low diversity dinocyst suite with frequent *Isabelidinium rotundatum, I. cretaceum and a number of specimens transitional to I. cretaceum elongatum* (variety lacking apical horn). Accessory taxa include *Amphidiadema denticulata with common Heterosphaeridium* spp. and *frequent Trithyrodinium vermiculatum.* Shelfal marine.
CUTT	2400	*Isabelidinium cretaceum* (Santonian)	Belfast Mudstone "C"	R	Perm	P-F	Mod.	Mod.	Rich dinocyst assemblage, dominated by *Heterosphaeridium* spp. (50%+), with *Amphidiadema denticulata*, frequent *Odontochitina wannabe* and frequent *Trithyrodinium vermiculatum*. The *Isabelidinium* suite includes *I cretaceum*, *I. cretaceum elongatum* (Marshall) and *I. belfastense rotundatum* (sensu Marshall). Shelfal marine.
CUTT	2450	*Isabelidinium cretaceum* (Santonian)	Belfast Mudstone "C"	R	Perm	VP-F	Mod.	Mod.	Moderately diverse dinocyst assemblage with common *Heterosphaeridium* spp. (15%+), *Amphidiadema denticulata*, *Isabelidinium cretaceum elongatum*, rare *Odontochitina wannabe* and frequent *Trithyrodinium vermiculatum.* Shelfal marine.

SAMPLE	DEPTH (metres)	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESERVATION	YIELD	DIVERSITY	REMARKS
				%	AGE				
CUTT	2500	*Isabelidinium cretaceum* (Santonian)	Belfast Mudstone "C"	R	Perm	P-F	Mod.	Mod.	Low diversity microplankton suite, dominated by *Heterosphaeridium* spp. (25%%+) with frequent *Isabelidinium cretaceum* and *I. cretaceum elongatum. Odontochitina triangularis* and *Trithyrodinium vermiculatum* recorded. Shelfal marine.
CUTT	2550	*Isabelidinium cretaceum* (Santonian)	Belfast Mudstone "C"	R	Perm	P-F	Mod.	Mod.	Moderately diverse dinocyst assemblage with common *Heterosphaeridium* spp. (25%), *Amphidiadema denticulata*, *Isabelidinium cretaceum I. cretaceum elongatum* and rare *Odontochitina magna.* Shelfal marine.
CUTT	3060	*Conosphaeridium striatoconum* to upper *Kiokansium polypes* (Lower Coniacian to upper Turonian)	Belfast Mudstone "C" to Flaxman Fm	2	Perm	VP-F	Mod.	Mod.	Relatively rich, moderately diverse, microplankton suite with prominent *Heterosphaeridium* spp. (12%) and *Amosopollis cruciformis* (8%). *C. striatoconum* Zone pick based, tentatively, on questionable specimen of *C. striatoconum. K. polypes* Zone pick based on occurrence of the eponymous species with frequent *Apteodinium* sp. (3%). Near shore marine.
CUTT	3159	*Kiokansium polypes* (Turonian)	Flaxman Fm	-	-	P-F	Mod.	Mod.	Lean, moderate diversity, dinocyst suite with *Kiokansium polypes,* frequent *Heterosphaeridium* spp. (7%) and rare *Amosopollis cruciformis.* Spore-pollen suite not diagnostic. Near shore marine.

SAMPLE	DEPTH (metres)	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESERVATION	YIELD	DIVERSITY	REMARKS
				%	AGE				
CUTT	3225	*Kiokansium polypes* (Turonian)	Flaxman Fm	-	-	P-F	Mod.	Mod.	Rich, moderately diversity, dinocyst suite with frequent *Kiokansium polypes* (4%), common *Heterosphaeridium* spp. (21%), *Apteodinium* sp. and *Palaeoperidinium cretaceum*. Spore-pollen suite not diagnostic. Near shore marine.
CUTT	3243	*Kiokansium polypes* (Turonian)	Flaxman Fm	-	-	P-F	Mod.	Mod.	Rich, low diversity, dinocyst suite with frequent *Kiokansium polypes* (3%), common *Heterosphaeridium* spp. (15%) and frequent *Apteodinium* sp. (3%). Spore-pollen suite not diagnostic. Near shore marine.
CUTT	3264	*Kiokansium polypes* (Turonian)	Flaxman Fm	1	Perm	P-F	Mod.	Mod.	Lean, low diversity, dinocyst suite with frequent *Heterosphaeridium* spp. (6%), *Apteodinium* sp. and *Kiokansium polypes.* Spore-pollen suite not diagnostic. Near shore marine.
CUTT	3309	*Kiokansium polypes* (Turonian)	Flaxman Fm	-	-	P-F	Mod.	Mod.	Lean, low diversity, dinocyst suite with frequent *Heterosphaeridium* spp. (3%), *Apteodinium* sp., *Circulodinium deflandrei* (?), *Cyclonephelium compactum* and *Isabelidinium* spp. Spore-pollen suite not diagnostic. Near shore marine.
CUTT	3348	*Kiokansium polypes* (Turonian)	Flaxman Fm	-	-	P-F	High	Mod.	Very rich, moderately diverse, dinocyst suite with a major *Heterosphaeridium* spp. acme (75%), *Apteodinium* sp., *Cyclonephelium compactum* and *Palaeoperidinium cretaceum*. Spore-pollen suite not diagnostic. Near shore marine.

SAMPLE	DEPTH (metres)	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESERVATION	YIELD	DIVERSITY	REMARKS
				%	AGE				
CUTT	3399	*Kiokansium polypes* (Turonian)	Flaxman Fm	-	-	P-F	Mod.	Mod.	Rich (40% total palynomorphs), moderate diversity, dinocyst suite with common *Cribroperidinium edwardsii* (12%), common *Heterosphaeridium* spp. (16%), *Apteodinium* sp., *Cyclonephelium compactum, Isabelidinium* cf. *evexus* and *Kiokansium polypes.* Spore-pollen suite not diagnostic. Near shore marine.
CUTT	3432	*Kiokansium polypes* (Turonian)	Flaxman Fm	-	-	VP-F	Mod.	Mod.	Rich (48% total palynomorphs), moderately diverse, dinocyst suite with common *Cribroperidinium edwardsii* (11%), common *Heterosphaeridium* spp. (21%), *Kiokansium polypes, Palaeoperidinium cretaceum* and *Spinidinium* sp. Spore-pollen suite not diagnostic. Near shore marine.
CUTT	3459	*Cribroperidinium edwardsii* (Turonian)	Waarre Fm "B" (?)	1	Perm	P-F	Mod.	Mod.	Rich (37% total palynomorphs), low diversity, dinocyst suite dominated by *Heterosphaeridium* spp. (27%), with frequent *Cribroperidinium edwardsii* (5%), *Cyclonephelium compactum* and *Chlamydophorella nyei* (2%). Spore-pollen suite not diagnostic. Near shore marine.
CUTT	3462	*Cribroperidinium edwardsii* (Turonian)	Waarre Fm "B" (?)	1	Perm	VP-F	Mod.	Mod.	Relatively lean (13% total palynomorphs), low diversity, dinocyst suite with *Cyclonephelium compactum* (5%), *Heterosphaeridium* spp. (7%), *Chlamydophorella nyei* and *Circulodinium deflandrei* (?). Spore-pollen suite not diagnostic. Near shore marine.

SAMPLE	DEPTH (metres)	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESERVATION	YIELD	DIVERSITY	REMARKS
				%	AGE				
CUTT	3486	*Cribroperidinium edwardsii* (Turonian)	Waarre Fm "A"	1	Perm	VP-F	Low	Mod.	Relatively lean (11% total palynomorphs), low diversity, dinocyst suite with *Cyclonephelium compactum* (4%), *Heterosphaeridium* spp. (5%), *Circulodinium deflandrei* (?) and fragments of *Cribroperidinium edwardsii* (possibly equivalent to 1-2%). Spore-pollen suite not diagnostic. Near shore marine.
CUTT	3507	*Cribroperidinium edwardsii* (Turonian)	Waarre Fm "A"	1	Perm	VP-F	Low	Mod.	Relatively lean (10% total palynomorphs), low diversity, dinocyst suite with *Cyclonephelium compactum* (5%), *Heterosphaeridium* spp. (4%), *Kiokansium polypes* and *Oligosphaeridium pulcherrimum*. Spore-pollen suite not diagnostic. Near shore marine.
CUTT	3570	Lower *Hoegisporis trinalis* (Turonian)	Waarre Fm "A"	1	Perm	VP-F	Low	Mod.	Spore-pollen suite (98% of total palynomorphs) includes frequent *Appendicisporites distocarinatus* (4%) and probable *Phyllocladidites mawsonii*. *Hoegisporis trinalis* and *Laevigatosporites musa* were not recorded. 2 specimens of *Heterosphaeridium* spp. were recorded during the count – other dinocysts were not observed. Fluvial to fringing marine.
CUTT	3593	Lower *Hoegisporis trinalis* (Turonian)	Waarre Fm "A"	1	Perm	VP-F	Low	Mod.	Spore-pollen suite (99% of total palynomorphs) includes *Appendicisporites distocarinatus, Hoegisporis trinalis, Phyllocladidites eunuchus* and *P. mawsonii.* A single specimen of *Heterosphaeridium* was recorded. Fluvial to fringing marine.

SAMPLE	DEPTH (metres)	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESERVATION	YIELD	DIVERSITY	REMARKS
				%	AGE				
CUTT	3593	Lower *Hoegisporis trinalis* (Turonian)	Waarre Fm "A"	2	Perm	VP-F	Mod.	Mod.	Spore-pollen suite (98% of total palynomorphs) includes *Appendicisporites distocarinatus* (4%), common *Cicatricosisporites* spp. (ca 17%) and *Hoegisporis trinalis.* A lean dinocyst component includes *Cribroperidinium edwardsii, Heterosphaeridium* spp., *Kiokansium polypes* and *Odontochitina* sp. Near shore marine.
CUTT	3723	Lower *Hoegisporis trinalis* (Turonian)	Waarre Fm "A"	1	Perm	P	Low	Mod.	Spore-pollen suite (99% of total palynomorphs) includes *Appendicisporites distocarinatus* (3%), common *Cicatricosisporites* spp. (10%) and *Phyllocladidites mawsonii.* A single specimen of *Heterosphaeridium* spp. was recorded. Near shore marine.
CUTT	3822	Lower *Hoegisporis trinalis* (?) (Turonian)	Waarre Fm "A" (?)	-	-	P	Low	Mod.	Spore-pollen constitute 99% of total palynomorphs and are poorly preserved. Zone pick tentatively supported by questionable occurrence of *Appendicisporites distocarinatus* and *Phyllocladidites mawsonii.* Rare *Heterosphaeridium* specimens considered caved (much lighter). Non-marine (?).

SAMPLE	DEPTH (metres)	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESERVATION	YIELD	DIVERSITY	REMARKS
				%	AGE				
CUTT	3870	Lower *Hoegisporis trinalis* (Turonian)	Waarre Fm "A"	-	-	P	Low	Mod.	Zone pick supported by unequivocal *Appendicisporites distocarinatus* and probable *Phyllocladidites eunuchus.* *Hoegisporis trinalis* recorded, but possibly caved. *Kiokansium polypes* and several specimens of *Heterosphaeridium* spp. recorded (some or all of the latter may be caved – lighter colour). Near shore marine (?).
CUTT	3870	Lower *Hoegisporis trinalis* to *Coptospora paradoxa* (Albian to Turonian)	Waarre Fm "A" to Eumeralla Fm	-	-	P	V.low	Low	Very lean assemblage, poorly preserved, with "frequent" *Cicatricosisporites* spp., rare *Dilwynites granulatus* and *Triporoletes* spp. None of the diagnostic elements of the *H. trinalis* Zone were observed. A single specimen of *Heterosphaeridium* recorded – considered to be caved. Non-marine (?).
CUTT	3914	Lower *Hoegisporis trinalis* to *Coptospora paradoxa* (Albian to Turonian)	Waarre Fm "A" to Eumeralla Fm	-	-	P	Ex.low	Low	Extremely lean assemblage, poorly preserved, with *Appendicisporites distocarinatus* (possibly caved), common *Cicatricosisporites* spp. and *Triporoletes* sp. No other of the diagnostic elements of the *H. trinalis* Zone were observed. No dinocysts observed. Non-marine.

ENCLOSURE I : COMPOSITE LOG (1:500 SCALE)

ENCLOSURE III : DEPTH STRUCTURE MAPS

ENCLOSURE III : LOG INTERPRETATION ANALOGUE PLOT