CULVERIN-1

WELL COMPLETION REPORT
VOLUME 2: INTERPRETIVE DATA

VIC/P56
Gippsland Basin
Victoria

Nexus Energy Ltd

February 2007

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LOCATION:	Survey:	Volador 3D
	Line:	299
	Trace:	883
	Offset:	11.4m

PERMIT:	VIC/P56
BASIN:	Gippsland
PARTICIPANTS:	Nexus Energy (Op) 40%, KNOC 30%, SCGAU P/L 20%, Anzon Australia 10%

SURFACE LOCATION:	Latitude:	38° 24' 08.14"S
	Longitude:	148° 39' 14.92E
	Easting:	644 437.3mE
	Northing:	5 748 256.4mN
	Datum:	GDA94
	Spheroid:	GRS80
	Map Grid:	MGA
	Projection:	UTM Zone 55 (Central Meridian 147° E)

WELL DESIGNATION:	Exploration
STATUS:	Plugged and Abandoned
STRUCTURE TYPE:	Eroded monadnock / Tilted fault block
RIG NAME AND TYPE:	Ocean Patriot, MODU
RIG CONTRACTOR:	DOGC

TOTAL DEPTH:	Driller:		3758.0mMD
	Logger:		3757.0mMD
ELEVATION:	Datum:		LAT
	RT-ASL (LAT):		21.5m
	WD (LAT):		585.0m
	RT-ML:		606.5m
SPUD DATE:	13:30hrs		16/12/2005
REACHED TD:	24:00hrs		06/01/2006
RIG RELEASED:	15:00hrs		15/01/2006

HOLE SIZES:	914mm (36")	607 – 650m
	445mm (17 ½")	650 – 1525m
	311mm (12 ¼")	1525 – 3758m
CASING:	Size	Shoe Depth
	762mm (30")	650.9m
	340mm (13 ⅜")	1511.8m
PLUGS:	No. 1	3750 – 3560m
	No. 2	2865 – 2735m
	No. 3	1550 – 1421m
	No. 4	721 – 625m

FORMATION TOPS

FORMATION	PROGNOSED DEPTHS			ACTUAL DEPTHS			Diff.
	mMDRT	mTVDSS	Thickness	mMDRT	mTVDSS	Thickness	High/Low
Sea Floor/ Gippsland Limestone	607.0	-585.0	1975.0	606.5	-585.0	1899.9	-
Top of Lakes Entrance	2582.0	-2560.0	325.0	2508.0	-2484.9	315.3	75.0 H
Top of Latrobe Group	2907.0	-2885.0	705.0	2824.0	-2800.2	932.2	85.0 H
Base Tuna/Flounder Channel	2937.0	-2915.0		2835.0	-2811.1		104.0 H
Top 67.5 Ma Sand	2947.0	-2925.0		2895.0	-2871.0		54.0 H
Upper Longus MFS	Not prognosed	-		2958.0	-2933.8		-
Near 68.5 Ma Sand	3257.0	-3235.0		3158.0	-3133.4		102.0 H
Near 70.3 Ma Sand	3542.0	-3520.0		3411.8	-3386.2		130.2 H
Near 70.5 Ma	Not prognosed	-		3484.9	-3459.2		
71_Ma marker	Not prognosed			3582	-3556.6		
TD	3612.0	-3590.0		3758.0	-3732.4		142.4 L

LWD LOGS				
RUN NO	HOLE SIZE	TOOLS	INTERVAL	COMMENTS
2821.51	445mm (17 ½”)	DM-GR	650-650	POOH due to suspect battery failure.
2	445mm (17 ½”)	DM-GR	650-1525	Drilled to section TD.
3	311mm (12 ¼”)	DM-DGR-EWR-P4-SLD-CTN-ACAL	1525-3402	POOH due to slow ROP.
4	311mm (12 ¼”)	DM-DGR-EWR-P4-SLD-CTN-ACAL	3402-3571	POOH due to slow ROP.
5	311mm (12 ¼”)	DM-DGR-EWR-P4-SLD-CTN-ACAL	3571-3571	POOH due to Pulser failure.
6	311mm (12 ¼”)	DM-DGR-EWR-P4-SLD-CTN-ACAL	3571-3758	Lost comms with tool at 3714m.

WIRELINE LOGS				
LOG TYPE	SUITE/RUN	INTERVAL mRT	BHT/TIME	COMMENTS
PEX-HALS-DSI-GR	1/1	3758 – 607	87.9 ℃ / 22:15hrs	Main pass logged at 1800ft/hr hi res to 2775m then 3478ft/hr in standard res to 607m.
VSI(4)-GR	1/2	3690 - 607	91.0 ℃ / 34:10hrs	Recorded VSP levels (15m spacing) to 3200m. Continued check shots at 100m spacing to 607m.

2. INTRODUCTION

Culverin-1 was a Year 3 commitment wildcat exploration well located in the south-east corner of VIC/P56 on the eastern side of the Gippsland Basin, approximately 80km from nearest landfall in eastern Victoria. As shown in Figure 1, it is situated 11km SSE of Basker Field, 19km NNE of Blackback Field and 20km ESE of Flounder Field with the nearest exploration wells being Great White-1 (5.9km SSE), Bignose-1 (7.0km NW), Volador-1 (9.9km WSW) and Basker South-1 (9.9km NNE). Culverin-1 was drilled by the Diamond Offshore semi-submersible MODU *Ocean Patriot* after spudding at 1330 hours on December 16, 2005 in a water depth of 585 metres.

The geological objectives of the well were a series of intra-Latrobe Group sands in the Maastrichtian (*F. longus*) section which is thickened in this part of the Gippsland Basin (Partridge, 2003, Bernecker and Partridge, 2005). These sands were regarded to be vertically partitioned into two prospects, primarily based on differences in the trapping mechanism (Figure 2).

The upper interval (Culverin prospect) is a tilted fault block extending from the erosional monadnock immediately beneath the Top of Latrobe Group (TOL) unconformity and includes those sands which are reliant on the lateral sealing capacity of the channel fill (marine transgressive mudstones and siltstones of the Lower to Middle Eocene Flounder Formation) to make a viable trap (around the “67.5Ma” seismic marker) (Figure 2 and Figure 8). Based on the nearest offset wells with equivalent section preserved (Bignose-1 and Volador-1) the sands in this interval were expected to be dominantly thick, upward-coarsening, coastal barrier and shore face sands with excellent reservoir potential.

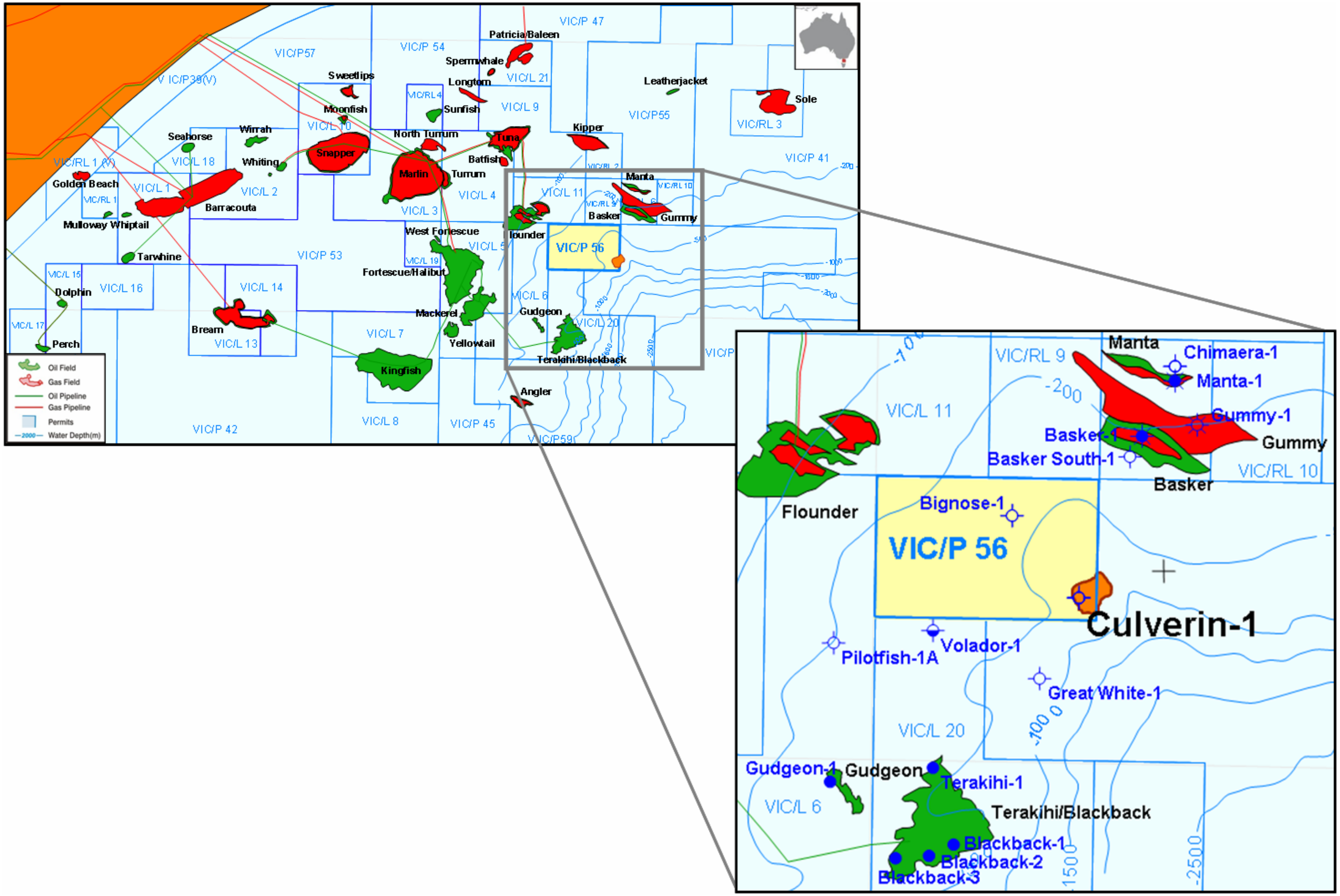

Figure 1: Culverin-1 Location Map.

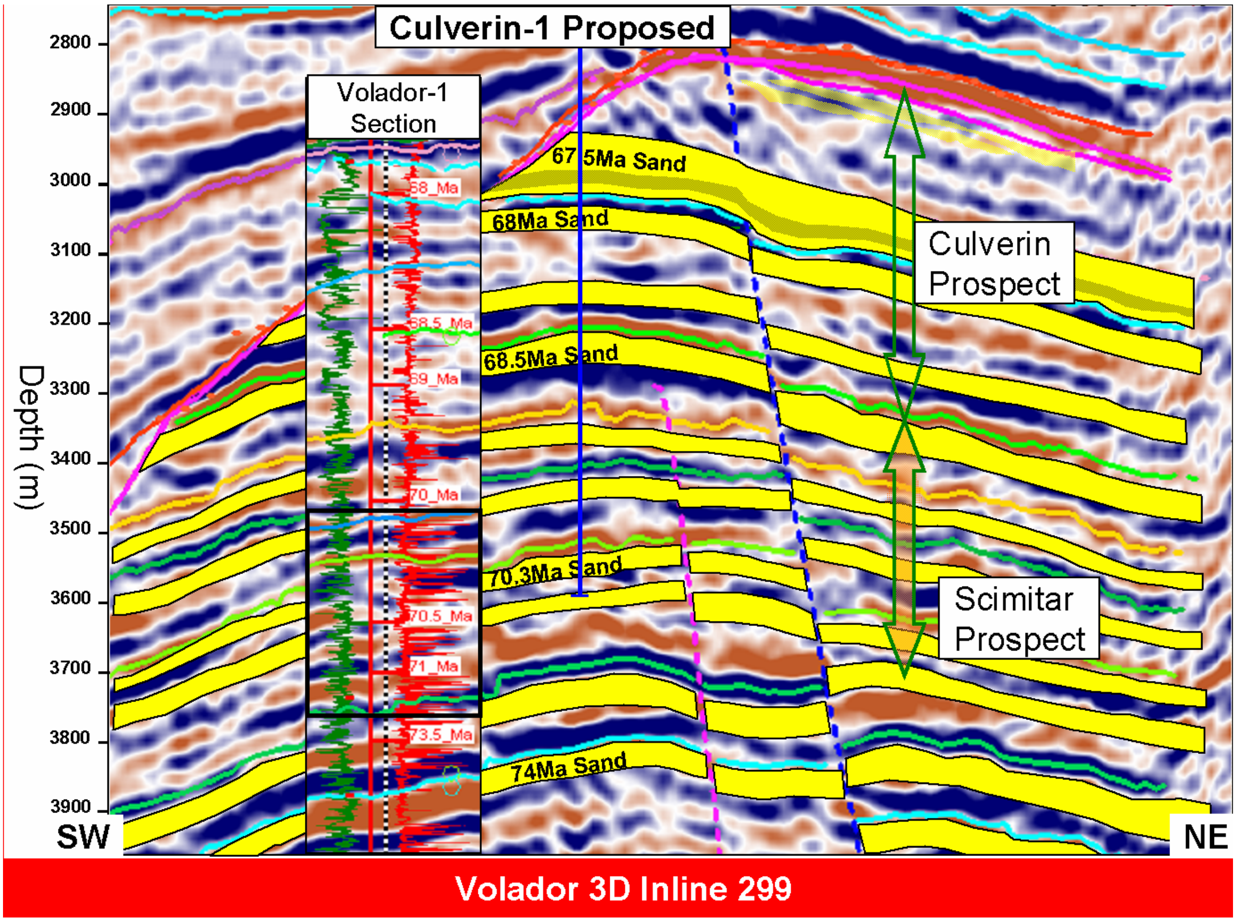

Figure 2: **Culverin and Scimitar Prospects Definition.**

Beginning immediately below Culverin, the Scimitar prospect comprises the interval in which the increasingly antiformal structure is sufficiently well developed to provide independent four-way closure (around and below the “68.5Ma” seismic marker) (Figure 2). Again based on offset wells, the potential reservoirs in this interval were expected to be thin, interbedded fluvial channel sands with moderate to poor reservoir properties.

The major risk element for the Culverin prospect was thought to be seal and for Scimitar it was considered to be both seal and reservoir.

The well reached a total depth of 3758mMD at 2400 hours on January 6, 2006 and was plugged and abandoned after running wire line logs. The rig was released on January 15, 2006.

3. SUMMARY OF WELL RESULTS

As shown in Table 2 and Figure 3, the prognosed horizons in Culverin-1 came in around 50-100m high to prognosis. This seems to be mostly due to slightly higher velocities than actual being used in the depth conversion and, to a lesser extent, to a time shift to tie the seismic data to the actual well path. When these corrections are factored in, the Culverin-1 well appears to be outside of closure at the TOL level and to have smaller closure than prognosed at deeper levels. However, even after integration of the well data, there is still considerable uncertainty about depth conversion in this area (as there are alternative methodologies available), and this continues to preclude a definitive and unambiguous understanding of the depth structure.

The stratigraphy of the target section was largely as expected from offset wells (Figure 4) except that the marine *F. longus* section (above the flooding surface marker) appears more distal than the equivalent interval in the offset wells, which all feature prominent shoreface (coastal barrier and back-barrier) sands.

Overall net proportion of sandstone was lower than anticipated, but porosity (calculated from log data) in the sands that were found was as good or better than in the equivalent sections of the offset wells (Figure 5).

The thickness of Tuna-Flounder Channel fill (Flounder Formation) was only 11m, which was 29m less than that anticipated pre-drill. As well as being thinner, the lithology of this unit, which was prognosed to form the lateral seal for the Culverin prospect, appears to be overall coarser grained than in offset wells (Figure 4).

Source rock quality was mostly fair to very good and the maturity of the intra-Latrobe section ranged from immature at TOL to early mature for oil generation below 3370mMD. Hydrocarbon extracts from source rock shales/siltstones show hydrocarbon distributions typical of immature to early mature terrigenous organic facies (refer APPENDIX 2).

Only minor indications of hydrocarbons were encountered in Culverin-1, with only one small oil zone identified from petrophysical log analysis (1.5m net oil on rock at 3607.0-3609.3mMD) and relatively low amounts of mud gas throughout the target section, with a peak of 272 units at 3608mMD. No unambiguous hydrocarbon fluorescence was observed throughout the well (refer APPENDIX 3 and ENCLOSURE 2).

The hydrocarbon extract from cuttings from 3605-3610mMD shows subtle mixing of a more mature “oily” component (presumably locally soourced), over-printing the base indigenous “source rock” extract hydrocarbon signature (refer APPENDIX 2).

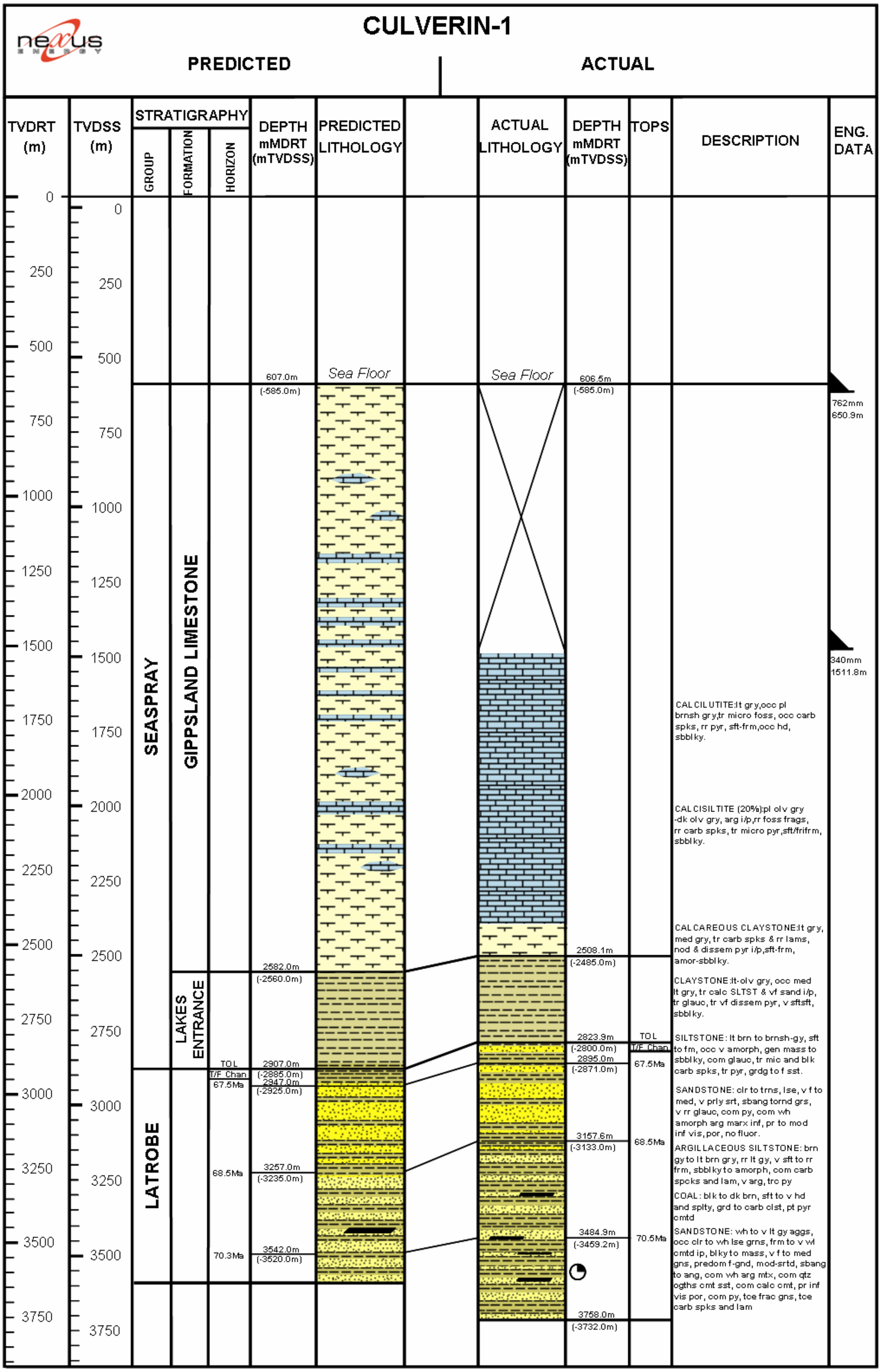

Figure 3: Culverin-1 Well Predicted versus Actual.

4. GEOLOGY

4.1 Overview

With the overwhelming proportion of known hydrocarbon accumulations in the Gippsland Basin occurring at or near the top of the preserved Latrobe Group section, this interval continues to be of prime prospectivity. This is particularly true in the eastern part of offshore Gippsland, where two of the basin's newest developments (Blackback and Basker-Manta-Gummy) are situated. Lying almost mid-way between these two fields, the stacked Culverin/Scimitar prospects appeared to be well located, and to contain many of the key elements required for a commercial hydrocarbon accumulation.

The major issues pertaining to the Culverin/Scimitar prospects stem from their location beneath the current shelf slope, in an area where episodes of extensive channelling since the Eocene have created large vertical variations in both intervals of the preserved stratigraphy and the topography of the current sea floor. This has presented a range of difficulties and remaining uncertainties, mostly with regard to seismic depth conversion and the production of reliable depth structure maps, but also ranging to questions about the extent and quality of relict reservoir, migration pathways, and the presence and effectiveness of top, base and lateral seals.

A reasonably close-spaced grid of 1994 2D seismic exists over most of VIC/P56 and the southern third of the permit, including the Culverin/Scimitar prospects, is covered by the 1994 Volador 3D survey. Thus, no new seismic data was acquired in the lead up to drilling, but extensive interpretation of the existing data was undertaken.

4.2 Regional Stratigraphy and Geological History

The Gippsland Basin formed during the break up of Gondwana and contains a stratigraphic sequence that ranges from at least Early Cretaceous to Recent. For much of its history the basin fill was dominated by siliciclastics, which then became subordinate to cold-water carbonates in the Oligocene. The overall sequence is commonly divided into three main packages Figure 6);

1. a mostly immature, pre- to early-break up rift valley fill comprising litho/feldspathic and volcaniclastic sediments (Strzelecki Group),
2. a generally more-mature, rift to sag phase, sand-rich siliciclastic package variably interspersed with coals and basaltic volcanics, with an overall increasingly marine influence up section (Latrobe Group), and
3. a fully marine, dominantly fine-grained carbonate succession ranging from marl to limestone (Seaspray Group).

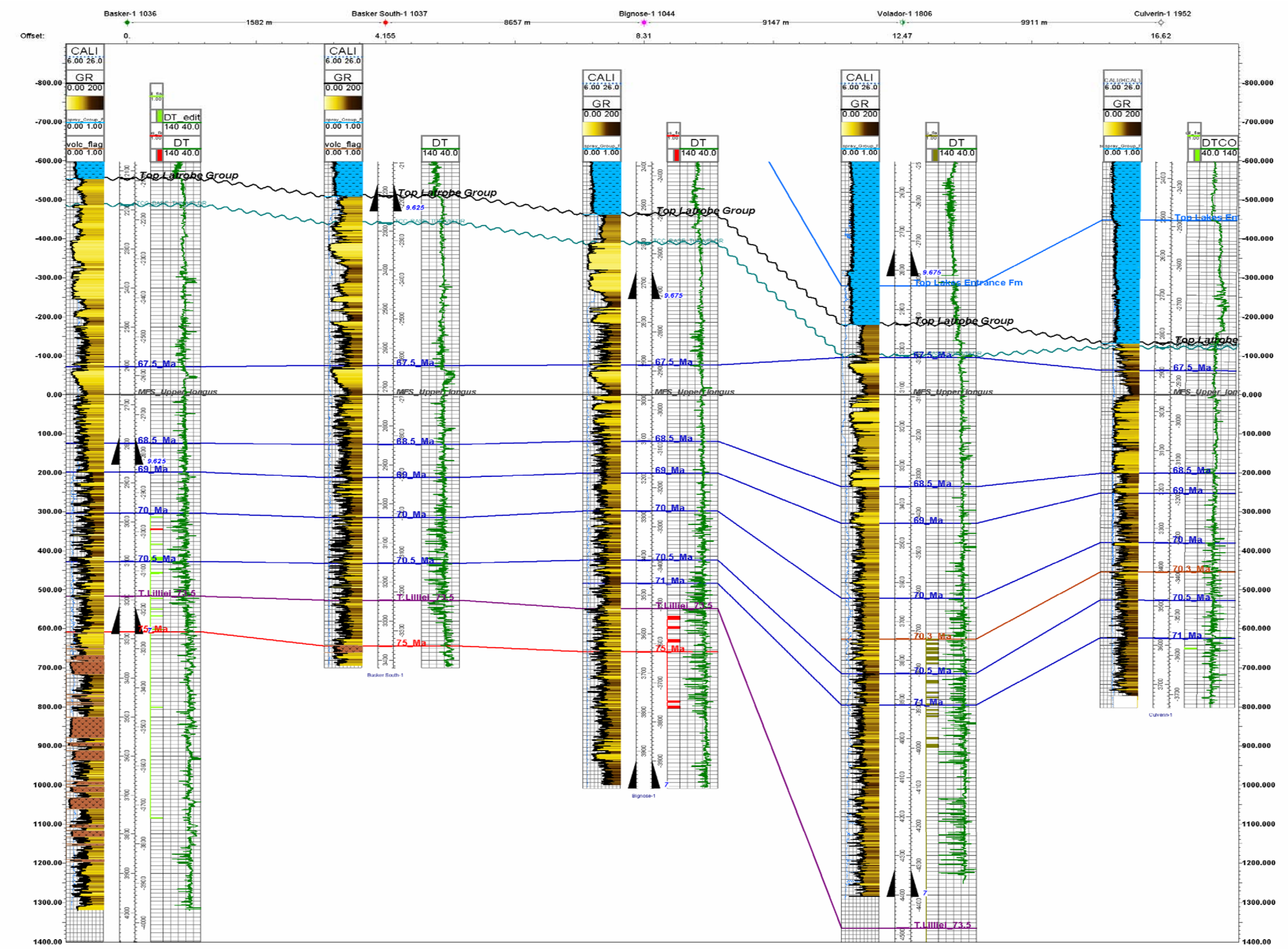

Figure 4: Stratigraphy of offset wells to Culverin-1 - datumed on *F. longus* marine flooding surface (MFS).

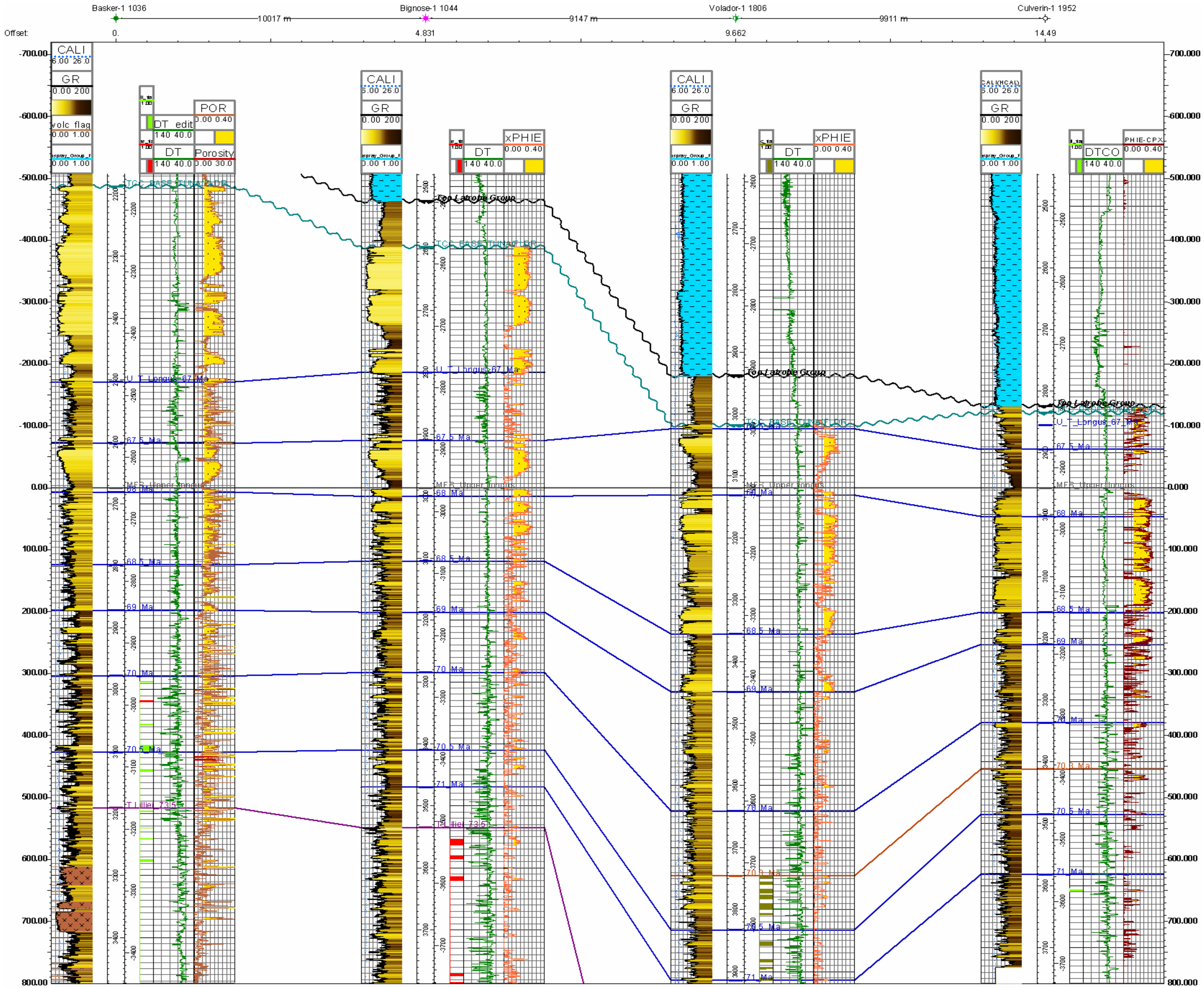

Figure 5: Comparison of reservoir porosity (log-calculated) for Culverin-1 with offset wells. (Note: effective porosity displayed for Culverin-1, Volador-1 and Bignose-1; total porosity for Basker-1)

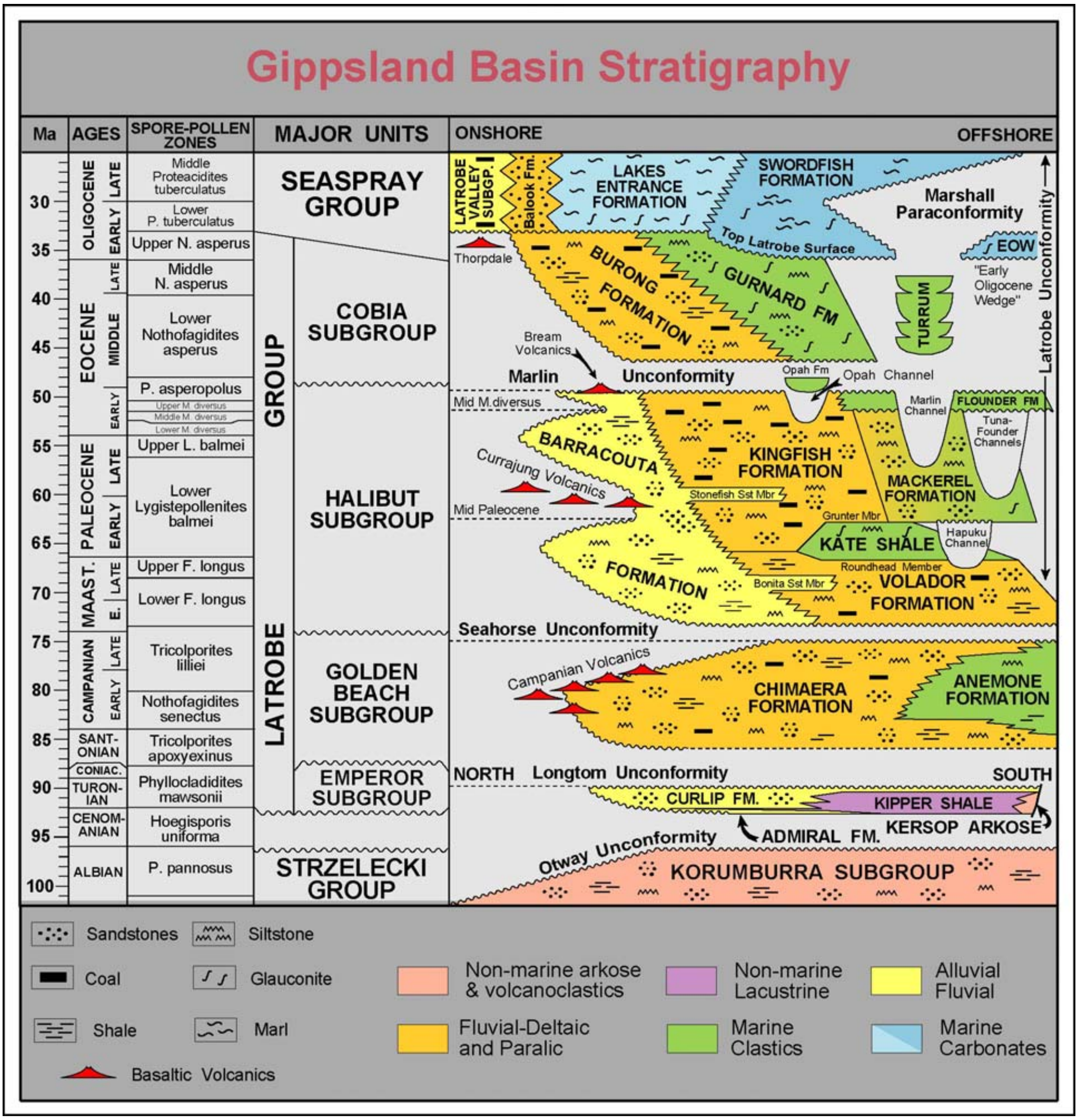

Figure 6: Gippsland Basin stratigraphy (modified from Bernecker *et al*., 2002).

The overall geometry of the basin reflects its origins as a pull-apart divergent continental margin between Australia and Antarctica in the Early Cretaceous, although it has since had a complex history of both extensional and compressional events, strongly influenced by the Late Cretaceous to mid-Eocene opening of the Tasman Sea. As shown in Figure 7, the main tectonic elements of the basin are the east-west trending Central Deep, the Northern and Southern Terraces and the Northern and Southern Platforms, separated by major fault systems.

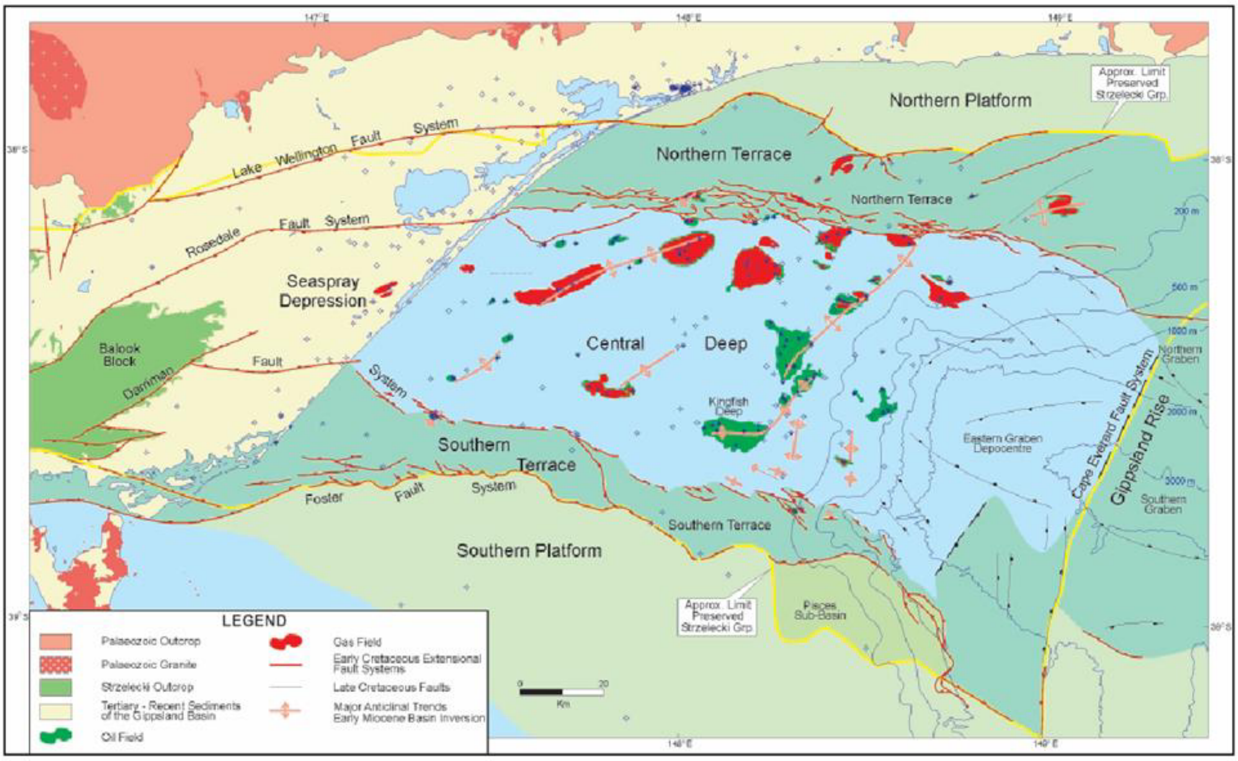

Figure 7: Gippsland Basin major tectonic elements (from Woollands & Wong, 2001).

Early Cretaceous Strzelecki Group strata outcropping onshore effectively define the western edge of the Gippsland Basin, as well as featuring prominently in the stratigraphic sections in most of the small number of offshore wells drilled on both the northern and southern terraces. Due to the prohibitive drilling depths that would be required, no offshore wells have penetrated below the Strzelecki Group and, in the Central Deep none have even reached its top, but it is thought to be in excess of 3km thick in places (Bernecker et al., 2002).

Deposition of the Latrobe Group commenced in the Turonian with the high sedimentation rates of the syn-rift, fluvio-lacustrine Emperor Subgroup. Cessation of this package is marked by the Longtom Unconformity associated with the opening of the Tasman Sea. As basin extension and thermal sagging continued to provide accommodation space through the Santonian and Campanian, the Golden Beach Subgroup, comprising large volumes of mostly fluvial to shallow marine siliciclastics (episodically intercalated with volcanics) was laid down, mostly in the Central Deep. The earliest known fully marine sediments were deposited in the south-east of the basin in the Santonian as part of this package. The top of the Golden Beach Subgroup is marked by a significant unconformity in the west, but the timing and extent of the gap in the sediment record apparently diminishes basin ward (to the southeast) where it converges around the *T. lilliei*/*F. longus* palynozone boundary (Bernecker and Partridge, 2001) in the earliest Maastrichtian.

Subsequent to that, during the post-rift thermal subsidence phase, deposition of the Latrobe Group siliciclastics continued into the Eocene. Over most of the basin these are dominantly non-marine, coaly lower coastal plain sediments, grading to upper coastal plain to the west and northwest. From Late Maastrichtian onward they also include a series of marine incursions which step episodically from the southeast, delineated by generally northeast-trending beach-barrier complexes and intervals of marine siltstone and shale, with their extent and duration controlled by the interplay of subsidence and sediment influx.

Commencing in Early to Middle Eocene time compressional tectonics began to have their first significant influence in the offshore Gippsland Basin, causing uplift of several areas and the incision of channel/canyon systems. The concomitant erosional surface is known to have cut down as deep as the Early Maastrichtian strata in some places in the eastern part of the basin, resulting in the formation of several monadnocks. After this, the final phase of Latrobe Group sedimentation in the central and eastern parts of the basin consisted of the (mostly) relatively sediment-starved shallow to open marine “condensed” glauconitic sandstone, siltstones and mudstones of the Flounder, Gurnard and Turrum Formations in the late Early Eocene to Early Oligocene.

With the diminution of clastic sediment supply to the shelf from the early Oligocene, deposition of the cool water carbonate-dominated Seaspray Group began with the marls and calcareous siltstones of the Lakes Entrance Formation, followed by the limestones and calcareous siltstones of the Gippsland Limestone. In the Miocene compressional events caused uplift and inversion of several faults, which led to major channelling events in offshore Gippsland.

The overall hiatus between the Latrobe Group and the overlying Seaspray Group comprises multiple episodes of erosion and deposition of variable extent and duration at any one location. Belying this complexity, it is commonly labelled the Top of Latrobe (TOL) unconformity across the basin.

All of the known hydrocarbon accumulations in the offshore Gippsland Basin occur in the Latrobe Group, which ranges up to several kilometres thick in the Central Deep.

4.3 Structure

The pre-drill mapping of the Culverin and Scimitar prospects interpreted them to be fault-independent four-way closures at their respective top of porosity reservoir levels.

The upper interval (Culverin prospect) is a tilted fault block extending from the erosional monadnock immediately beneath the TOL unconformity and includes those sands which are reliant on the lateral sealing capacity of the channel fill to make a viable trap (around the “67.5 Ma” seismic marker) (Figure 2, Figure 8 and Figure 20).

The Culverin prospect was formed similarly to other monadnock features in the region by the incision associated with the base of the Early Eocene Tuna/Flounder Channel. Pre-drill mapping of the Culverin Prospect shows the Base Tuna/Flounder Channel surface has about 175 metres of vertical closure with an areal extent of 4.1 sq km.

A fault to the northeast of the mapped Culverin prospect that displaces older intra-Latrobe Group sediments was interpreted to die out before penetrating the Top of Latrobe Group (~67.5Ma) reservoir. However, the possibility that this fault actually displaces the Top Latrobe reservoir at Culverin was represented in the significant seal risk assessment associated with the pre-drill prospect

The geometries and thicknesses of other prospective stacked reservoir sands occurring below the 67.5 Ma sand are configured such that they would form traps that are dominantly fault seal dependent *i.e.* the amount of fault independent closure is significantly less at these levels compared to that at the 67.5 Ma horizon.

Beginning immediately below Culverin, the Scimitar prospect comprises the reservoir interval in which antiformal structure is sufficiently well developed to provide independent four-way closure (around and below the "68.5 Ma" seismic marker) (Figure 2, Figure 8 and Figure 9).

Deeper potentially-prospective stacked reservoir sands below the 68.5 Ma reservoir level are configured such that they are also variously reliant on fault seal to trap commercial hydrocarbon accumulations.

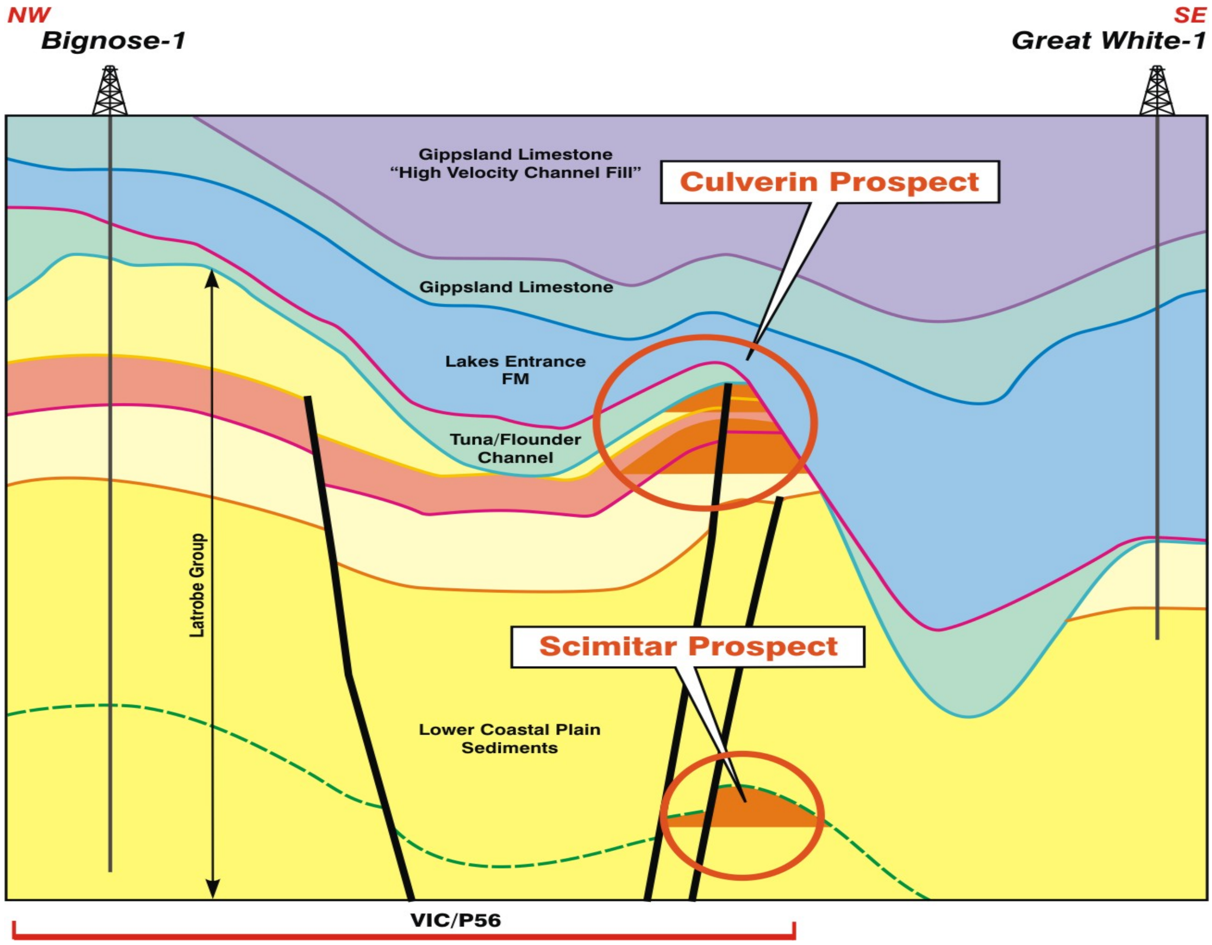

Figure 8: Diagrammatic cross-section through Culverin/Scimitar Prospects.

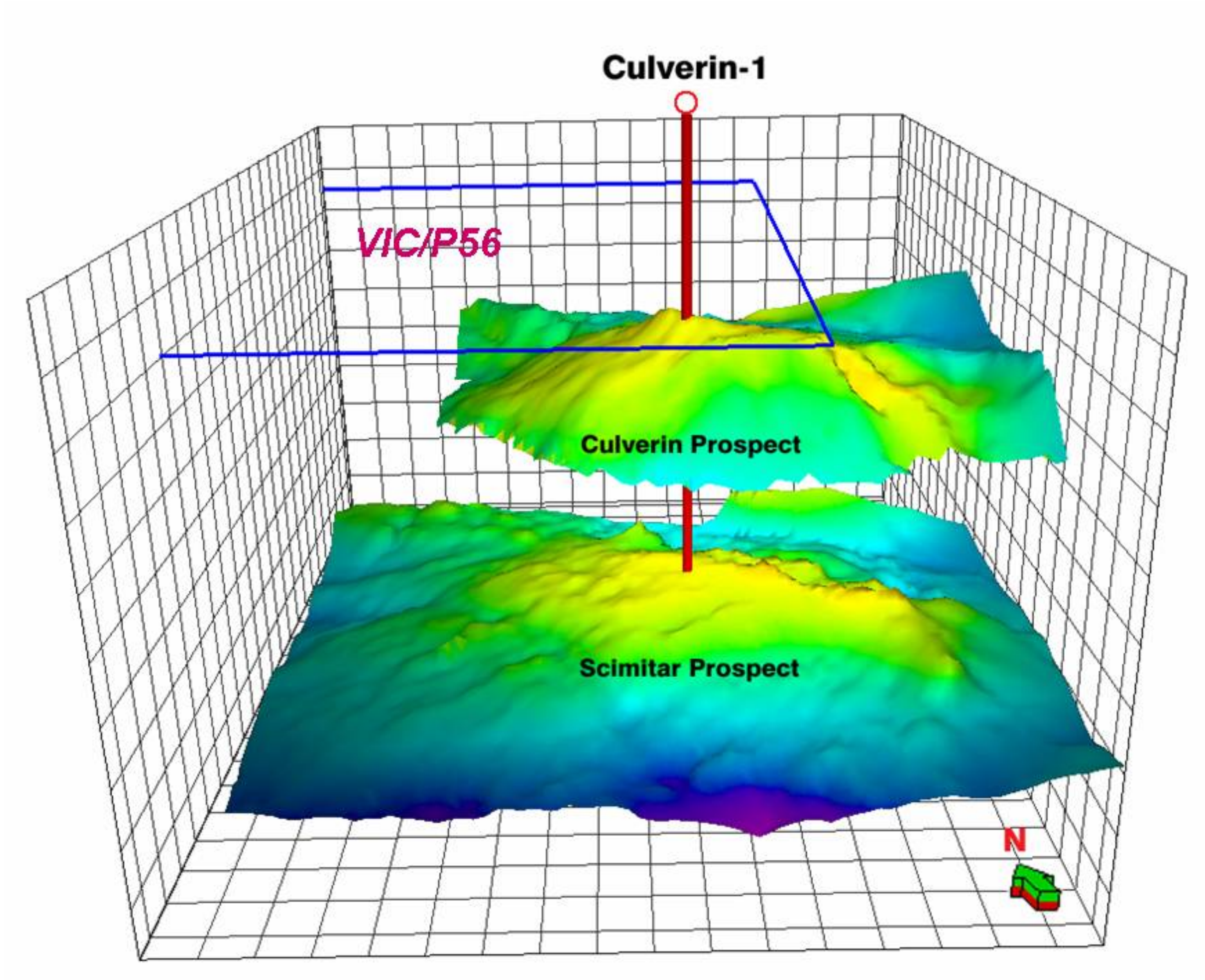

Figure 9: Three-dimensional perspective view of Culverin/Scimitar Prospects.

4.4 Stratigraphy

The stratigraphic section anticipated in Culverin-1 was based on integration of the seismic data with the stratigraphy penetrated in adjacent wells (Table 1) especially Volador-1, Bignose-1 and Basker-1. Revised palynological data for the Volador-1 well (Partridge, 2003), extends the thickness of the *F. longus* palynological zone penetrated in the well compared to that in earlier interpretations, making it the thickest confirmed section of this zone in the Gippsland Basin.

As shown by the comparison of prognosed versus actual depths to key horizons (Table 2 and Figure 3), the section penetrated in Culverin-1 was largely as expected from offset wells, but came in shallower than predicted (see discussion in the Geophysics section). In addition to the summary below, the stratigraphic interpretation of Culverin-1 is presented, along with the summary of all geological data, on the Composite Log (Enclosure 1, this volume).

The delineation of stratigraphic units and key horizons is largely based on the correlation of petrophysical logs and seismic data to adjacent wells (Figure 4, Figure 10 and Figure 11) but variously includes consideration of the lithologies observed in Daily Geological Reports and cuttings descriptions (Appendices 9 and 10, in Basic Data volume) as well as the mudlog (Enclosure 1, Basic Data volume) and the interpreted palynology data (Appendix 1, this volume). No cuttings were observed or collected above 1525mMD and no cores or sidewall cores were obtained throughout the well. Biostratigraphic work was limited to palynological analysis and was only conducted on 16 selected cuttings samples below 2790mMD (from just above the TOL unconformity).

As shown in Figure 10 and Figure 11, the seismic correlation between Culverin-1 and Volador-1 is hampered by the development of ”noisy” data quality due to significant time distortions in the vicinity of channel cuts.

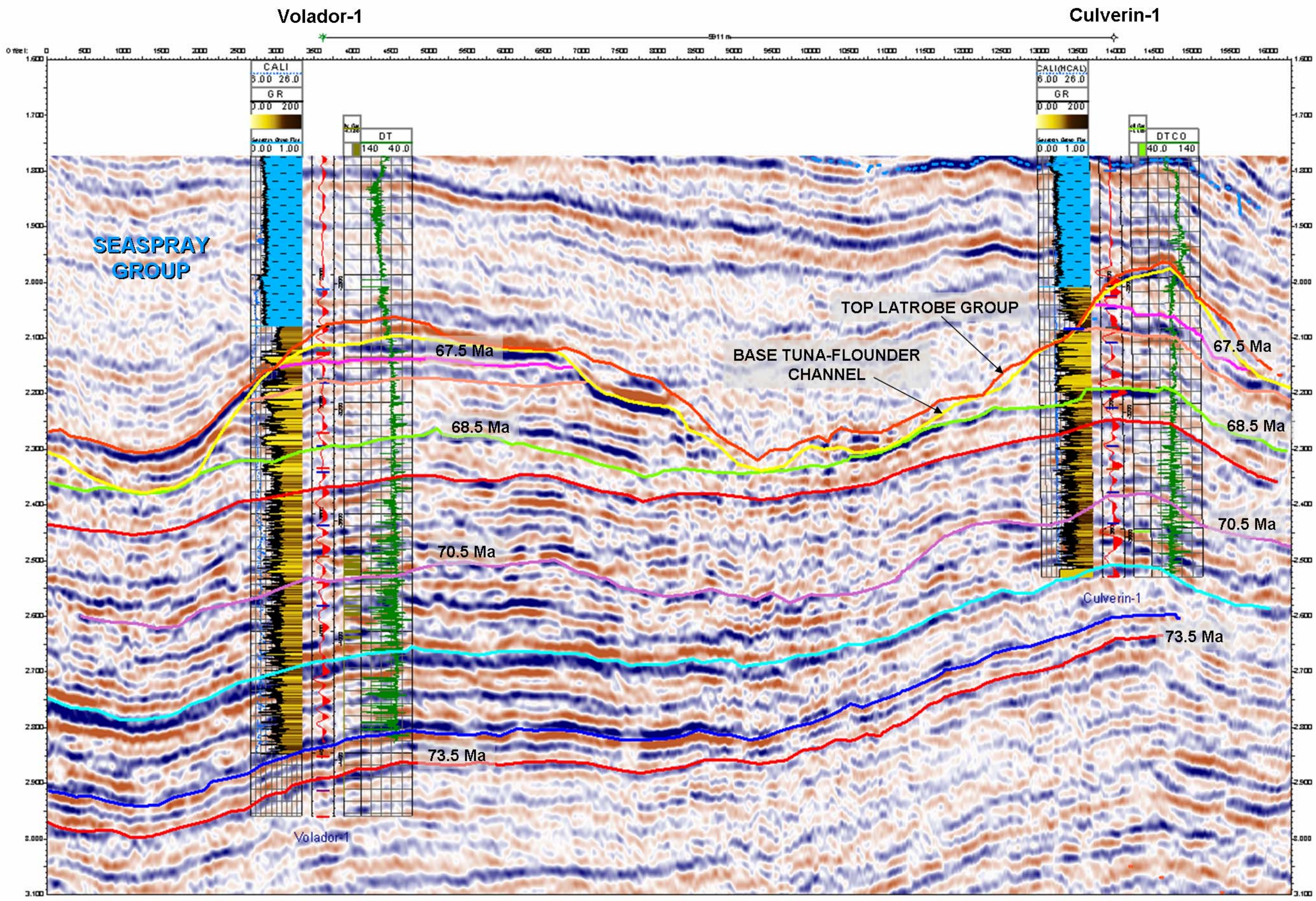

Figure 10: Volador-1 to Culverin-1 seismic section.

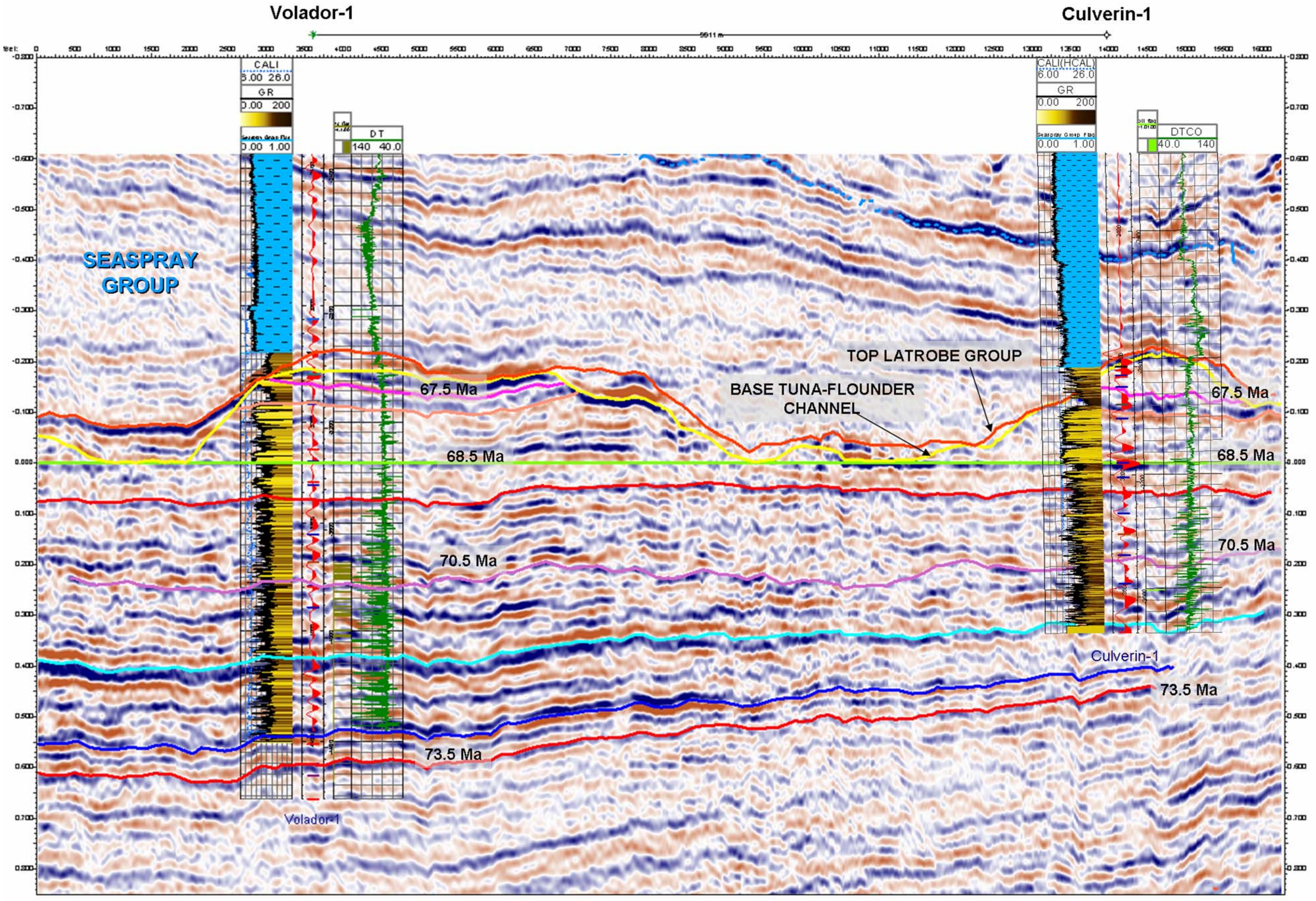

Figure 11: Volador-1 to Culverin-1 seismic section datumed on 68.5 myr marker horizon.

Well Name	Year	Operator	Water Depth (m)	Total Depth (mTVDSS)	Age at TD (paly zone)	TCC depth (mTVDSS)	Age at TCC (paly zone)	TCC to TD (m)	HC Shows? TOL	HC Shows? Intra Latrobe
Pilotfish-1A	1982	Esso	206	3499	*T. lilliei*	2929	Upr *F. longus*	570	No	No
Volador-1	1982	Shell	260	4585	*T. lilliei?*	3007	Upr *F. longus*	1578	No	Yes
Basker-1	1983	Shell	162	3965	*T. lilliei*	2162	Upr *F. longus*	1803	No	Yes
Bignose-1	1983	Shell	354	3966	*T. lilliei*	2571	*L. balmei*	1395	No	Yes
Basker South-1	1983	Shell	264	3387	*T. lilliei*	2250	Lwr *L. balmei*	1137	No	No
Terakihi-1	1990	Esso	403	3017	Upr *F. longus*	2817.5	Upr *F. longus*	199.5	Yes	No
Great White-1	1996	Esso	658.5	3441.5	Lwr *F. longus*	3210.5	Upr *F. longus*	231	No	No

Table 1: Information for wells offset/adjacent to Culverin-1 (TCC denotes "Top of Coarse Clastics").

HORIZONS / FORMATION TOPS							
HORIZON / TOP	PROGNOSED DEPTHS			ACTUAL DEPTHS			Diff.
	mMDRT	mTVDSS	Thickness	mMDRT	mTVDSS	Thickness	High/Low
Sea Floor/ Gippsland Limestone	607.0	-585.0	1975.0	606.5	-585.0	1899.9	-
Top of Lakes Entrance Fm	2582.0	-2560.0	325.0	2508.0	-2485.0	315.2	75.0 H
Top of Latrobe Group	2907.0	-2885.0	705.0	2824.0	-2800.0	932.4+	85.0 H
Base Tuna/Flounder Channel	2937.0	-2915.0		2835.0	-2811.0		104.0 H
Top 67.5 Ma Sand	2947.0	-2925.0		2895.0	-2871.0		54.0 H
Upper Longus MFS	Not prognosed	-	-	2958.0	-2933.8		-
Near 68.5 Ma Sand	3257.0	-3235.0		3158.0	-3133.4		102.0 H
Near 70.3 Ma Sand	3542.0	-3520.0		3411.8	-3386.2		130.2 H
Near 70.5 Ma	Not prognosed	-		3484.9	-3459.2		
71_Ma marker	Not prognosed			3582	-3556.6		
TD	3612.0	-3590.0		3758.0	-3732.4		142.4 L

Table 2. Culverin-1 Horizons - Prognosed versus Actual Depths

Seaspray Group -585.0 (Seafloor) to -2800.0mTVDSS

Gippsland Limestone -585.0 (Seafloor) to -2485.0mTVDSS (606.5-2508.0mMDRT)
(No cuttings descriptions above 1525mMD)
Calcilutite, occasionally argillaceous, with minor Calcisiltite and Calcarenite.
No biostratigraphy was conducted on this interval, but from offset wells it is known to have been deposited in open marine conditions and ranges in age back to mid-Miocene.

Lakes Entrance Formation -2485.0 to -2800.0mTVDSS (2508.0-2824.0mMDRT)
Calcareous Claystone and minor Calcilutite grading to Claystone towards base.
Palynological analysis of cuttings below 2790mMD show them to be very lean but, based on dinoflagellates, this interval is assigned to the *P. tuberculatus* Spore-Pollen Zone and a marine depositional environment.

Latrobe Group -2800.0 to -3732.4mTVDSS (Total Depth)

Tuna/Flounder Channel fill -2800.0 to -2811.0mTVDSS (2824.0-2835.0mMDRT)
Siltstone, commonly glauconitic, grading to fine Sandstone.
Palynological analysis of cuttings across this interval show them to be very lean and, based on dinoflagellates, assigned to the *P. tuberculatus* Spore-Pollen Zone. However, this designation is likely to be due to contamination from the overlying interval. Channel fill sediments in the nearest offset wells range from *N. asperus* in

Great White-1 to *M. diversus* in Volador-1 and Bignose-1. The minor glauconitic content and correlation to adjacent wells suggest deposition in a marine environment.

F. longus intra-Latrobe -2811.0 to -3732.4mTVDSS (2835.0-3758.0mMDRT)
Interbedded to Massive Sandstone, Siltstone and Claystone, with minor interbedded Coal below 3325mMD.
Palynological analysis of cuttings throughout this interval indicate that it is entirely within the *F. longus* Spore-Pollen Zone, ranging from the "Upper C" Subzone at the top to the "Lower A" Subzone at Total Depth. (Note, the 2840-50m sample, which was designated "*L. balmei* or older" is taken to be *F. longus* based on comments in the palynology report - Appendix 1, this volume). Depositional environments for this interval are interpreted to range from marine lower shoreface at the top to non-marine coastal plain at the base.

Within this intra-Latrobe Group section the following subintervals have been identified;
Base TFC to Upper longus MFS – this subinterval from the marine flooding surface (MFS) up to the Tuna/Flounder channel cut dominantly comprises Claystone to Siltstone with minor Sandstone and is interpreted to have been deposited in a marine (lower shoreface) environment.
Upper longus MFS to 68.5Ma marker – this subinterval mostly comprises massive/blocky, good quality Sandstone with minor interbedded Claystone. Depositional setting is envisaged to range from shallow/marginal marine to lowermost coastal plain, marking the transition from increasingly non-marine with depth (below) to increasingly more marine (above).
68.5Ma marker to Total Depth – this subinterval comprises mostly thinly interbedded Sandstone, Siltstone and Claystone, with minor interbedded Coal below 3325mMD. Only a few sandstone units (in the upper half of this subinterval) are more than 5m thick. Depositional setting is interpreted to be almost completely non-marine coastal plain, apart from a few very minor marginal marine indicators towards the top.

4.5 Reservoir Quality

The reservoir quality of the Late Cretaceous (*F. longus*) interval penetrated in Culverin-1 is similar to that in offset wells, although with a slightly reduced overall net-to-gross.

Correlation to Volador-1 indicates *F. longus* coastal barrier and back-barrier sands occur down to 3210mMD in Culverin-1. These sands contain medium- to coarse-grained clean quartz with little clay or cement, similar to those at Volador-1. Log porosities of up to 30% are calculated, but are mostly in the range 16-28% (Figure 12). They are good to excellent potential reservoirs, but they are water bearing in Culverin-1.

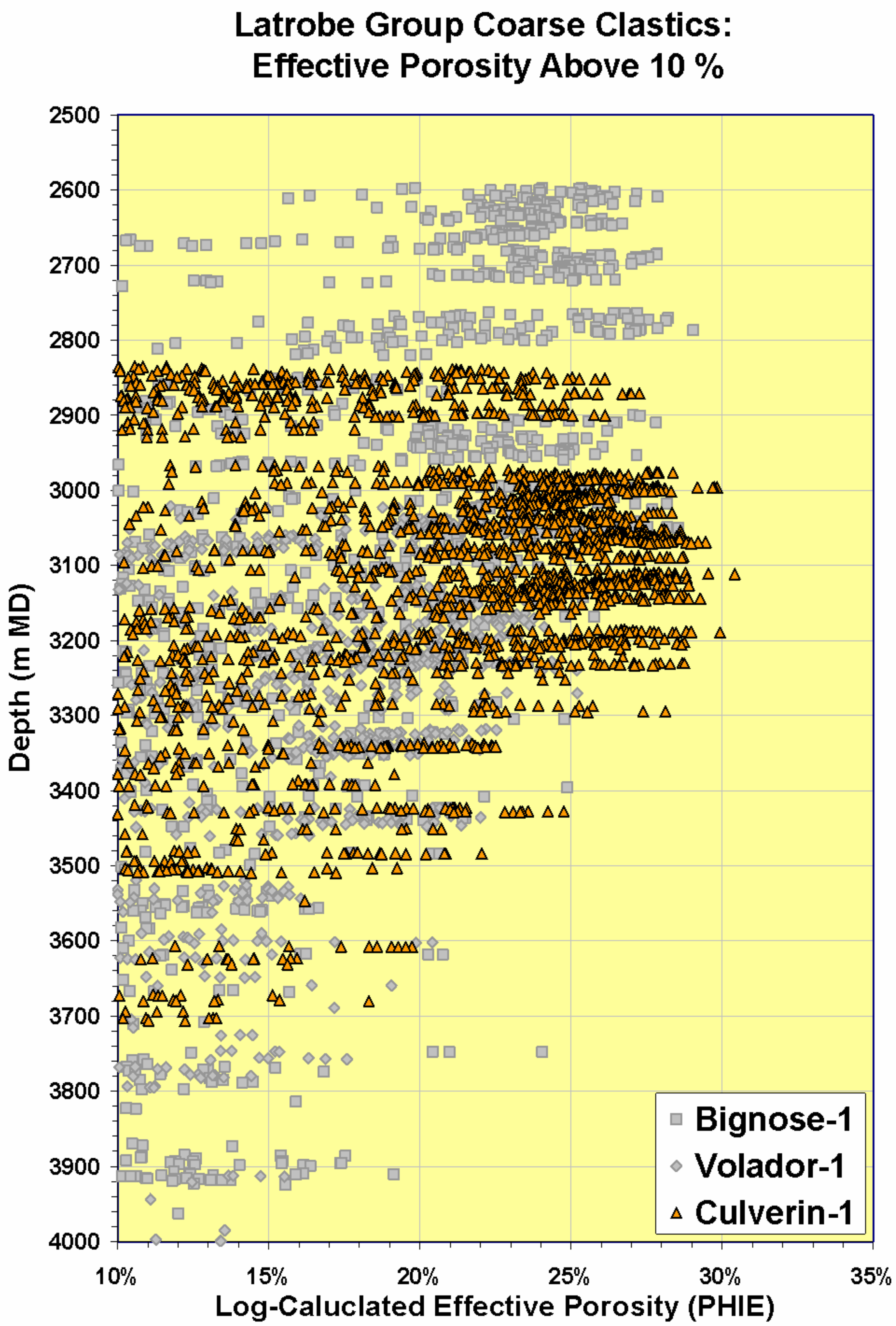

Figure 12: Cross-plot of Latrobe Group Coarse Clastics Effective Porosity (%) versus Depth (m MD).

From 3210 m down to TD, sands are generally much tinner and show fining upwards trends which are interpreted to be minor fluvial point-bar and crevasse-splay deposits, similar to those present in correlative sequences in Bignose-1 and Volador-1. These sandstones are generally more argillaceous, fine- to medium-grained, and with a significantly greater content of (weathered) lithics and clay than the overlying coastal sands. They also contain common calcareous (dolomite/siderite) cement and (in offset wells) show pressure solution of sand grains. Most of the sands in this section are less than a few metres thick, with a few ranging up to about ten metres. Log porosities range 5-25%.

4.6 Hydrocarbon Shows

Details of petrophysical log analysis for Culverin-1 are presented in APPENDIX 3.

Based on reservoir parameter cut-offs of PHIE>=10%, VCL<=50% and SWE<100%, Culverin-1 intersected 1.52m net oil reservoir sand across the interval 3607.00-3609.29mMDRT. Reservoir properties across this zone are good with average PHIE 17.29%, average VCL 10.11% and average SWE 34.1%. An oil-water contact (OWC) is not evident on log data; 3609.29mMDRT is Lowest Known Oil from log analysis.

No other hydrocarbon bearing zones were identified from petrophysical analysis of the wireline (or LWD) log data.

The results are presented in Table 2 of APPENDIX 3 of this report.

4.6.1 'Reserval' Cuttings Gas Data Analysis

Total mud gas concentration and gas composition were principally measured using the Geoservices 'Reserval' gas monitoring system. Geoservices' FID Chromatograph Panel system was also used for auxiliary/backup gas detection (refer Appendix 8 of Culverin-1 Basic Well Completion Report for mudlogging report, and Enclosure 2 for Gas-Ratio Log).

Gas monitoring commenced using the Geoservices 'Reserval' from the beginning of the 311mm (12.25") hole section at 1525 m through to the well's Total Depth (TD) of 3758 m.

No significant gas was encountered while drilling through the sediments above 3470 m in the 311mm (12.25") hole section. Background Total Gas levels in this section ranged from 7 to 30 Units (1 Unit = 200 ppm) with the maximum gas reading of 58 Units occurring at 2008 m. The gas throughout this section was extremely dry, consisting of 96-99 % C_1 (methane), with traces of C_2 (ethane), C_3 (propane), C_4 (butane), and C_5 (pentane) gas. These low gas values were partly due to mud weight being gradually increased during this interval from 9.5 to 10.2 ppg.

Below 3470 m the background total gas levels began to steadily increase (Figure 13), primarily due to the increased incidence of thin gas bearing sandstone layers and intercalated coals in the drilled lithology. The background gas levels between 3470 m and 3758 m (TD) ranged from 20 to 45 Units. This gas was relatively wetter, with C_1 to C_5 proportions commonly between 74-88% C_1, 8-12% C_2, 3-8% C_3, 1-5% C_4 and Trace-3% C_5. The maximum gas peak encountered in this well occurred at 3608 m with 272 Units of Total Gas recorded and a C_1 to C_5 breakdown of 82/10/5/2/1. However, several other notable gas peaks relating to coal and sandstone bodies were also recorded at:

- 3533m – 148 units – C_1 to C_5 breakdown of 92/6/1/1/Trace
- 3544m – 186 units – C_1 to C_5 breakdown of 88/7/3/2/Trace
- 3582m – 155 units – C_1 to C_5 breakdown of 92/5/2/1/Trace
- 3595m – 248 units – C_1 to C_5 breakdown of 92/5/2/1/Trace
- 3613m – 161 units – C_1 to C_5 breakdown of 88/8/3/1/Trace

According to the hydrocarbon Wetness, Balance and Character ratio indicators (refer to Appendix 8 of Culverin-1 Basic Well Completion Report for explanation of Geoservices 'Reserval' gas log ratio indicators) each of these gas peaks correspond to a potentially productive gas zone (i.e. where $0.5 < W_h < 17.5$, and $B_h < W_h < 100$), except for the gas peak at 3608 mMD which has gas ratios indicative of a potentially productive oil zone (i.e. where $17.5 < W_h < 40$, and $B_h < W_h$). The interpretations of these zones are listed below and gas ratio diagrams are shown in Figure 14.

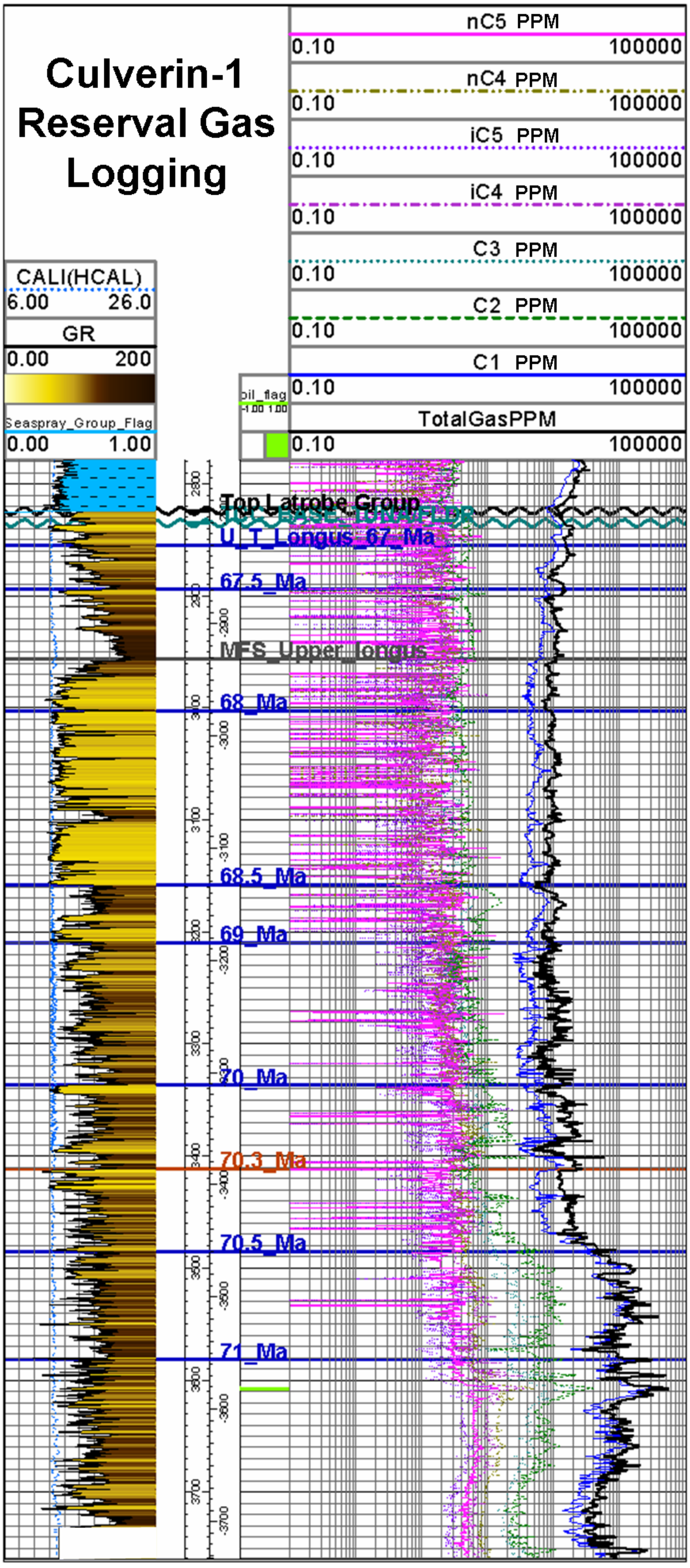

Figure 13: Culverin-1 'Reserval' Gas Logging Plot (One gas unit=200 ppm)

4.6.2 'Reserval' Gas Ratio Interpretation and Diagrams

Depth Interval (m)	Main* / Auxiliary**	Gas Peak (units)	Wetness	Balance	Character	Zone Interpretation
3531 – 3533	Main	148	8.4	40.9	0.70	Potentially productive low
	Auxiliary	187	6.9	91.1	0.18	density gas zone
3543 – 3544	Main	186	12.0	19.1	0.47	Potentially productive medium
	Auxiliary	130	9.6	43.5	0.40	density gas zone
3581 – 3583	Main	155	7.6	42.3	0.59	Potentially productive low
	Auxiliary	121	5.8	100.0	0.28	density gas zone
3594 – 3597	Main	248	8.1	38.4	0.55	Potentially productive low
	Auxiliary	129	6.2	82.0	0.31	density gas zone
3605 – 3610	Main	272	18.0	11.4	0.54	Potentially productive low gravity oil zone
	Auxiliary	169	14.0	22.4	0.27	Potentially productive high density gas zone
3611 – 3615	Main	161	12.9	20.1	0.52	Potentially productive high
	Auxiliary	100	9.9	39.1	0.24	density gas zone

Table 3: Interpretations for Peak 'Reserval' Gas Log Zones.

* Main = Gas composition and total gas in mud were principally measured using the Geoservices Reserval

** Auxiliary = Geoservices FID Chromatograph Panel results

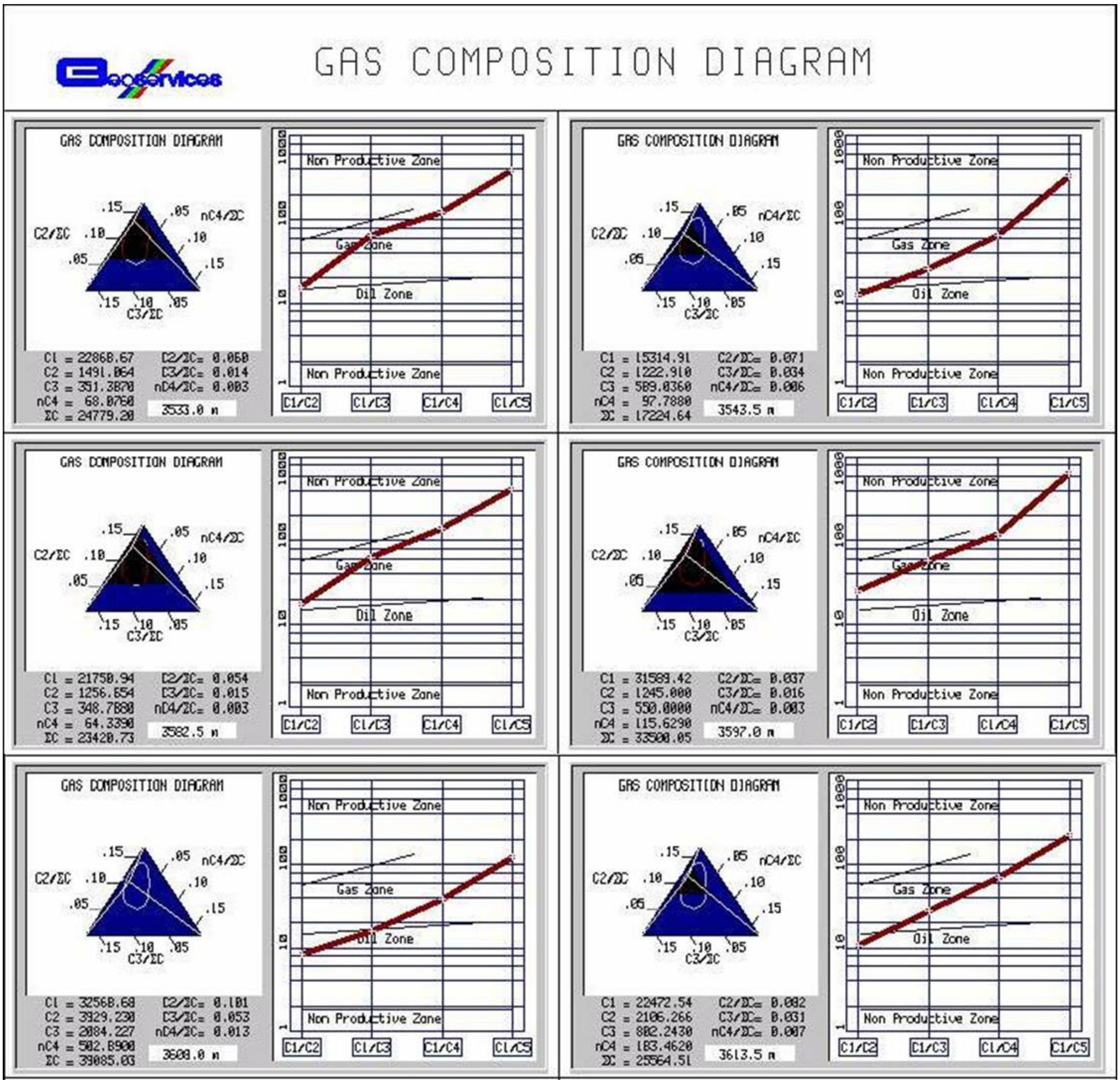

Figure 14: Reserval Gas Composition Diagrams.

4.6.3 Explanation of 'Reserval' Gas Composition Diagrams

The Triangle or Gas Composition Diagram is used to graphically represent the hydrocarbon distribution in the gas and to determine whether it corresponds to a gas or oil reservoir. The triangular diagram is obtained by tracing lines on three scales at 120° to each other, corresponding respectively to the ratios of ethane, propane and normal butane to the total gas.

The scales are arranged in such a way that if the apex of the triangle is upward, the diagram represents the analysis of gas from a gas zone, while if the apex points downwards, the diagram represents the analysis of gas from an oil zone. A large triangle diagram represents dry gas or low GOR oil, while small triangles represent wet gases or high GOR oils. The centre of the triangle should fall inside the area delineated by the dotted line, which encircles compositions that are regarded as 'normal'. If the triangle area is outside this area the gas indicates that the reservoir is not exploitable and that the heavier hydrocarbon composition is 'abnormal' i.e. hydrocarbons that are chemically altered or gases with special compositions which are not associated with oil.

The Gas Ratio Analysis Diagram is a plot of the ratio of C_1 to the other gas elements. The magnitude of the methane to ethane ratio determines if the reservoir contains gas or oil, or if it is non-productive. The following conclusions are possible:

Ratio C_1/C_2:	< 2	non-productive zone
	2 - 15	oil present
	15 - 65	gas present
	> 65	non-productive zone

The slope of the line of the ratio plot of C_1/C_2, C_1/C_3, C_1/C_4 and C_1/C_5 indicates whether the reservoir will produce hydrocarbons or hydrocarbons and water. Positive line slopes indicate production; negative line slopes indicate water-bearing formations. When using the Gas Ratio Diagram, the following points should be borne in mind:

1. Productive dry gas zones may show only C_1, but abnormally high shows of C_1 are usually indicative of saltwater zones.
2. If the ratio C_1/C_2 is low in the oil section and the ratio C_1/C_4 is high in the gas section, the zone is probably non-productive.
3. If any ratio (C_1/C_5 excepted in an oil based mud) is lower than the preceding ratio then the zone is probably non-productive.
4. The ratios may not be definitive for zones of low permeability.
5. Steep gas ratio plots may be indicative of tight zones.

4.6.4 Interpreted Oil Zone Petrophysical Analysis

The interval 3605-3609mMDRT has a significant resistivity anomaly (Figure 15). This zone was interpreted as oil bearing based on integrated petrophysical analysis using a combination of the neutron-density log character, resistivity anomaly, total density near and far counts, ‘Reserval’ ditch gas readings and fluorescence shows described from cuttings.

No H_2S or CO_2 was recorded during the drilling of this well.

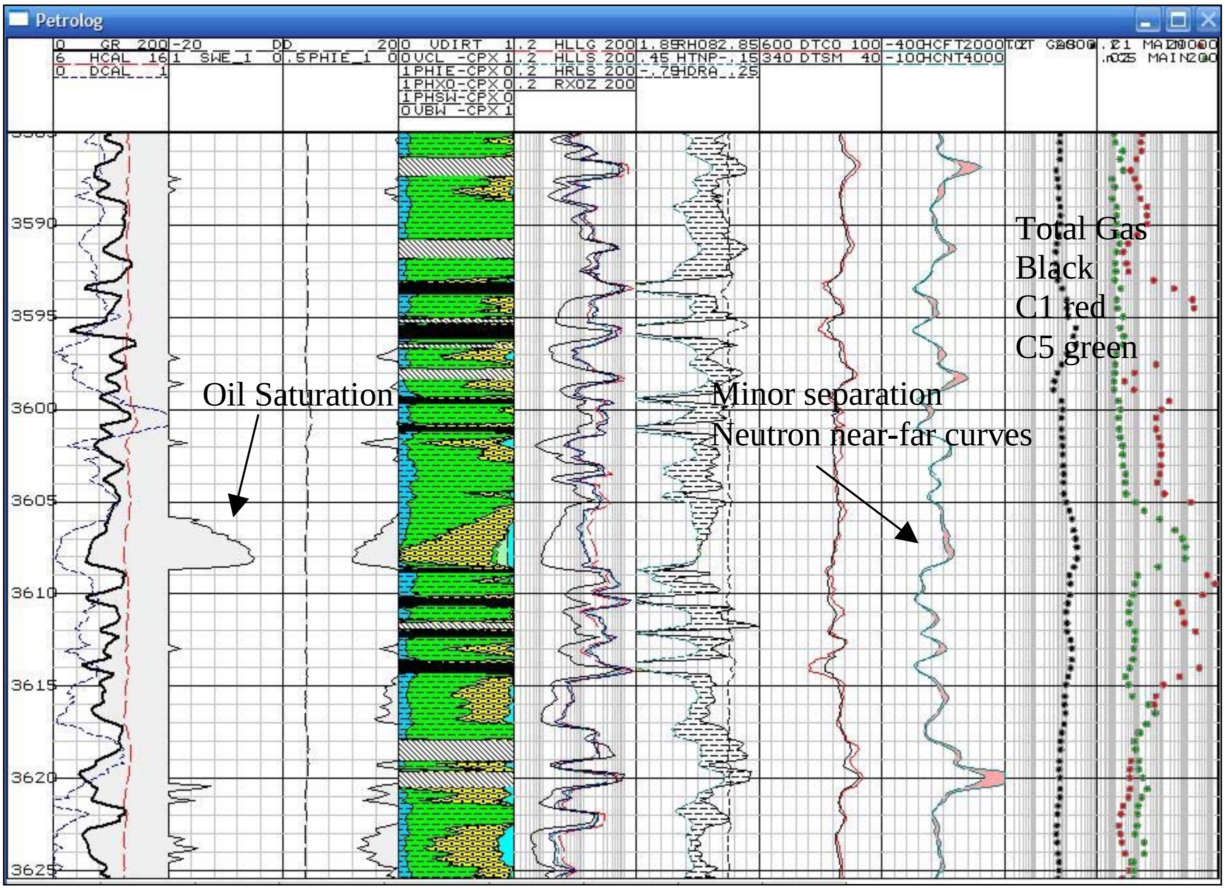

Figure 15 Culverin-1 Petrophysical Log with Reserval Gas anomalies.

4.6.5 Geochemical Analysis of Interpreted Oil Zone Cuttings Solvent Extract

In order to determine the quality of the interpreted oil zone identified on logs, solvent extraction, liquid chromatography and gas chromatography geochemical analyses were performed on the cuttings interval from 3605–3610 m MD. These same analyses were also performed on source rock shale cuttings from 3750-3755 m MD, with a view to establishing the composition of a “typical” source rock extract, to be compared with the signature associated with possible migrant oil show hydrocarbons.

These chromatograms are somewhat similar in appearance (Figure 16), and show hydrocarbon distributions typical of immature to early mature terrigenous source rock extracts. This is indicated by distinct high molecular weight (n-C_{23} plus)/waxy n-alkane odd-over-even predominance and high pristane/n-C_{17} alkane ratios. There is no clear indication that the extract from the interpreted oil zone represents a relatively more mature “oil-like” hydrocarbon distribution, which would be expected and most likely be obvious if it was a zone of migrant oil accumulation. However in view of other evidence indicating the presence of an oil zone between 3607-3609.3 m MD, the relatively reduced odd-even predominance and lower pristane/n-C_{17} ratio in the 3605-3610m sample compared to the deeper 3750-3755m sample, may be supportive of subtle mixing of a more mature “oily” component (presumably locally sourced), overprinting the base indigenous “source rock” extract hydrocarbon signature.

Figure 16 shows comparison of the Culverin-1 solvent extracted cuttings samples saturate hydrocarbon signatures with a similarly situated solvent extracted source rock sample from the Volador-1 well situated southwest of Culverin-1. The hydrocarbon distribution of a tested whole oil from Volador-1 is also shown in Figure 16. In light of the Volador-1 hydrocarbon signatures, the presence of some migrant oil component for the 3605–3610 m MD sample remains contentious.

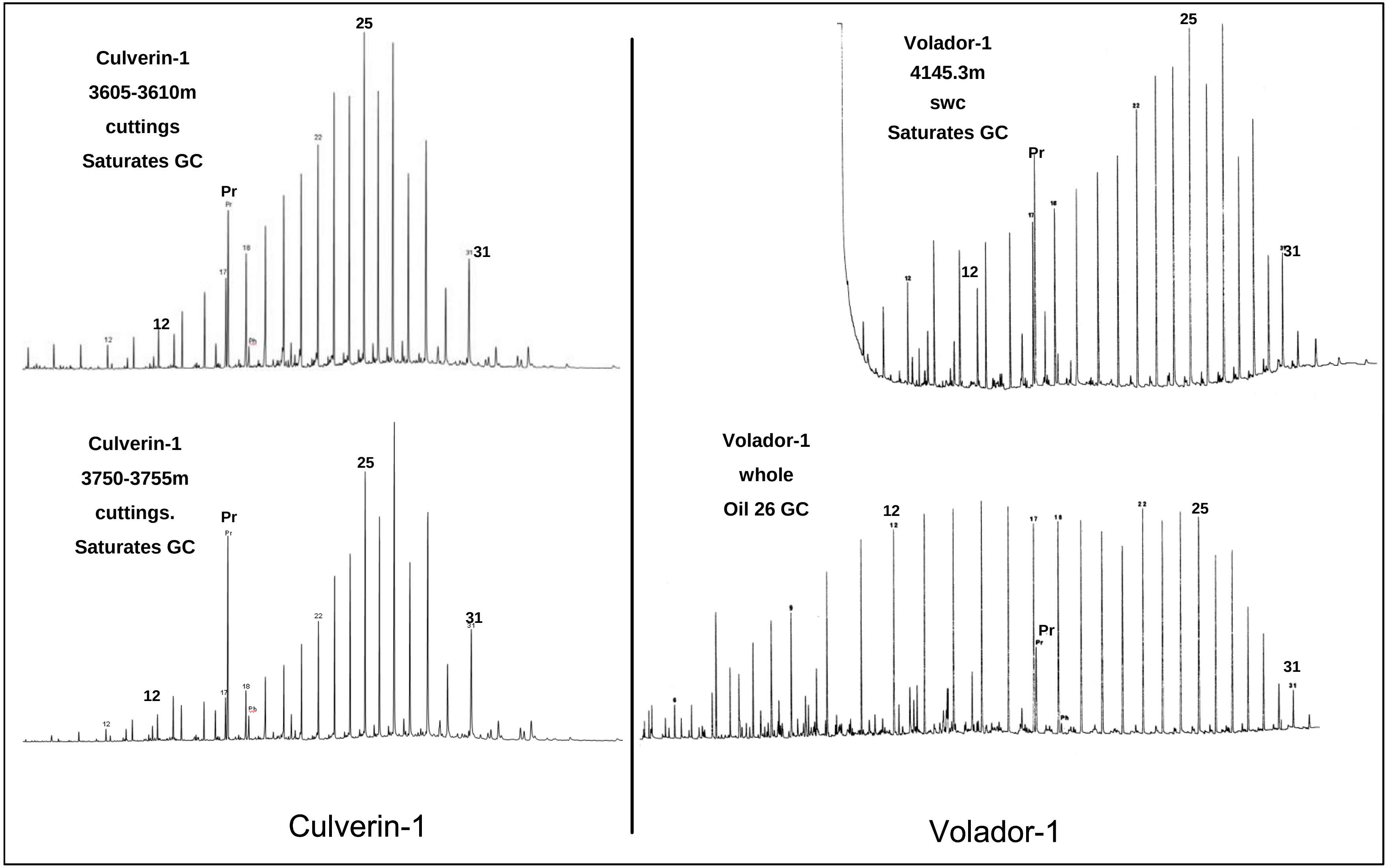

Figure 16: Comparison of cuttings extract saturate fraction gas chromatograms from Culverin-1 with source rock extract and tested whole oil chromatograms from Volador-1.

5. GEOPHYSICAL DISCUSSION

5.1 Geophysical Data

The Culverin/Scimitar prospects are situated in the vicinity of the shelf slope break where the effects of locally steep and rugose water bottom topography due to submarine canyon incision, combined with the progradational and severely channelled Miocene Gippsland Limestone section, can degrade seismic data quality and introduce significant time distortions.

Three vintages of seismic data were used in the seismic interpretation and mapping for the generation of the Culverin/Scimitar prospect. All seismic data was reprocessed for simulated pre-stack water replacement corrections, changing the velocity of the water layer from 1490m/sec to 2200m/sec (Figure 17). This procedure eliminates sharp, non-geological changes that occur to reflections in areas of steep and changing water bottom, and allows easy correlation of horizon picks between surveys, which also improves well tie confidence.

Seismic data quality was generally good, but with reduced stacking quality beneath sea floor channels.

The nearest well control was provided by the Bignose-1 (7.0 km NW), Volador-1 (9.9 km WSW), Basker South-1 (9.9 km NNE), Basker-1 (11.5 km NNE) and Great White-1 (5.9 km SW) wells.

Details regarding the VIC/P56 3D and 2D seismic surveys used for mapping the Culverin Prospect, and the simulated water replacement procedure are given in APPENDIX 4.

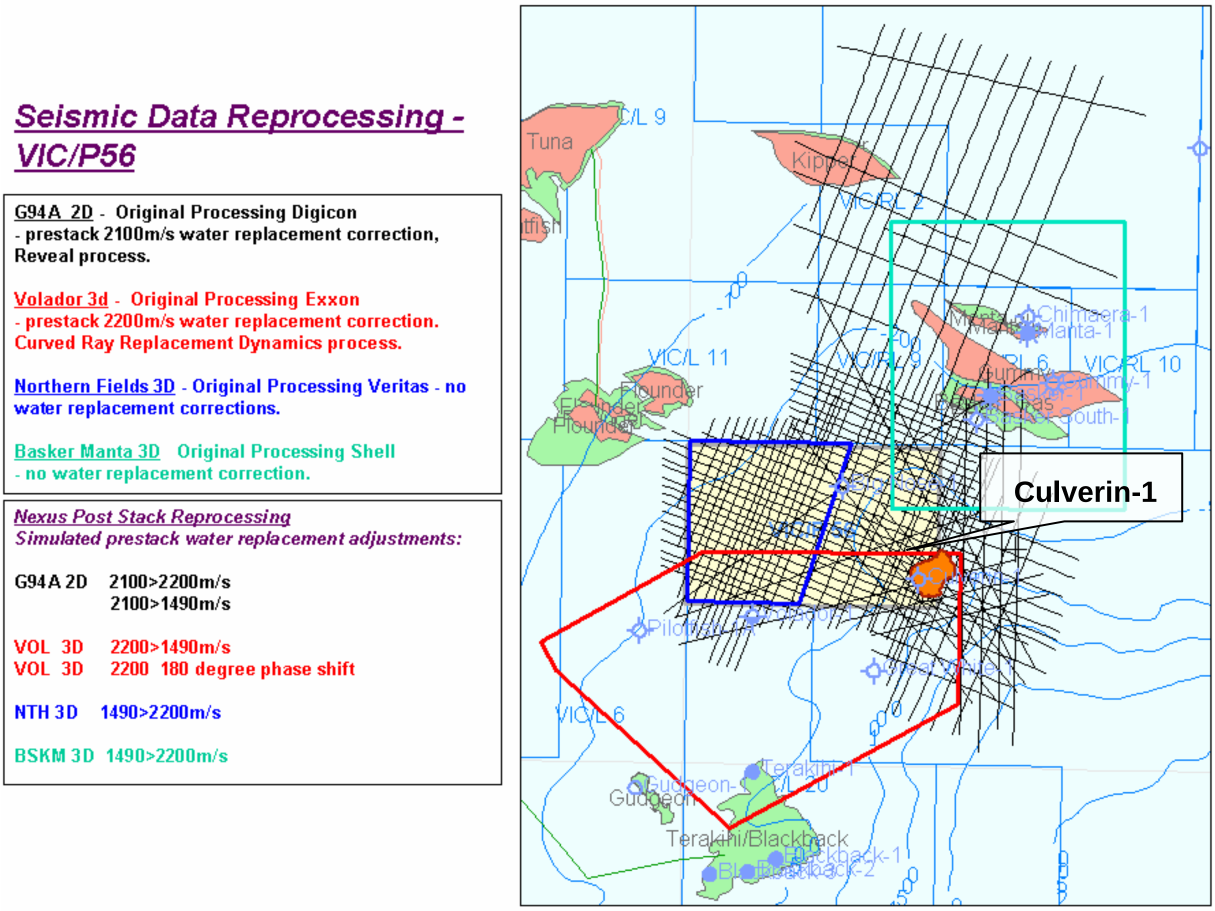

Figure 17: VIC/P56 Seismic Lines.

5.2 Time Interpretation

The following eight key horizons were picked on the Volador 3D survey and surrounding 2D seismic lines over the Culverin Prospect:

1. Sea Floor (0 my)
2. Base High Velocity Channelling (16.5 my)
3. Top Latrobe Group (35.5 my)
4. Base Tuna Flounder Channel (48.5 my)
5. 67.5 my marker
6. 68.5 my marker
7. 70.3 my marker
8. 74 my marker

The geometry of horizons 3-8 are depicted in Figure 18, Figure 19 and Figure 20.

The sea floor is very irregular over the Culverin Prospect because of channel cuts (Figure 18 and Figure 19). An accurate sea floor pick is required for depth conversion and was important for designing the anchor pattern for the drilling rig.

The Base High Velocity Channelling occurs at the base Gippsland Limestone / Top Lakes Entrance Formation. This surface is difficult to correlate in some areas.

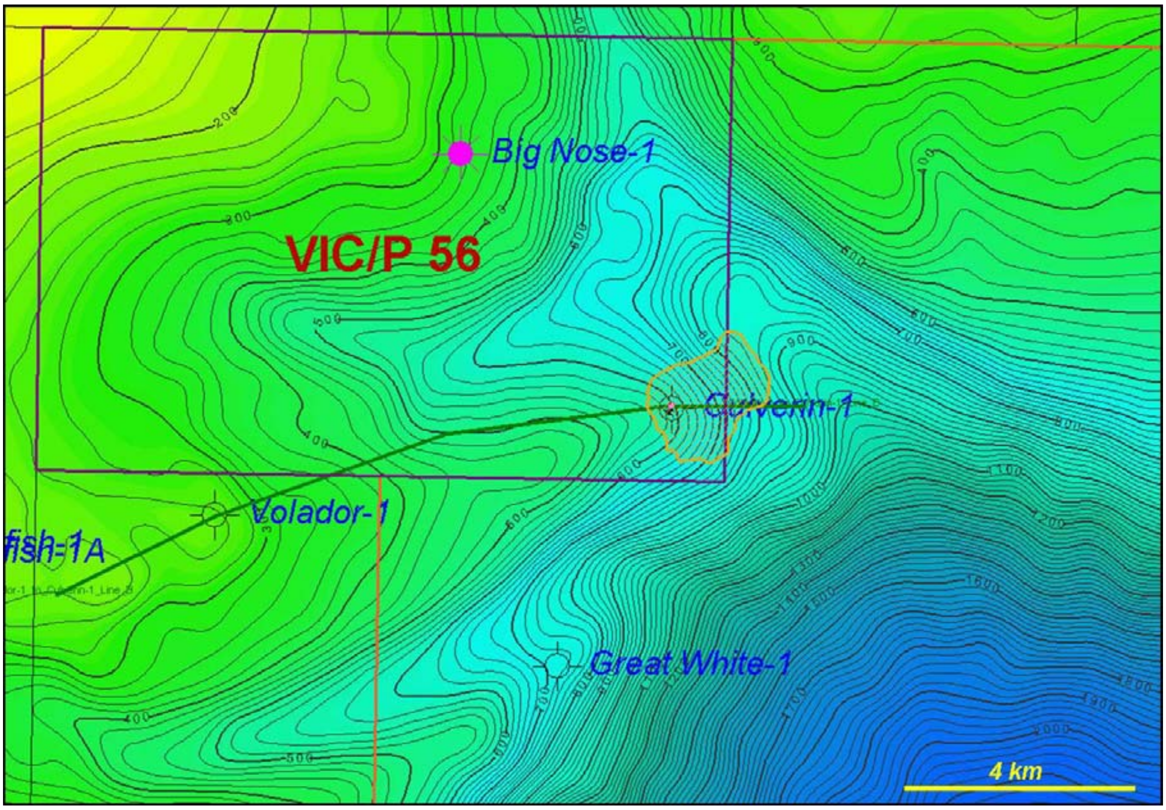

Figure 18: Culverin Prospect water bottom map (contour interval=20 metres).

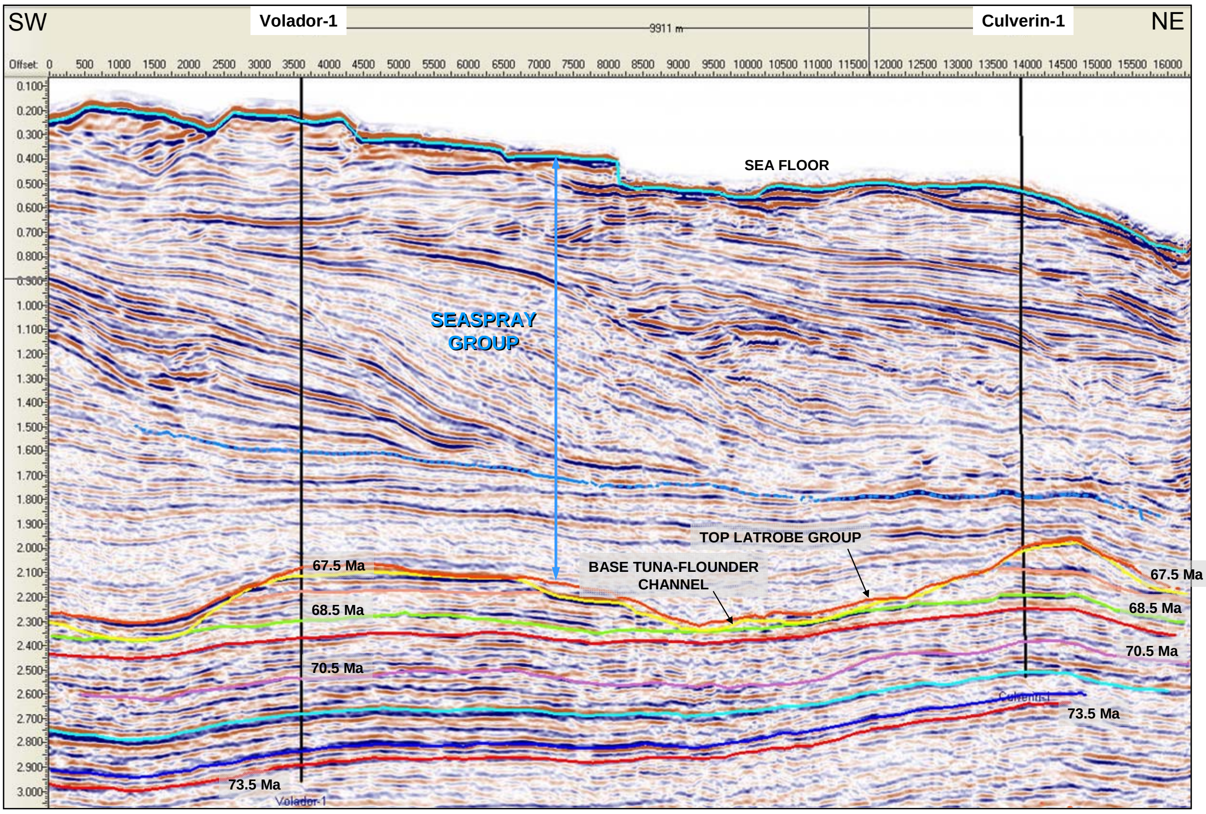

Figure 19: Culverin/Scimitar Prospect mapped horizons - Section line displayed in Figure 18.

The Base Tuna-Flounder Channel is a prominent erosive/channelled surface in-filled with a thin interval of Flounder Formation over the Culverin Prospect. In this area the Flounder

Formation was expected to be a good quality seal. Poorer seal quality Turrum Formation was expected to infill the deeper channel cut to the SE (Johnstone *et al*., 2001).

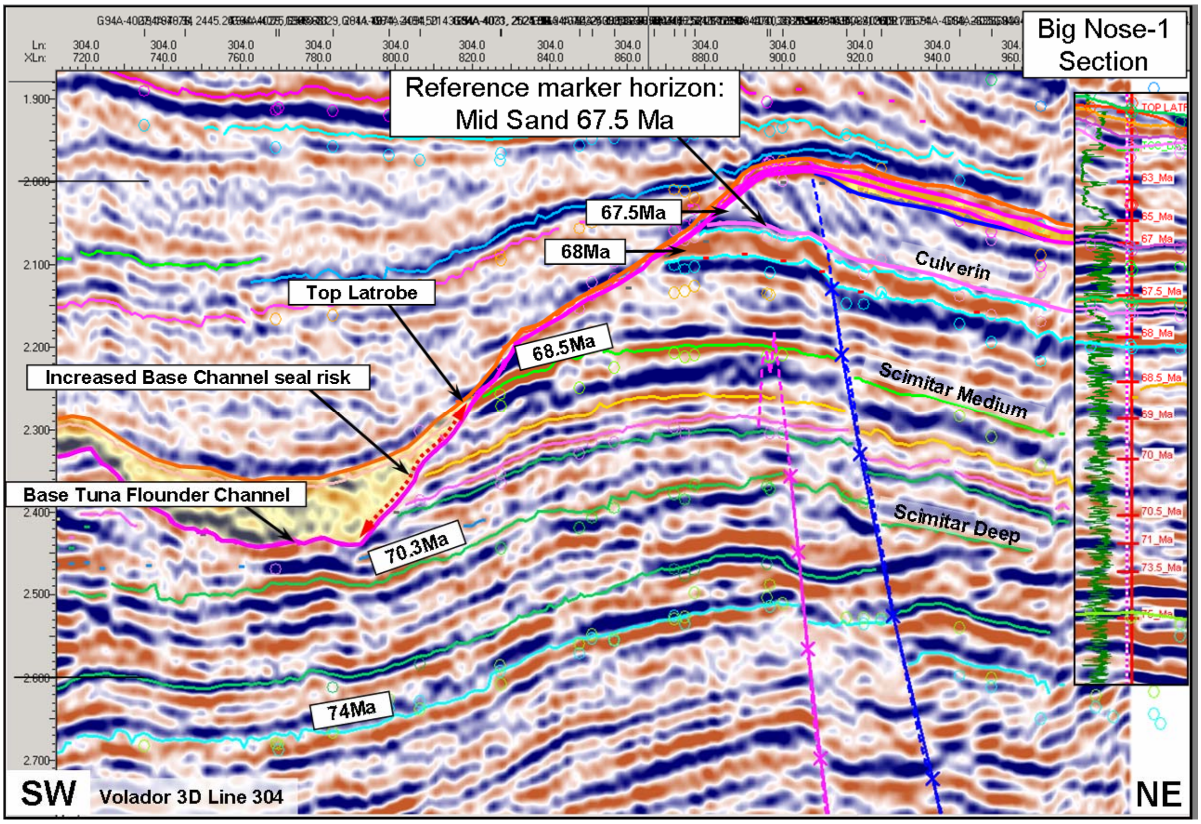

Figure 20: Culverin / Scimitar Prospect Horizon Picks.

The 67.5Ma Horizon is the base of a 100m thick shale interval within the Intra-Latrobe monadnock that was expected to form a top seal for the primary target sands of the Culverin Prospect. Coastal barrier sands penetrated at this level have good reservoir potential. This horizon is correlated with high confidence from the Bignose-1 well, located about 7km to the NW. The seismic data quality tends to degrade near this level over the prospect but the characteristic pattern of nearby reflectors increases the correlation confidence.

The 68.5Ma Horizon marks the top of the secondary target (Scimitar Prospect), which was interpreted pre-drill to consist of pay intervals in stacked coastal plain sands. The Tuna-Flounder Channel cuts this horizon and adds to the seal risk because of the Turrum Fm channel fill (Johnstone *et al*., 2001).

The Tuna Flounder channel does not cut as deep as the 70.3Ma horizon, so the stacked pay intervals have reduced seal risk below this horizon. The 74Ma horizon is a good quality Intra-Latrobe marker and is the deepest event mapped throughout the prospect area.

The horizon picks were tied into the Pilotfish-1A, Volador-1 and Great White-1 wells on the Volador 3D and the Bignose-1 well on the 2D seismic data.

Figure 21 shows the pre-drill Base Tuna-Flounder Channel two-way time structure map which defines the Culverin Prospect.

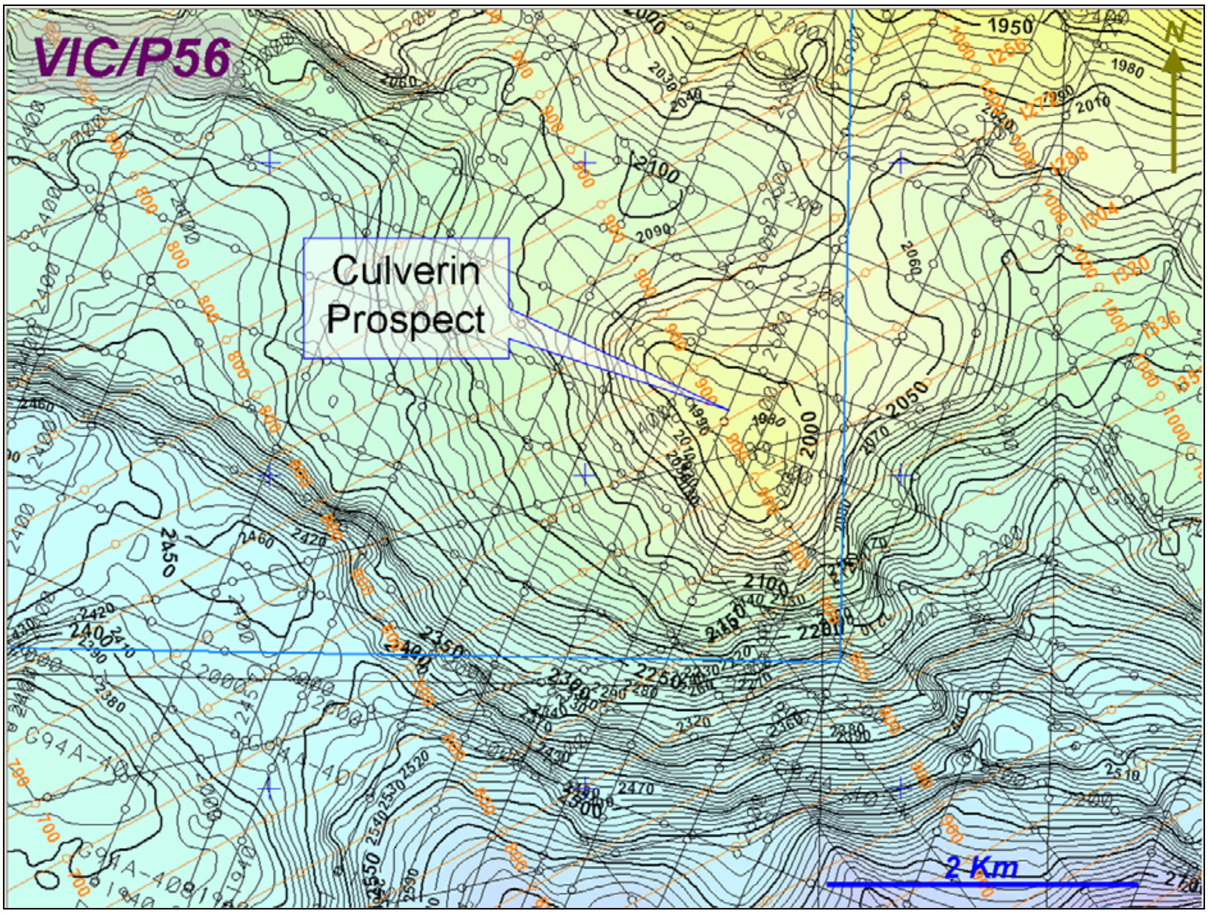

Figure 21: Culverin Prospect Base Tuna-Flounder Channel Time Map.

5.3 Depth Conversion - Pre and post drill

5.3.1 Pre-drill Depth Conversion

Depth conversion of the VIC/P56 horizon time mapping was performed using smoothed Dix corrected stacking velocities to the Top Latrobe horizon. This velocity grid was calibrated to the well ties as a final step using a velocity error ratio with $1/R^2$ distribution. Depth conversion to other horizon levels was based on well interval velocities.

The pre-drill Culverin Prospect Base Tuna-Flounder Channel Depth Map is shown in Figure 22.

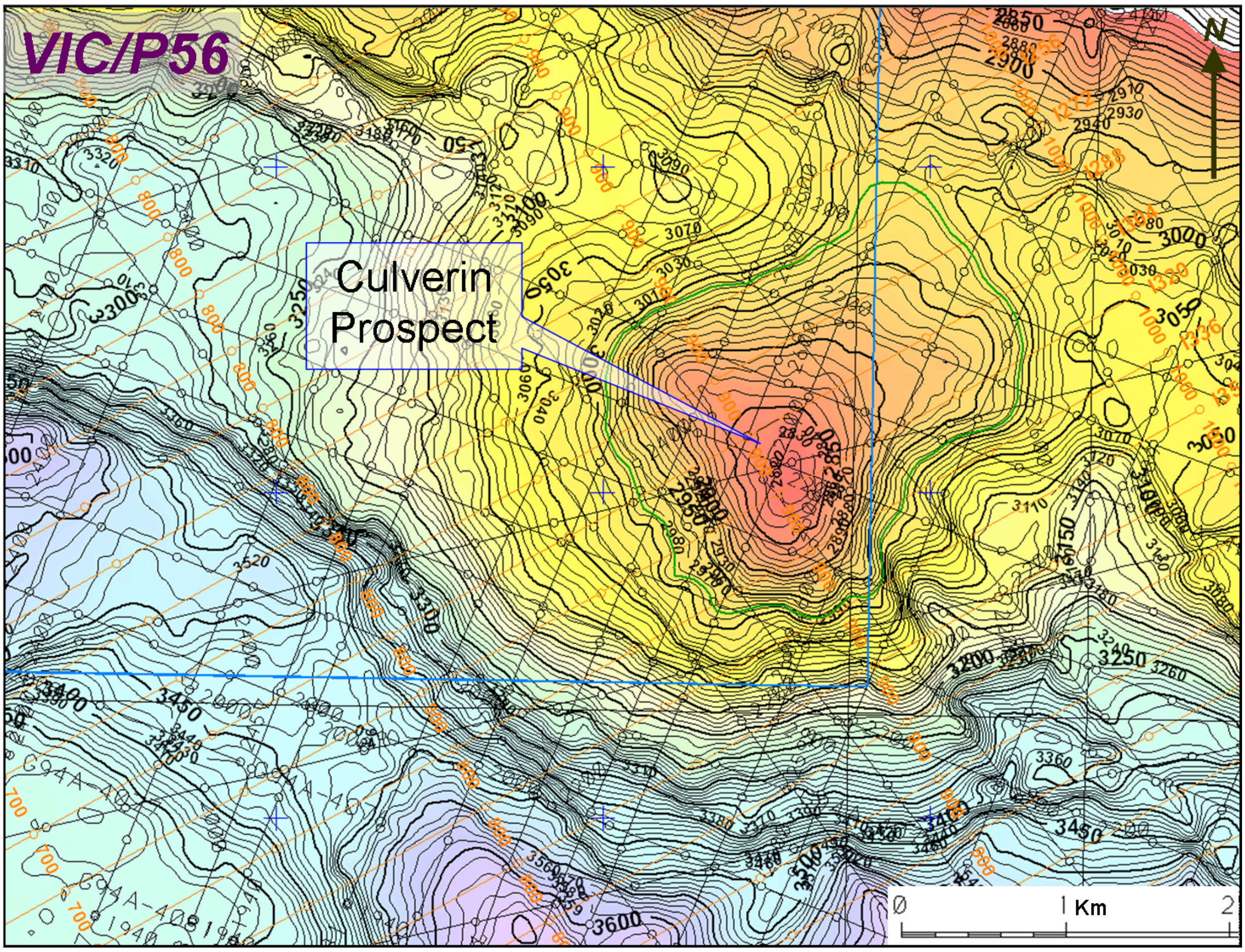

Figure 22: Culverin Prospect pre-drill Base Tuna-Flounder Channel Depth Map

5.3.2 Post-drill Depth Conversion Analysis

In light of data obtained from Culverin-1, a post-drill analysis of the seismic interpretation and time-depth conversion was performed to elucidate sources of error associated with pre-drill depth mapping (and time-depth conversion processing).

The mean error at Top Latrobe level in the wells near VIC/P56 was +/- 22m.

Review of seismic stacking velocity data showed significant regional anomalous velocity variation that, in part, was supported by the well velocities. This velocity variation was from low velocities in the south to higher velocities towards the north and, most notably, north of the Culverin/Scimitar prospect. The net effect of this velocity variation was to enhance the structural closure of the prospect. Figure 23 is a Dix corrected, unsmoothed, uncalibrated average velocity grid to the Top Latrobe horizon, overlain by the water bottom contours. The water replacement corrections have removed most of the low velocity effects of the water bottom channels, and it also can be seen that there is no significant regional correlation of the velocity field with the water bottom shape (except in the very deep water to the southeast). The high velocity zone passing partly through and supported by the Bignose-1 well results, is from a velocity variation within the shallow carbonates section and above all mapped horizons.

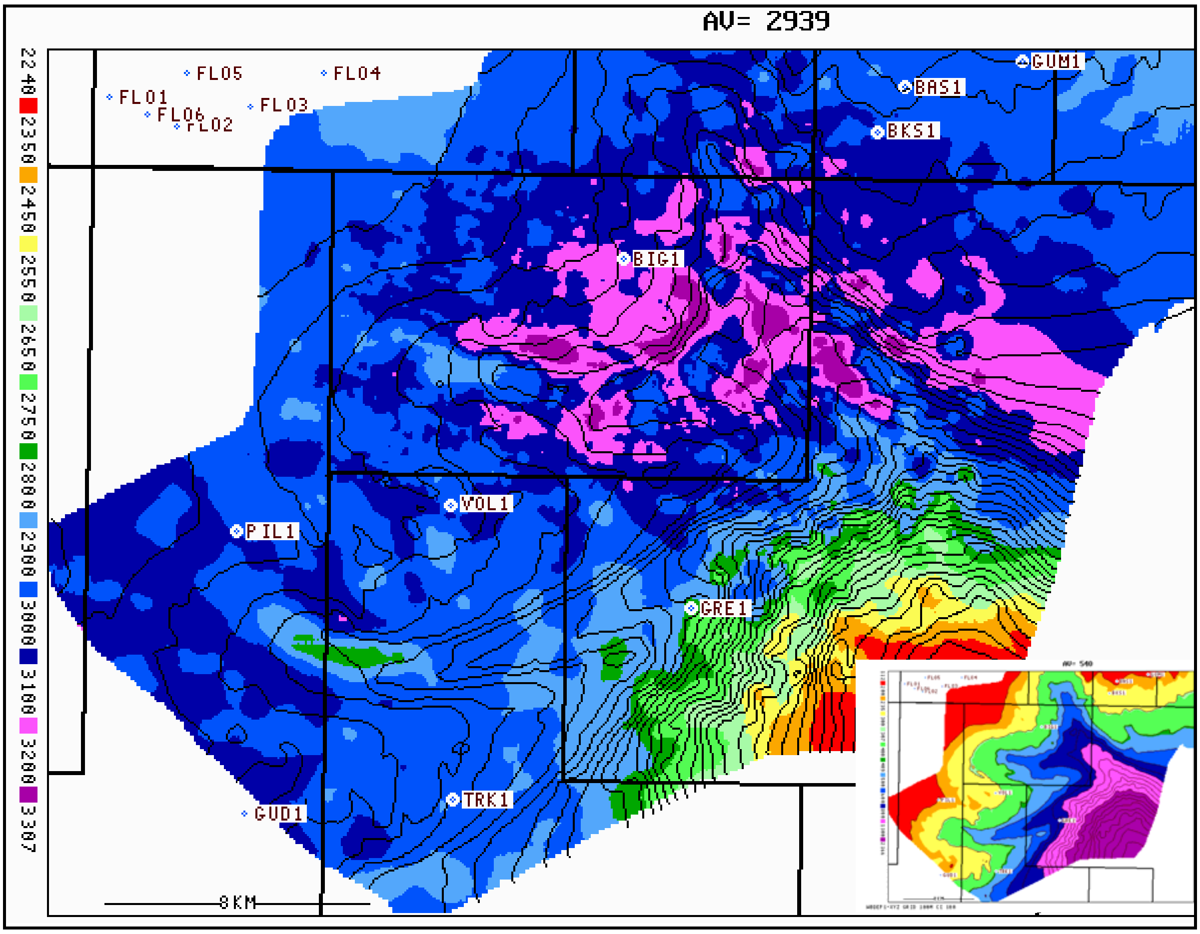

Figure 23: Dix corrected, unsmoothed, uncalibrated average velocity grid to the Top Latrobe formation, overlain by the water bottom.

A synthetic seismogram with quadrature phase was generated from the sonic and checkshot data (Figure 24). The synthetic seismogram was a good match to the seismic data after it was shifted down 17 msecs. (Figure 25). The tie was good for all seismic markers, except in the close proximity of the eroded slope of the Top Latrobe horizon and Base Tuna Flounder Channel (Figure 26). The 11 msec deep mis-tie at these levels is most likely an artefact of the seismic migration, rather than a general mis-pick. Both of these time shifts contributed to the well coming in shallow at these levels.

Figure 27,Figure 28 andFigure 29 show a breakdown of the depth prognosis errors for the Top Latrobe, Base Tuna Flounder Channel and 68.5 my year horizons.

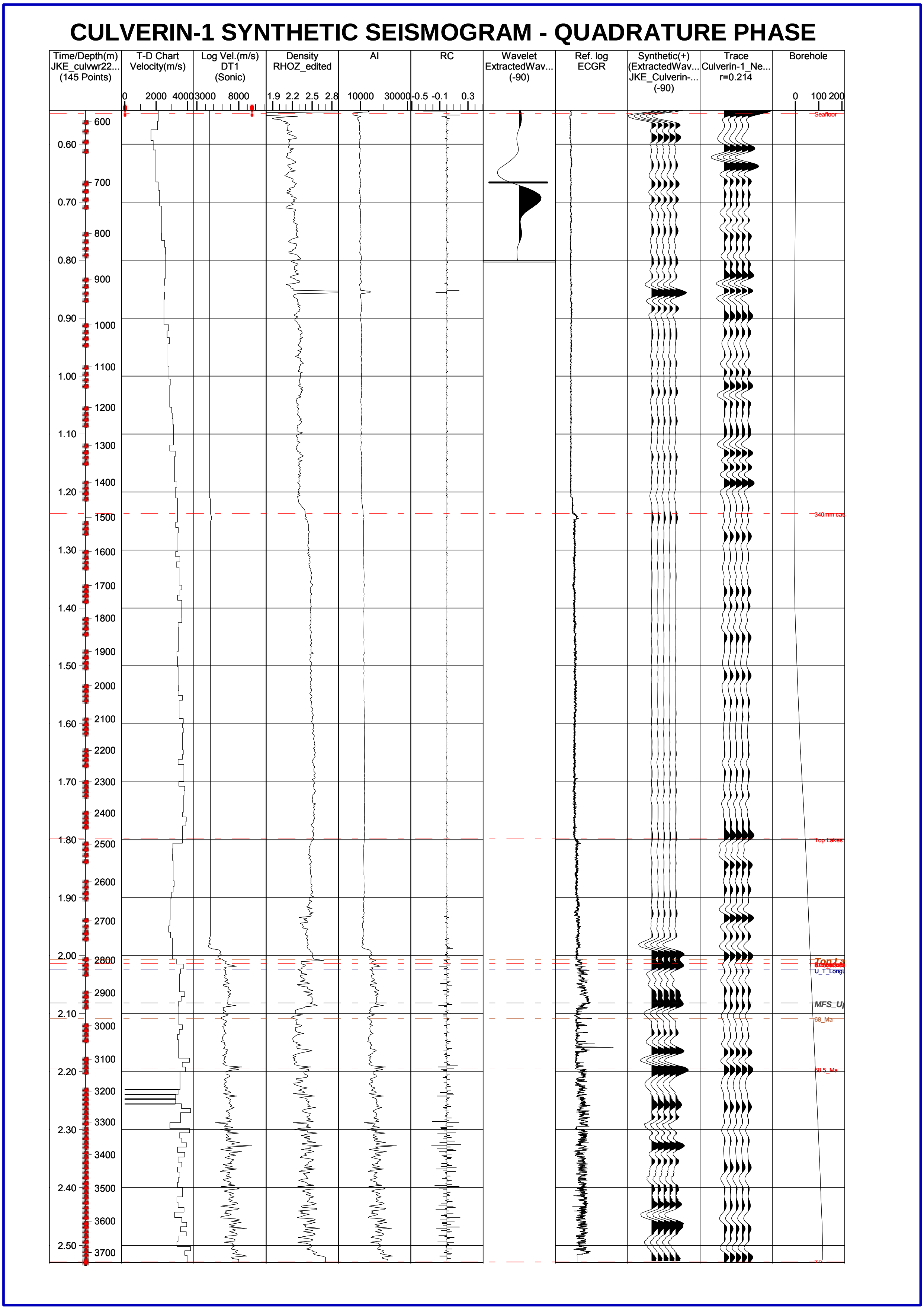

Figure 24: Culverin-1 Synthetic Seismogram (Quadrature Phase) with 17 msec shift downward.

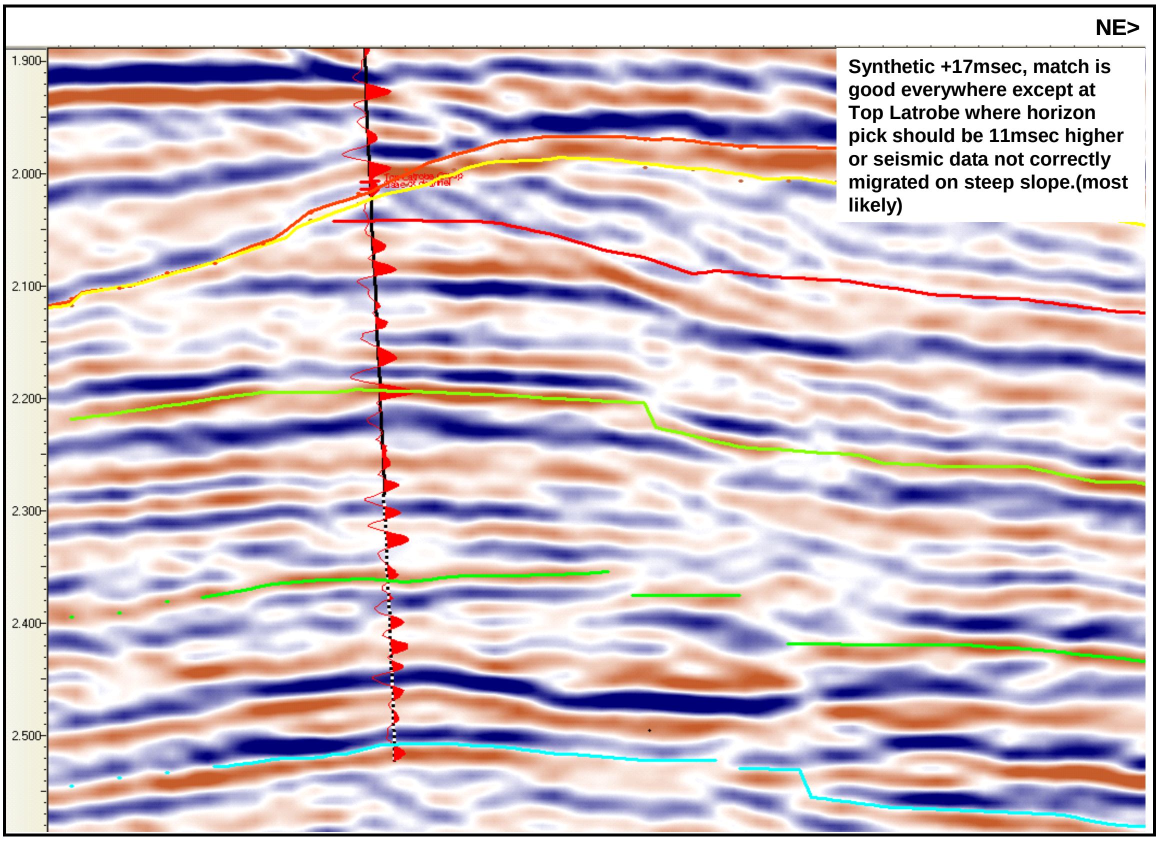

Figure 25: Volador 3D Inline-297 with Culverin-1 synthetic seismogram with 17msec added.

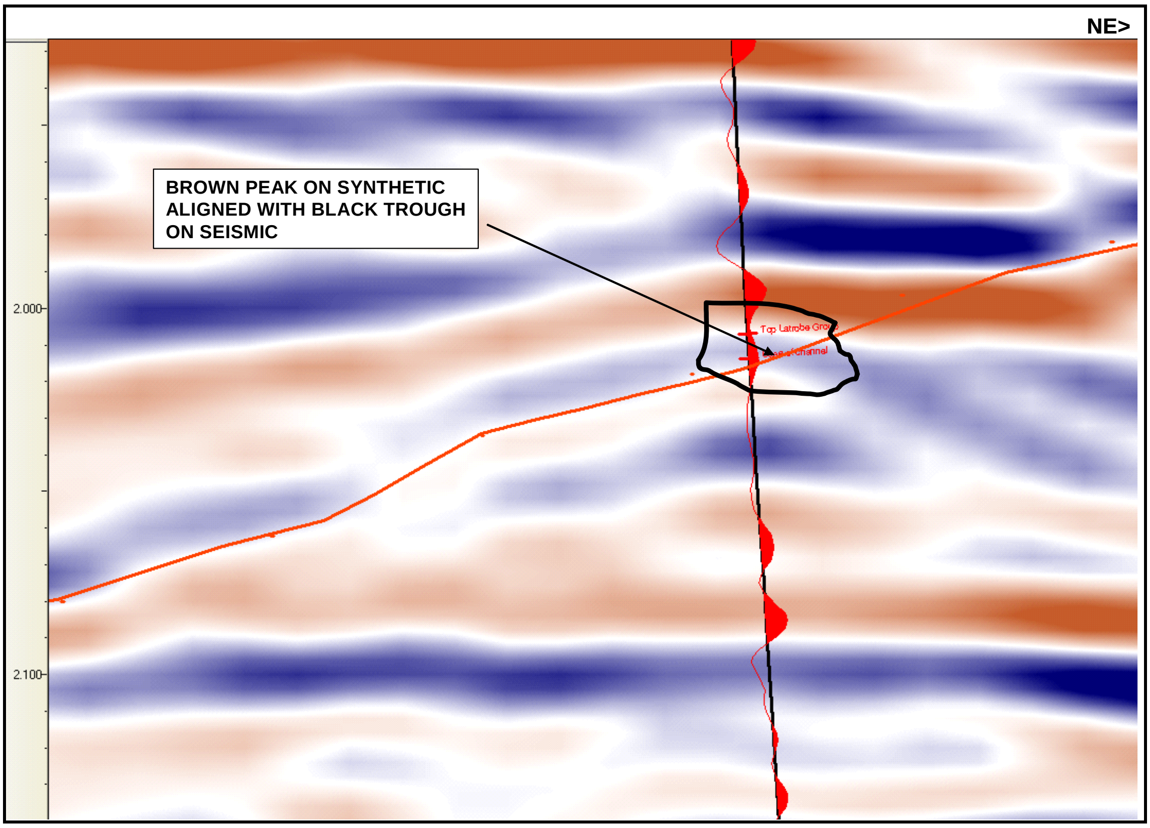

Figure 26: Volador 3D Inline-297 Top Latrobe 11msec deep mismatch.

TOP LATROBE PROGNOSIS=-2885m; TOP LATROBE ACTUAL=-2800; Total var = -85m
TOP LATROBE DEVIATED LOCATION PROGNOSIS -2871m; Error due to well deviation= -14m

CHECK SHOT SURVEY =1990MSEC (VERSUS 2018 SEISMIC) v=2000*2800/1990=2814m/sec
SYNTHETIC NEEDS +17MSEC SHIFT TO TIE SEISMIC (not predicted cf. Volador-1 and Great White-1)
SYNTHETIC MATCH WITH SEISMIC AFTER 17MSEC INDICATES TOL 2007msec (VERSUS 2018msec seis)

error due to time shift	**= -23m**
error due to pick/migration	**= -16m**
error due to velocity	**= -32m**

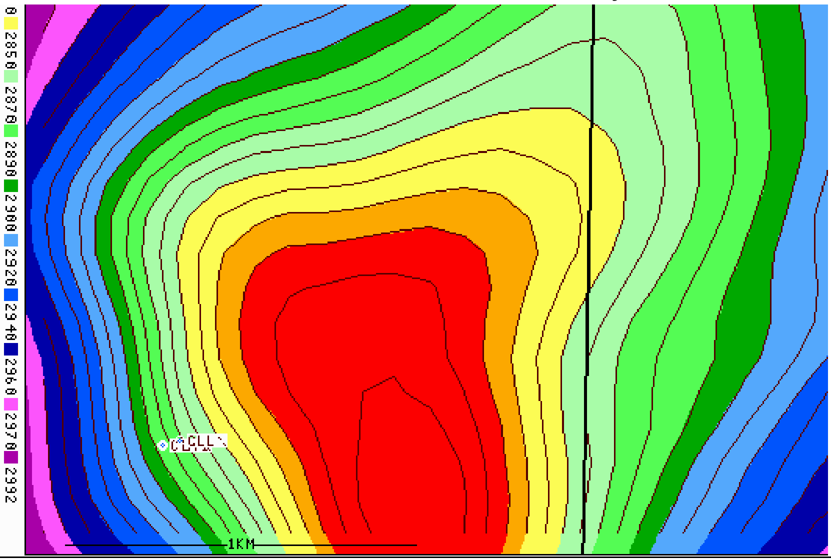

Figure 27: Breakdown of the depth prognosis errors for the Culverin-1 well result for the pre-drill Top Latrobe Depth Map.

BTFC PROGNOSIS=-2915m; BTFC ACTUAL=-2812; Total var = -103m
TOP LATROBE DEVIATED LOCATION PROGNOSIS –2906m; Error due to deviation = -9m

CHECK SHOT SURVEY =1997MSEC (VERSUS 2024 SEISMIC) v=2000*2812/1997=2816m/sec
SYNTHETIC NEEDS +17MSEC SHIFT TO TIE SEISMIC (not predicted cf Volador-1 and Great White-1
SYNTHETIC MATCH WITH SEISMIC AFTER 17MSEC INDICATES BTFC 2014 (VERSUS 2024)

error due to time shift	**= -23m**
error due to pick/migration	**= -15m**
error due to velocity	**= -56m**

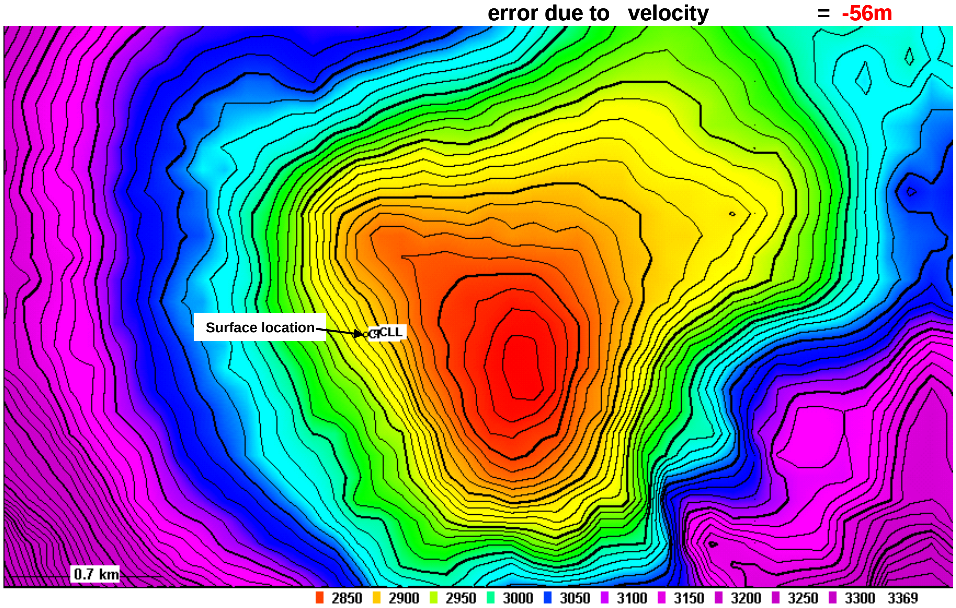

Figure 28: Breakdown of the depth prognosis errors for the Culverin-1 well result for the pre-drill Base Tuna-Flounder Depth Map.

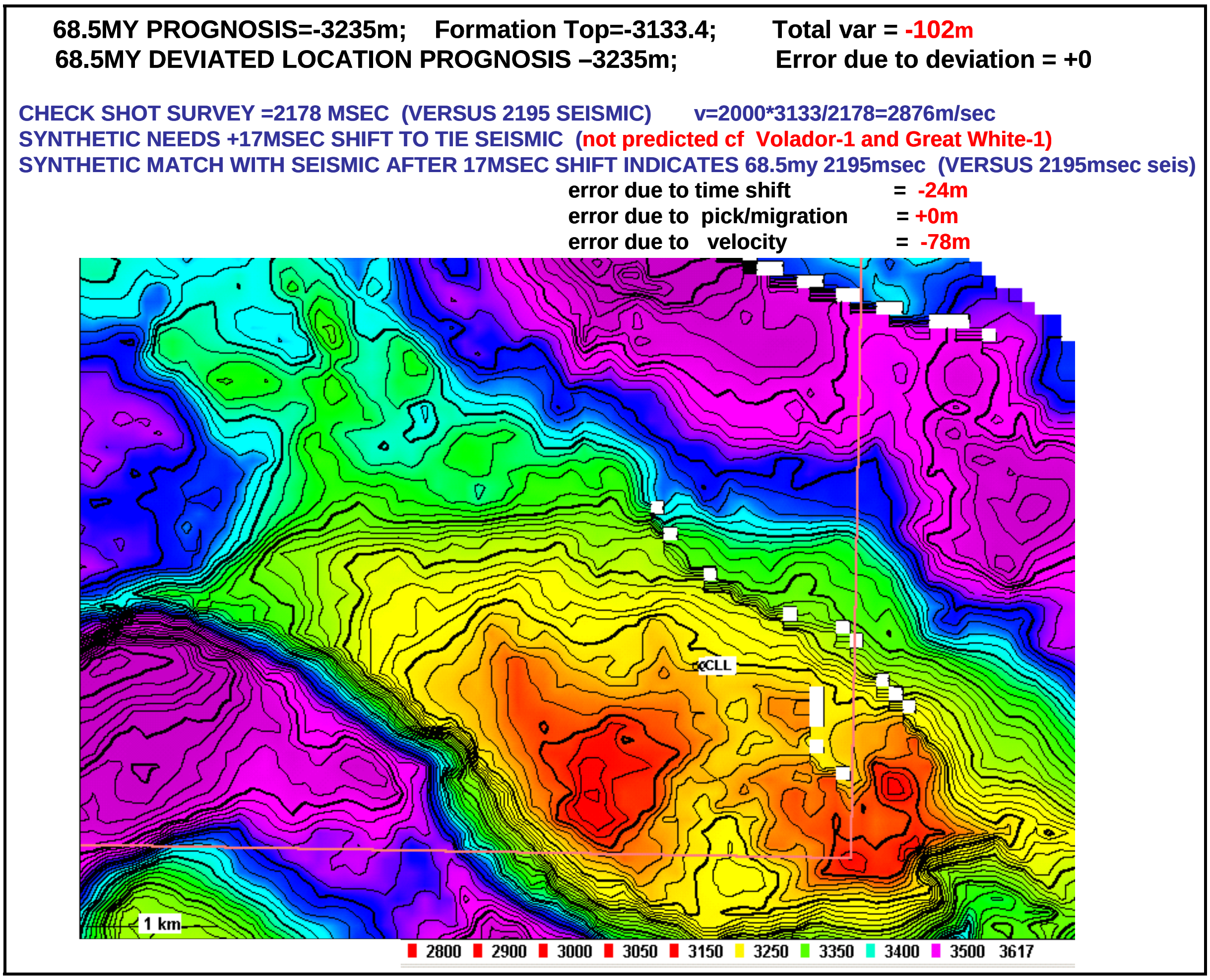

Figure 29: Breakdown of the depth prognosis errors for the Culverin-1 well result for the pre-drill 68.5 MY Marker Depth Map.

As a first pass analysis of the prognosis errors at the various seismic marker levels, the prognosis errors were distributed as a linear error in interval velocity between the seafloor and the mapped horizon. This resulted in increase in vertical relief at all levels;

Top Latrobe	80m -> 100m
Base Tuna Flounder Channel	160m -> 180m
68.5 MY Marker	220m - > 280m
70.3 MY Marker	120m -> 180m

As part of a more regional analysis of the area the depth conversion was re-done using two different methods: - a stacking velocity method similar to the original method and an interval velocity layer method using well interval velocities and depth of burial functions. Both methods are different to the original method in that they include Culverin-1 results as a significant control point. Depth Maps for the Top Latrobe, Base Tuna-Flounder Channel and an 80 my marker (deeper than the 68.5 Ma horizon presented in the Culverin/Scimitar prospect pre-drill maps) generated by each of these methods, are presented in APPENDIX 4.

Both of these depth conversion methods show the Culverin-1 well outside of closure at Top Latrobe and Base Tuna Flounder Channel levels, and reduced closure at the deeper level.

More work is required on the intermediate intra-formational levels to confirm the validity of the structure at the primary targets of the well.

6. CONCLUSIONS AND CONTRIBUTIONS TO GEOLOGICAL KNOWLEDGE

The most likely reasons why the Culverin-1 well did not encounter an economic hydrocarbon accumulation are:

The well was effectively located outside of four-way structural closure due to factors associated with depth conversion of seismic time mapping and, to a lesser extent, issues associated with the well location and the drilled well-path.

Hydrocarbon charge appears to have been limited due to ineffective access to mature, quality source either by vertical /cross-stratal migration or via lateral migration pathways. This is related to the quality/integrity of various sealing facies involved as either cap seal, base seal, fault seal or possibly some combination of these, and their impact on the formation of an effective trap configuration for the Culverin Prospect.

Contributions to geological knowledge:

1. The reservoir quality of the Late Cretaceous (*F.longus* palynological zone) interval penetrated by the well is similar to that in offset wells, with slightly reduced net to gross.
2. The well result increases confidence for the extension of potential reservoir facies based on interpretation of seismic sequence stratigraphy into the eastern region of the Gippsland Basin, which currently has limited well control.
3. The well has provided further control on the lithology and thickness of the Eocene channel-fill Flounder Formation in this area.
4. Stratigraphic data from this well provides another control point to assist with problematic seismic time-to-depth conversion processing in an area of steep and rugose water bottom topography combined with the progradational deposition and severely channelled Miocene Gippsland Limestone section.

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APPENDIX 1: CULVERIN-1 PALYNOLOGY REPORT

PALYNOLOGY OF

CULVERIN-1

GIPPSLAND BASIN, AUSTRALIA

by

ROGER MORGAN

Prepared for
NEXUS ENERGY LTD **March 2006**

REF: GIP.CULVERIN-1 REPORT

PALYNOLOGY OF

CULVERIN-1

GIPPSLAND BASIN, AUSTRALIA

CONTENTS **PAGE**

1 SUMMARY

2790/2820 m (cutts) – 2830/40 m (cutts) : *P. tuberculatus* Zone : Oligocene : offshore marine : immature

2840/50 m (cutts) : *L. balmei* Zone or older (probably *F. longus* Zone) : Paleocene or older (probably Maastrichtian) : ??offshore marine : marginally mature

2860/70 m (cutts) – 2950/60 m (cutts) : *F. longus* Zone, upper c subzone and *M. druggii* dinoflagellate Zone : Maastrichtian : nearshore or marginal marine : marginally mature

3090/3100 m (cutts) : *F. longus* Zone, upper a subzone : Maastrichtian : ?marginal marine : marginally mature

3140/50 m (cutts) – 3180/85 m (cutts) : *F. longus* Zone, lower c subzone : Maastrichtian : probably non-marine (marginal marine elements considered caved) : marginally mature

3220/25 m (cutts) – 3755/58 m (cutts) : *F. longus* Zone, lower a subzone (3220/25-3580/85 aii subzone, 3720/25-2755/58 ai subzone) : Maastrichtian : probably non-marine (marginal marine elements considered caved) : early mature for oil, marginally mature for gas/condensate

2 INTRODUCTION

Study is based on 16 cuttings samples submitted by Kevin Lanigan of Nexus Energy.

The basic zonation is that of Stover and Evans (1973) and Stover and Partridge (1973) as revised by Partridge (1976) and shown in Figure 1. This scheme was updated by Helby, Morgan and Partridge (1987) and further subdivisions proposed by Morgan (2004). Subdivision and extra correlative events in the *L. balmei* and *F. longus* Zones are somewhate tentative and currently under test. Note that the extra events suggest most upper/lower subzones can be further subdivided into a/b/c sub subzones.

Dinoflagellate zones were recognised in Angler-1 by Morgan (2002) and are shown on Figure 2. Discussion of these can be found in Morgan (2002) and they incorporate extensive new taxonomic work by Marshall (1988, 1990) and Roncaglia et. al (1999) and stratigraphic work by Morgan (1989, 2002) and Partridge (2002a, b). Only the *M. druggii* Zone is seen in Culverin-1.

Palaeoenvironmental assessments are based on specimen counts of 100 specimens, also providing a percentage content of all species. Criterea for the palaeo-environmental subdivisions are given on Table 1. In running text, rare = <1-3%, frequent = 4-10%, common = 11-30%, abundant = 31-50% and superabundant = 51-100%.

Confidence ratings include the factor of sample type, and distinctiveness of the fossil event, according to the scheme shown on Figure 3. This is the STRATDAT scheme used by Esso.

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

TABLE 1

SUMMARY OF PALYNOLOGICAL DATA : CULVERIN-1

DEPTH (m)	SAMPLE TYPE	MICROFOSSIL YIELD	PERCENTAGE				DIVERSITY *1		SPORE-POLLEN ZONE	CR *2	DINOFLAGELLATE ZONE	CR *2	ENVIRONMENT *3
			MICROPLANKTON			SPORE-POLLEN-	MICROPLANKTON	SPORE-POLLEN					
			DINOFLAG	SPINY AC.	FRESH ALGAE								
2790/2820	CUTTS	EX LOW	87	0	0	13	MODERATE	LOW	?P. TUBERCULATUS	D5	OPERCULODINIUM	D3	OFFSHORE MARINE
2820/2830	CUTTS	EX LOW	63	2	0	35	MODERATE	MODERATE	P. TUBERCULATUS	D3	OPERCULODINIUM	D3	SHELFAL MARINE
2830/2840	CUTTS	EX LOW	70	0	0	30	MODERATE	MODERATE	P. TUBERCULATUS	D3	OPERCULODINIUM	D3	OFFSHORE MARINE
2840/2850	CUTTS	LOW	(70)	0	0	30	MODERATE	MODERAT	L. BALMEI OR OLDER	D4			?OFFSHORE MARINE
2860/2870	CUTTS	MODERATE	(23)	1	3	73	MODERATE	MODERATE	F. LONGUS, UPPER c	D2	M. DRUGGII	D2	MARGINAL MARINE
2950/2960	CUTTS	EX LOW	(25)	2	0	75	LOW	MODERATE	F. LONGUS, UPPER c	D2	M. DRUGGII	D2	MARGINAL MARINE
2090/3100	CUTTS	LOW	(1)	0	2	97	EX LOW	HIGH	F. LONGUS, UPPER a	D1			?NON-MARINE
3140/3150	CUTTS	LOW	(2)	1	0	97	EX LOW	HIGH	F. LONGUS, UPPER c	D1			?NON-MARINE
3160/3165	CUTTS	LOW	0	0	0	100	NIL	HIGH	F. LONGUS, LOWER c	D1			NON-MARINE
3180/3185	CUTTS	LOW	(<1)	0	0	99+	(EX LOW)	HIGH	F. LONGUS, LOWER c	D1			?NON-MARINE
3220/3225	CUTTS	LOW	3	0	2	95	(EX LOW)	HIGH	F. LONGUS, LOWER aii	D2			?NON-MARINE
3330/3335	CUTTS	LOW	0	0	0	100	NIL	HIGH	F. LONGUS, LOWER aii	D1			NON-MARINE
3450/3455	CUTTS	LOW	0	0	0	100	NIL	HIGH	F. LONGUS, LOWER aii	D1			NON-MARINE
3580/3585	CUTTS	EX LOW	0	0	0	100	NIL	MODERATE	F. LONGUS, LOWER aii	D1			NON-MARINE
3720/3725	CUTTS	LOW	1	0	3	96	(EX LOW)	HIGH	F. LONGUS, LOWER ai	D2			?NON-MARINE
3755/3758	CUTTS	LOW	(<1)	(1)	3	94	(EX LOW)	HIGH	F. LONGUS, LOWER ai	D2			?NON-MARINE

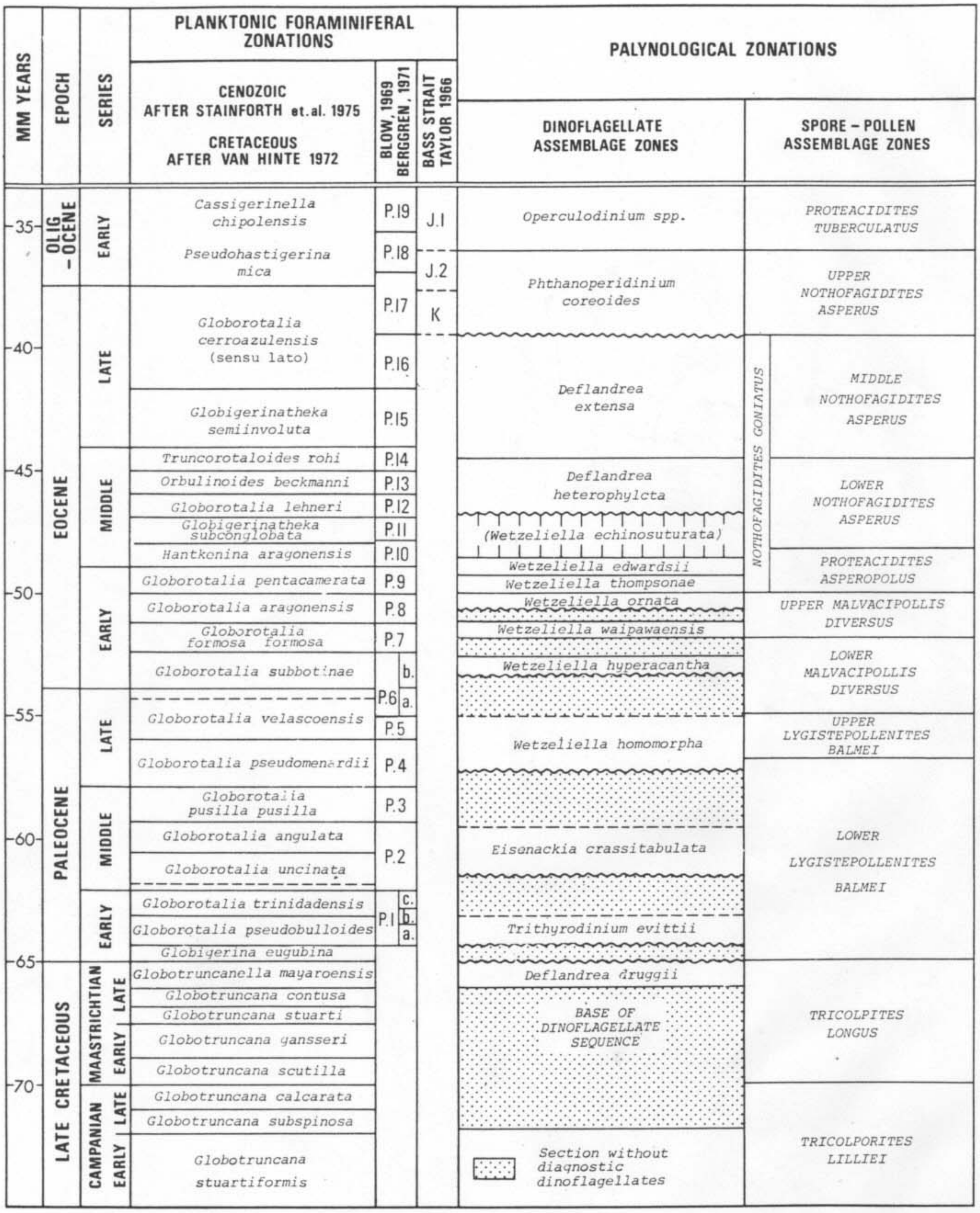
*1 DIVERSITY	
HIGH	20-29 SPECIES
MOD	10-19 SPECIES
LOW	5-9 SPECIES
EX LOW	1-4 SPECIES

*2 CONFIDENCE RATINGS	
A = Core	1 = Excellent Confidence High diversity with key species
Bp = Sidewall core (percussion)	
Br = Sidewall core (rotary/mechanical)	2 = Good Confidence Moderate diversity with key species
C = Coal cuttings	
D = Ditch cuttings	3 = Fair Confidence Low diversity with key species
E = Junk basket	
F = Miscellaneous/unknown	4 = Poor Confidence Moderate to high diversity without key species
G = Outcrop	
	5 = Very Low Confidence Low diversity without key species

*3 ENVIRONMENTS	DINOFLAGELLATE CONTENT%	DINOFLAGELLATE DIVERSITY	FRESHWATER ALGAE CONTENT%
OFFSHORE MARINE	67 to 100	VERY HIGH	LOW
SHELFAL MARINE	34 to 66	HIGH	“
NEARSHORE MARINE	11 to 33	MODERATE	“
VERY NEARSHORE MARINE	5 to 10	MODERATE-LOW	“
MARGINAL MARINE	<1 to 4	LOW-VERY LOW	“
BRACKISH	0, SPINY ACRITARCHS ONLY	EXTREMELY LOW	“
NON-MARINE (UNDIFF)	0, NO SPINY ACRITARCHS	NIL	LOW
NON-MARINE (LACUSTRINE)	0, NO SPINY ACRITARCHS	NIL	MODERATE 10%+

	LOG HORIZONS / PALYNOLOGY HORIZONS	Basker-1	Bignose-1	Culverin-1	Volador-1
top	Paleocene blocky sand = top *L. balmei* Zone in Basker-1, Bignose-1	2186	2596	-	-
top	Paleocene twin gamma peak = top *P. pyrophorum* in Bignose-1	2343	2667	-	-
	Paleocene *P. pyrophorum* gamma peak = *P. pyrophorum* acme in Basker-1	2452	2735	-	-
	Paleocene *T. evittii* shale gamma peak (mfs) = *T. evittii* acme in Basker-1, Bignose-1	2485	2752	-	-
top	Maastrichtian interbedded shale (s.b.) = top *F. longus* Zone, upper c subzone, and top *M. conorata* in Basker-1, Bignose-1	2500	2802	-	3025 (truncated)
top	Maastrichtian coarsening sequence	2610	2925	2837	3035
	M. druggii shale gamma peak (mfs) = *M.conorata* acme in Basker-1, Culverin-1, Volador-1	2667	2982	2955	3120
	intra massive sand gamma peak =top *F. longus* Zone, upper a subzone in Culverin-1	2782	3100	3098	3310
base	massive sand =top *F. longus* Zone, lower c subzone in Culverin-1	2798	3105	3157	3355
base	sand fining sequence (sb) = top *F. longus* Zone, lower aii subzone in Culverin- 1	2872	3143	3210	3450
	gamma peak (?mfs) (=top spiky sonic)	2915	3275	3310	3590
base	sand fining sequence (?sb)	3035	3362	3397	3800
top	upper massive shale	3197	3450	3510	4020
top	lower massive shale	3245	3507	3550	4110
	gamma peak (?mfs)	3260	3517	3573	4125
top	upper coarsening sequence = top *F. longus* Zone, lower ai subzone in Culverin- 1	3285	3535	3607	4153
top	lower coarsening sequence	3345	3618	3646	4190
base	lower coarsening sequence	3390	3642	3662	4237
base	sand fining sequence (?sb) (= top flat sonic) = base *F. longus* Zone in Culverin-1, Volador-1 = close above top *T. lilliei* Zone in Volador-1	3552	3790	3735	4405

TABLE 2 VOLADOR FORMATION LOG HORIZONS :
BASKER-1, BIGNOSE-1, CULVERIN-1, VOLADOR-1



FGURE 1 TERTIARY ZONATION SCHEME (Partridge 1976)

SPORE-POLLEN EVENTS	SPORE-POLLEN SUBZONES		DINOFLAGELLATE EVENTS	DINOFLAGEL-LATE SUBZONES	DINOFLAGELLATE SUBZONE (SENSU PARTRIDGE)
base *P. grandis* *	Upper *L. balmei*			*A. hyperacanthum*	
top *I. "antipoda"*		c			
top frequent *A. obscurus*		b	top *E. crassitabulata*	*E. crassitabulata*	
base frequent *A. obscurus*	Lower *L. balmei*		base *E. crassitabulata*		
base common *L. balmei*					
base *I. "antipoda"*		a	top *T. evittii*	*T. evittii*	
top consistent *G. rudata*			base *T. evittii*		
top *T. confessus* *			top *M. conorata*	*M. druggii*	
top *T. verrucosus*		c	base *M. conorata*		
top *T. sectilis, T. lilliei, F. longus*					
top frequent *G. rudata*	Upper *F. longus*				
top common *A. obscurus*		b			
base common *A. obscurus*					
base *G. rudata* > *N. endurus*		a			
base *S. puncatus*					
top common *N. endurus* *		c			
base common *G. rudata* **					
	Lower *F. longus*	b			
top *T. "megasectilis"* **					
base *T. "megasectilis"*		a			
1. base *F. longus* *					
2. base *T. verrucosus* *					
3. base *T. waipawaensis*		b			
4. top *F. sabulosus*					
5. more consistent *F. sabulosus* **					
	Upper *T. lilliei*		6. consistent dinoflagellates *		
		a	7. freq/common dinoflagellates		
			8. top *I. marshallii*	Upper *I. marshallii*	
			9. base *C. bretonica*		
10. *N. endurus* influx *		c			
			11. top common *I. marshallii* *	Middle *I. marshallii*	
12. top consist/frequent *F. sabulosus* **		b			*V. spinulosa*
	Lower *T. lilliei*		13. base common *I. marshallii* *		
14. top *G. rudata* increase **					
		a	15. base *I. marshallii*		
16. base *B. sectilis* *				Lower *I. marshallii*	
17. base *T. lilliei* *					
			18. base *V. spinulosa*		
		b	19. top frequent *I. variabile*		
			20. top *T. suspectum* *	Upper *I. variabile*	
21. top frequent *F. sabulosus* **	Upper *N. senectus*				
			22. top common *I. variabile* *	Middle *I. variabile*	
		a	23. top *Nelsoniella* spp. *		*T. suspectum*
			24. top frequent *Chatangiella* spp.	Lower *I. variabile*	
25. base *G. rudata* *					
26. base frequent *Nothofagidites* **		c			
27. base frequent *F. sabulosus* **	Lower *N. senectus*	b			
			28. top common *C. arvensis* *	*C. arvensis*	*C. arvensis*
		a	29. base common *C. arvensis* *		
30. base consist *Nothofagidites* *					
31. base *F. sabulosus*				*I. ponticum*	*I. ponticum*
			32. top common *I. ponticum*		
	Upper *T. apoxyexinus*		33. base *T. suspectum*		
			34. top common *C. porosa* *	*C. porosa*	*C. porosa*
			35. base common *C. porosa*		
36. base frequent *Proteacidites* *					
	lower *T. apoxyexinus*				
base *T. gillii**					
37. base *C. ohaiensis, Proteacidites*spp.					

FIGURE 2 DETAILED SUBZONATION SUMMARY (MORGAN 2004)

Single Asterisk * shows defining event for upper/lower subzone
Double Asterisk ** shows defining event for a/b/c sub-subzones

FIGURE 3 MATURITY PROFILE : CULVERIN-1

3 PALYNOSTRATIGRAPHY

3.1 2790/2820 m (cutts) – 3830/40 m (cutts) : *P. tuberculatus* Zone

These samples are all extremely lean with very rare palynomorphs. Foraminifera or nannofossils might produce more definitive ages. Amongst the rare palynomorphs, dinoflagellates are dominant and include frequent *Operculodinium* spp. without older markers, suggesting the *Operculodinium* spp. Zone of Partridge (1976) and the correlative *P. tuberculatus* spore pollen Zone. Other frequent dinoflagellates include *Cordosphaeridium multispinosum, Spiniferites ramosus* and *Systematophora placacantha.* Rare elements in a non-descript assemblage include *Apteodinium australiense* and *Nematosphaeropsis balcombiana*.

Spores and pollen are rare and include *Cyatheacidites annulatus* without younger markers, indicating the *P. tubercuatus* Zone. Other taxa include *Cyathidites minor, Dilwynites granulatus, Falcisporites similis, Nothofagidites emarcidus, Nothofagidites falcata* and *Phyllocladidites mawsonii*.

Offshore marine environments are indicated by the dominance of dinoflagellate in these lean assemblages.

Yellow spore colours indicate immaturity for hydrocarbons.

The absence of older markers (which were expected in the lower two samples) is probably due to unsuitable lithologies for palynomorph preservation. Other possible causes include masking by caving, and cuttings samples being off depth. Sidewall cores would have helped.

3.2 2840/50 m (cutts) : *L. balmei* Zone or older (probably *F. longus* Zone)

This sample is very similar to those above, being very lean with non-descript dinoflagellates dominant amongst the palynomorphs. However, a single *Gambierina rudata* occurs here indicating the *L. balmei* Zone or older. *G. rudata* very rare and intermittent in the *L. balmei* Zone, but consistent to frequent in the *F. longus* Zone. Thus, although this sample may belong to the *L. balmei* Zone, the *F. longus* Zone is more likely. Unfortunately, the sample is too lean to be definitive. Sidewall cores would have helped.

Amongst the dominant dinoflagellates are frequent *Operculodinium* spp. and *Spiniferites ramosus*, but are probably all caved. Amongst the spores and pollen are frequent *F. similis* and rare elements include *G. rudata* (single specimen), *Peninsulapollis gillii* and *P. mawsonii*.

Environments appear to be offshore marine due to the dominance of dinoflagellates, but are probably not, as most of the assemblage appears to be caved.

Light brown spore colours suggest marginal maturity for oil but immaturity for gas/condensate.

The absence of a more definitive older assemblage appears to be due to unfavourable lithology (despite an encouraging log response). Other contributing causes may be masking by caving and the possibility of the cuttings being off depth. Sidewall cores would have helped.

3.3 2860/70 m (cutts) – 2950/60 m (cutts) : *F. longus* Zone, upper c subzone and *M. druggii* dinoflagellate Zone

Assignment is indicated by the presence of *Manumiella conorata* in both samples. Dinoflagellates are minor, but include frequent *S. ramosus* and rare *M. conorata* considered in place, and other elements (*Cerebrocysta* sp., *Operculodinium* spp.) considered caved from the Lakes Entrance Formation above.

Palynomorphs are rare amongst the abundant plant debris. Spores and pollen include common *Cyathidites minor* and frequent *Cyathidites australis, Dilwynites granulatus, F. similis, Gleicheniidites* spp., *Microcachryidites antarcticus* and *P. mawsonii*. Rare elements include *G. rudata, Lygistepollenites balmei* and *Nothofagidits endurus*. Zone diagnostic spore-pollen taxa are not seen.

Nearshore marine environments are suggested by the dominant spores and pollen and subordinant dinoflagellates. However, some of the frequent *S. ramosus* may be caved, and marginal marine or very nearshore marine environments may be more accurate.

Light brown spore colours suggest marginal maturity for oil but immaturity for gas/condensate.

This assemblage is distinctive and usually seen in the Kate Shale of Bernecker and Partridge (2001), and equivalents.

3.4 3090/3100 m (cutts) : *F. longus* Zone, upper a subzone

Subzonal assignment is indicated at the top by *F. longus, Tricolpites confessus* and *Quadraplanus brossus*, and at the base by the base of section where *G. rudata* clearly outnumbers *N. endurus*. *Stereisporites punctatus* (the supporting marker for base *F. longus* upper subzone) was not seen. The sub-subzone (a) is indicated by common *G. rudata* in the absence of frequent *Australopollis obscurus*.

A single dinoflagellate (*S. ramosus*) was seen and may suggest marginal marine influence, but might also be caved.

Spores and pollen are dominant and include common *C. minor, F. similis, G. rudata, P. mawsonii* and *Proteacidites* spp., and frequent *Ceratosporites equalis, Cyathidites splendens, M. antarcticus, N. endurus* and *Retitriletes austroclavatidites*. Rare elements include *F. longus, P. gillii, Q. brossus* and *T. confessus*.

Marginal marine environments are suggested by the single dinoflagellate specimen amongst the dominant and diverse spores and pollen, but that specimen may be caved into non-marine fluvial or floodplain environments (abundant saccate pollen with subordinant miospores).

Light brown spore colours suggest marginal maturity for oil but immaturity for gas/condensate.

This assemblage is normally seen in the upper Volador Formation and equivalents.

3.5 3140/50 m (cutts) – 3180/85 m (cutts) : *F. longus* Zone, lower c subzone

Assignment is indicated at the top by the top of frequent *N. endurus* (equally as common as *G. rudata*) and at the base by the base of common *G. rudata*. Common are *C. minor, F. similis, P. mawsonii* and *Proteacidites* spp. with frequent *Araucariacites australis, G. rudata, Laevigatosporites ovatus, M. antarcticus, N. endurus* and *Vitreisporites pallidus*. Rare elements include *Battenipollis sectilis, F. longus, L. balmei, Q. brossus, Tetracolporites verrucosus* and *Tubulifloridites lilliei*.

Extremely rare dinoflagellates (*A. australiense, Cerebrocysta* sp., *Operculodinium* spp. and *S. ramosus*) and a single microforaminifera are considered caved, but some might be in place.

Non-marine environments are therefore considered most likely, but marginal margine environments at 3140/50 m (microforaminifera) cannot be excluded.

Light brown spore colours suggest marginal maturity for oil but immaturity for gas/condensate.

This assemblage is normally seen in the Volador Formation and equivalents.

3.6 3220/25 m (cutts) – 3755/58 m (cutts) : *F. longus* Zone, lower a subzone

Assignment is indicated at the top on youngest *Battenipollis "megasectilis"* and at the base on oldest *T. verrucosus* and the absence of older markers. Subdivision of this subzone is possible into an upper interval (aii subzone herein at 3220/25 m – 3580/85 m) containing *B. "megasectilis"* and a lower interval (ai subzone at 3720/25 m – 3755/58 m) lacking it. Common are *C. minor, F. similis, L. ovatus* and *P. mawsonii* with frequent *A. australis, D. granulatus, M. antarcticus, N. endurus, Proteacidites* spp. and *V. pallidus.* Rare elements include *Battenipollis sectilis, B. "megasectilis"* (3220/25 m to 3580/85 m), *F. longus, G. rudata, P. gillii, T. verrucosus, T. confessus, T. waiparaensis* and *T. lilliei*.

Dinoflagellates (*S. ramosus*) and microforams are rare components of several assemblages, but may be entirely caved.

Non-marine environments are most likely, assuming the trace dinoflagellates are all caved, amongst the diverse spores and pollen. Trace dinoflagellates are present at 3220/25 m, 3720/25 m and 3755/58 m.

Light brown to mid brown elements suggest early maturity for oil and marginal maturity for gas/condensate.

This assemblage is normally seen in the Volador Formation and equivalents.

4 CORRELATIONS

Nearby wells with palynology include Basker-1 (Van Neil 1983a), Bignose-1 (Van Neil 1983b) and Volador-1 (Van Neil 1983c and Partridge 2003). These data are broadly spaced, not quantitative and badly dated. They are not sufficiently detailed to recognise the new detailed subzones. Correlation is mostly using the events mentioned in the text of these reports, and is poorly constrained. The suggested log correlations are the reponsibilty of Roger Morgan (not Nexus) and are summarised in Table 2.

The Lakes Entrance Formation is continuous in all wells, overlying the older section.

Thin Early Eocene marine Latrobe Group shales are present in Basker-1, Bignose-1 and Volador-1. Logs suggest a 10 m section may be present in Culverin-1, but there is no palynology support (even as cavings) of this distinctive section deeper in the section.

The Paleocene Latrobe Group is thickest and most complete in Basker-1 with mostly massive blocky sands and a thin marine shale (*T. evittii* shale) at or near the base. This section is partly truncated in Bignose-1 and absent from Culverin-1 and Volador-1. The *T. evittii* shale contains a distinctive acme of *Trithyrodinium evittii* and is part of the Kate Shale of Bernecker and Partridge (2001). Palynology control is available in Basker-1 and Bignose-1. It represents a marine high stand with the highest gamma, probably the mfs. The abrupt base of the upward fining sequence below represents the base Tertiary sequence boundary.

The Maastrichtian Latrobe Group (= Volador Formation) contains some distinctive log features at the top, but they are less distinctive deeper in the section.

At the top is about 100 m of interbedded mostly shale with a very jagged gamma response underlain by a strong upward coarsening sequence about 75 m thick. The interval contains the *M. druggii* Dinoflagellate Zone and the *F. longus* Spore-pollen Zone, upper c subzone. Palynology control is available in Basker-1 and Bignose-1. The shales in this interval would probably also be part of the marine Kate Shale of Bernecker and Partridge (2001), and the shale gamma maximum at the base of the coarsening sequence is a marine mfs, with the rest of the sequence comprising a HST. The actual shale interval could be called the "*M. druggii* shale". Palynology control is available in Basker-1, Culverin-1 and Volador-1. This whole interval is complete in Basker-1 and Bignose-1, but is strongly truncated with only the coarsening upward sequence present in Culverin-1 and Volador-1.

Beneath is about 200 m of mostly massive blocky sand, with a short upward fining sequence into the "*M. druggii* shale" at the top. The interval is mostly blocky sand in Culverin-1 and Volador-1, but has become significantly shaley in Basker-1 and Bignose-1. About three quarters of the way down this interval is a gamma maximum with a coarsening sequence above. At the base is massive sand in Culverin-1 and Volador-1, but this horizon is more subtle in Basker-1 and Bignose-1. This interval contains the balance of the upper *F. longus* Zone (subzones a and b) and is palynologically controlled in detail only in Culverin-1. The blocky sands are unfavourable lithology for palynology.

Beneath is a thin (50-90 m) interval of mostly spiky gamma shale with a basal, upward-fining sand. The base of the sand is abrupt and may be a parasequence sequence boundary. Oldest frequent *G. rudata* corresponds to this horizon (controlled in Bignose-1, Culverin-1 and Volador-1), and the interval contains the *F. longus* Zone, lower c subzone (controlled in detail only in Culverin-1).

Beneath is about a 220 m interval of mostly spiky gamma shale, again with a set of upward-fining sands at the base. The base of the sand is abrupt and has a corresponding high sonic spike suggesting cementation, and may be a sequence boundary. In Culverin-1, this contains the upper part of the *F. longus* Zone, lower aii subzone.

Beneath is a 300-600m interval again of mostly spiky gamma shale with a basal set of upward fining sands. Again, the base of the sand is abrupt with a high sonic peak, suggesting cementation on a sequence or parasequence boundary. The entire interval shows a distinctive spiky sonic response, easily the spikiest part of the Volador Formation, with most spikes showing thin bands of low response. Within this thick interval, about half way down, are two intervals of fairly massive shale, with the lower one containing the highest gamma spike for the entire interval (?mfs) and a fining upward tendency. Immediately beneath these two shales are two coarsening upward intervals. In Basker-1, the upper one is massive sand and the lower one is low gamma massive volcanics. In Bignose-1, they are interbedded shales and thin sands. In Culverin-1 and Volador-1, they are spiky shales. Beneath is 50-100m of massive shales (containing two distinctive low sonic spikes, one near the top and one near the base), passing downwards into the basal set of sands. In Basker-1, these are massive low gamma volcanics, but in the other wells they remain thin sands in a spiky gamma shale. In Culverin-1, the entire interval contains the lower part of the *F. longus* Zone, lower aii subzone (down to the two massive sales) and the *F. longus* Zone, lower ai subzone (down to the base of the interval). The lower quality palynology data from the other wells is consistent, but not as precise. Van Neil (1983a,b) reports an increase in *Nothofagidites* at 3237m in Basker-1 and 3470m in Bignose-1 (which he calls top *T. lilliei* Zone, inconsistent with current usage). In both wells this is close to the two massive shales described above and the event supports the correlation herein.

Culverin-1 did not drill past this point, and the log panel supplied does not extend significantly below, although Basker-1 extends 400m deeper, Bignose extends 180m deeper and Volador-1 extends 200m deeper. The Bignose-1 logs indicate a 130m cycle comprising an upper massive shale (gamma peak at 3835m) and a lower fairly massive but upward fining sand below. Both units have a distinctive very flat sonic reponse. The Volador-1 data of Partridge (2003) suggests that this interval contains the *T. lilliei* Zone. Top *F. sabulosus* (3630m in Basker-1 and 3993m in Bignose-1) is consistent with that assignment, although its occurence in Volador-1 (4290m) seems a little higher against the log correlation. Given the sample intervals and the vintage of the data, the difference is probably not significant. Restudy of Basker-1 and Bignose-1 would produce a more consistent data set.

5 CONCLUSIONS

5.1 The existing Culverin-1 palynology, when combined with the logs, is sufficient to establish the correlation with reasonable confidence. That is;

- Culverin-1 TD correlates to about 200m above Volador-1 TD (ties to about 4400m in Volador-1).
- The Volador-1 section shows a uniform doubling of section thickness relative to Culverin-1, but no significant amount of section appears to be missing.

However, the Culverin-1 sampling is quite broad in some intervals, and could be infilled.

5.2 The new Gippsland subzones can be identified in Culverin-1, and precision is now much higher than in the surrounding wells.

Restudy of Basker-1, Bignose-1 and Volador-1 using existing slide sets (if they can be located), remounts from existing residues (if they can be located), and some new processing from infill cuttings would greatly increase confidence in the suggested correlations, which are only loosely constained by the existing palynology, especially towards the base.

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Well Name : CULVERIN-1

Operator : NEXUS ENERGY

Interval : 2800m - 3778m

Scale : 1:5000

Chart date: 03 April 2006

Palynological Data Chart : INTERPRETIVE DATA

% Abundance histogram : Highest occurrence

Roger Morgan

CULVERIN-1

Morgan Palaeo Associates

Maitland, South Australia

Enclosure 1

Sampling

Cutting

Core

Sidewall core

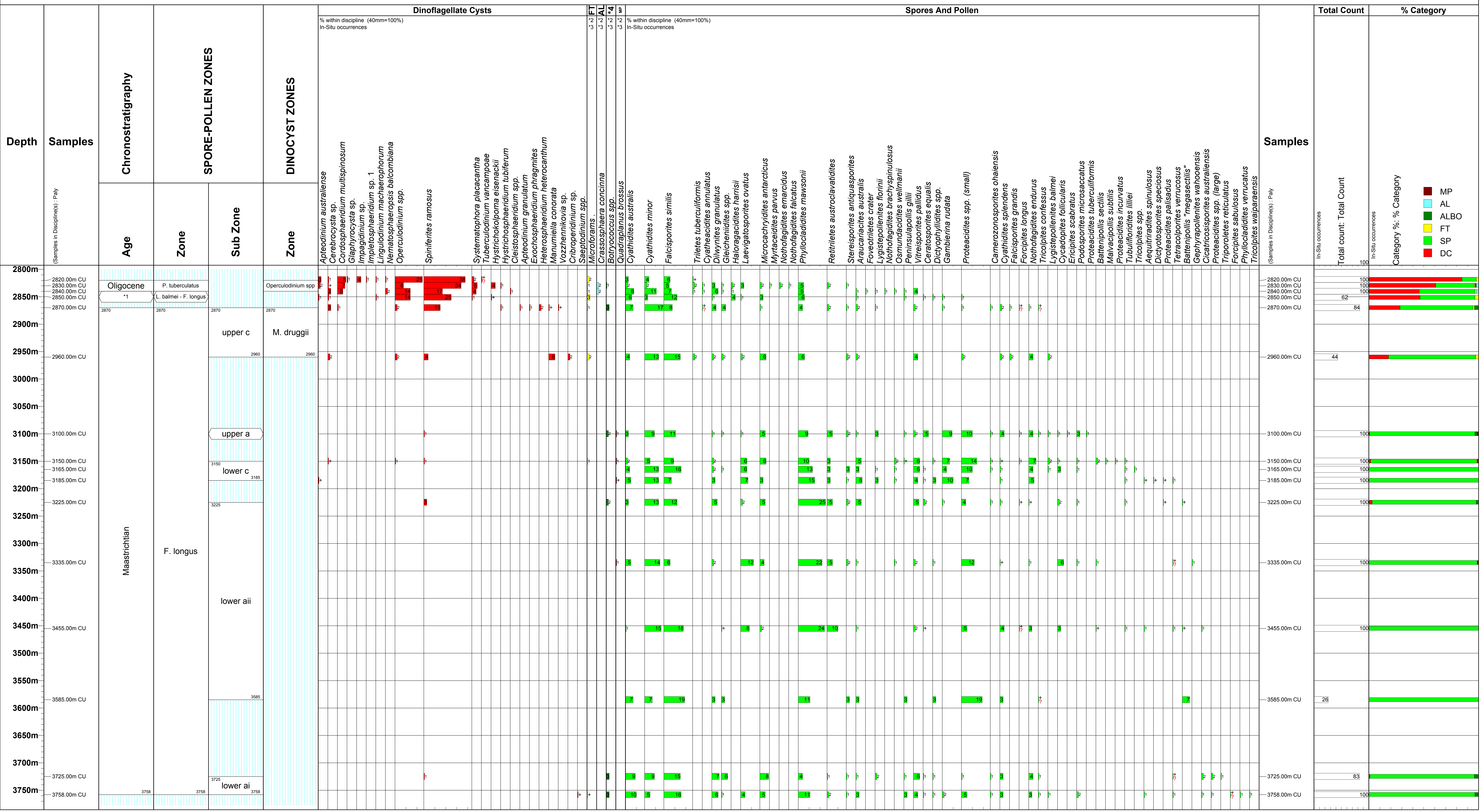
Text Keys

*1 Paleocene - Maastrichtian

*2 % within discipline (40mm=100%)

*3 In-Situ occurrences

*4 ALBO



APPENDIX 2: GEOCHEMISTRY REPORT

GEOCHEMISTRY REPORT

CULVERIN-1 WELL

VIC/P56
Gippsland Basin
Victoria

By

John K. Emmett

Nexus Energy Ltd

November 2006

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Introduction

A suite of cuttings samples from the Latrobe Group section in the Culverin-1 well was seleceted for evaluation of source rock quality and thermal maturity level, and for oil show solvent extract geochemical analyses. Samples were selected based on electric log characteristics.

Delta Log R analysis (Passey *et al.*, 1990) was performed to identify organic-rich strata more suitable for geochemical analysis (Figure 1).

Seven cuttings samples from the Latrobe Group section were selected for total organic carbon (TOC) and Rock-Eval pyrolysis analyses. These analyses as well as subsequent solvent extraction, liquid chromatography separation of the extract and gas chromatography of the hydrocarbon fraction for two selected samples, were performed by GEOTECH in Perth, Western Australia.

Six cuttings samples from the Latrobe Group were analysed for vitrinite reflectance, description of maceral composition and abundance, including liptinite fluorescence, by Keiraville Konsultants.

Results and Discussion

Total Organic Carbon (TOC) and Rock-Eval Pyrolysis

TOC and Rock-Eval pyrolysis results are presented in Table 1. The seven samples analysed showed signs of glycol drilling fluid contamination, and required removal of glycol by a water extraction process prior to analysis. Figure 2 shows the sequence stratigraphic location of analysed samples, and results of TOC %, hydrocarbon potential (S1+S2 mg HC/g TOC), Hydrogen Index determinations. All samples are from the *F. longus* palynozone of the Latrobe Group.

In Figure 3 Rock-Eval hydrocarbon source potential (S1+S2) is plotted against sample organic richness (TOC. %) Unfortunately, it is anticipated that S1 values have most likely been reduced by the water extraction process employed to remove drilling fluid contamination. Organic richness and associated hydrocarbon source potential, are rated as moderate to very good for the four deeper samples, but only fair to poor for the three shallower samples. Figure 4 (Rock-Eval HI vs Tmax: Source Matuation Plot) indicates that the samples analysed are immature to early mature for effective hydrocarbon generation.

Vitrinite Reflectance and Organic Petrography

Table 2 shows the results of vitrinite reflectance measurements and brief description of maceral abundances, liptinite fluorescence, mineral fluoescence and inertinite reflectance determinations. Vitrinite reflectance is plotted with depth in Figure 5.

Overall, vitrinite reflectance steadily increases with depth, but all samples would be regarded as being immature for effective hydrocarbon generation The deepest sample (close to well TD) has a mean vitrinite reflectance value of 0.64, which indicates the Latrobe Group section is approaching the top of the oil generation window, generally regarded as beginning at vitrinite reflectance values in the 0.65 – 0.7 range.

Observation of “rare to sparse oil drops” for this sample is also consistent wiith a very early oil mature section at TD.

The gradient of the vitrinite reflectance vs depth profile for Culverin-1 is comparatively similar to that of offset wells, although the indicative magnitude of heatflow experienced at the Culverin-1 well location, is generally lower than that indicated by vitrinite reflectance profiles in offset wells.

Details and histograms of vitrinite reflectance measurements for each sample are presented in Appendix 1 of this report.

Solvent Extract Analyses

The presence of a thin oil zone between 3607-3609.3 m MD in Culverin-1, was interpreted based on Reserval gas abundance data, cuttings fluorescence and cut observations, and reservoir porosity and hydrocarbon saturation parameters derived from wire line log responses. After much consideration with regard to the minimum economic oil pool size associated with this oil zone, it was decided not to test this interval.

In order to determine the quality of the oil show identified on logs, solvent extraction, liquid chromatography and gas chromatography geochemical analysis were performed on cuttings from 3605–3610 m MD. These same analyses were also performed on source rock shale cuttings from 3750-3755 m MD, with a view to establishing the composition of a “typical” source rock extract, to be compared with the signature associated with possible migrant oil show hydrocarbons.

Table 3, Table 4 and Table 5 show the solvent extraction data obtained from the two cuttings samples analysed. The amount of total extract ppm, and extract hydrocarbon fraction (ppm) is plotted against TOC richness in Figure 6. As shown in Figure 6, taking TOC richness into consideration, the total extract from the sandy cuttings interval spanning the interpreted oil zone is significantly higher than that for the shaley source rock interval, which could be interpreted to indicate the presence of non-indigenous or migrant hydrocarbons.

The saturate fraction gas chromatograms obtained from the solvent extracts from both cuttings samples are shown in Figure 7. These chromatograms are somewhat similar in appearance, and show hydrocarbon distributions typical of immature to early mature terrigenous source rock extracts. This is indicated by distinct high molecular weight (n-C23 plus)/waxy n-alkane odd-over-even predominance and high pristane/n-C17 alkane ratios. There is no clear indication that the extract from the interpreted oil zone represents a relatively more mature “oil-like” hydrocarbon distribution, which would be expected and most likely be obvious if it was a zone of migrant oil accumulation. However in view of other evidence indicating the presence of an oil zone between 3607-3609.3 m MD, the relatively reduced odd-even predominance and lower pristane/n-C17 ratio in the 3605-3610m sample compared to the deeper 3750-3755m sample, may be supportive of subtle mixing of a more mature “oily” component (presumably locally soourced), over-printing the base indigenous “source rock” extract hydrocarbon signature.

Figure 8 shows comparison of the Culverin-1 solvent extracted cuttings samples saturate hydrocarbon signatures with a similarly situated solvent extracted source rock sample from the Volador-1 well situated southwest of Culverin-1. The hydrocarbon distribution of a tested whole oil from Volador-1 is also shown in Figure 8. In light of the Volador-1 hydrocarbon signatures, the presence of some migrant oil component for the 3605–3610 m MD sample remains contentious.

Summary Conclusions

Good to very good quality hydrocarbon source rock carbonaceous shales and coals were penetrated in the *F. longus* palynozone sediments of the Latrobe Group in Culverin-1.

The Latrobe Group sediments are immature for effective hydrocarbon generation.

At Total Depth (3759.7 m MD) in Culverin-1, the Latrobe Group sediments are very close to the top of the effective oil generation window. The magnitude of heatflow at the Culverin-1 location is relatively lower than that of offset wells, based on observed vitrinite reflectance profiles.

The hydrocarbon distribution obtained from solvent extracted cuttings spanning an interpreted oil zone in Culverin-1, is most likely associated with indeginous organic matter, although there are very subtle indicators of possible blending with more mature exotic hydrocarbons, most probably locally sourced.

Table 1: Culverin-1 Well: Rock-Eval Pyrolysis Analysis

ANALYSIS OF ORGANIC MATTER BY ROCK-EVAL PYROLYSIS

CLUVERIN-1

Depth (m)		*Tmax*	*S1*	*S2*	*S3*	*S1+S2*	*S2/S3*	*PI*	*TOC*	*HI*	OI
2940-2950	Ctgs	418	0.34	1.39	1.34	1.73	1.04	0.20	1.55	90	86
3175-3180	Ctgs	429	0.33	3.05	1.01	3.38	3.02	0.10	1.40	218	72
3370-3375	Ctgs	435	0.34	1.50	1.36	1.84	1.10	0.18	1.09	138	125
3465-3470	Ctgs	434	0.60	3.52	1.50	4.12	2.35	0.15	2.12	166	71
3585-3590	Ctgs	431	1.18	6.91	2.21	8.09	3.13	0.15	3.57	194	62
3605-3610	Ctgs	433	1.53	7.17	1.26	8.70	5.69	0.18	3.54	203	36
3750-3755	Ctgs	433	1.24	8.88	2.02	10.12	4.40	0.12	4.09	217	49

A TMAX value is not reported if the S2 is <0.2mg/g

TMAX = Max. temperature S2 (^oC)

S1 = Volatile hydrocarbons (HC) (mg/g rock)

S2 = HC generating potential (mg/g rock)

S1+S2 = Potential yield (mg/g rock)

S3 = Organic carbon dioxide (mg/g rock)

PI = Production index

OI = Oxygen Index

TOC = Total organic carbon (wt % of rock)

HI = Hydrogen index

nd = no data

GEOTECHNICAL SERVICES PTY LTD

Table 2 Culverin-1: Vitrinite Reflectance and Organic Petrography

KK # Ref #.	Depth (m)	$R_v$max Mean	Range	SD	N	Sample description including liptinite fluorescence maceral abundances, mineral fluorescence
L0741	2940-2950	0.52	0.44-0.62	0.053	25	Sparse sporinite and rare liptodetrinite yellow to dull orange, rare cutinite orange, rare resinite greenish yellow. (Siltstone>sandstone> claystone=carbonate. Dom common, I>V>L. Inertinite common, vitrinite and liptinite sparse. Mineral fluorescence weak orange. Iron oxides rare. Pyrite common.)
Ctgs	$\overline{R}_I$max	1.25	0.94-1.88	0.264	10	
L0742	3175-3080	0.48	0.40-0.54	0.042	25	Rare sporinite and liptodetrinite yellow to dull orange, rare cutinite orange. (Sandstone>siltstone>>coal>shaly coal. Coal rare, V, vitrite. Shaly coal rare, V>>L, vitrite. Dom common, V>I=L. Vitrinite sparse, inertinite and liptinite rare to sparse. Mineral fluorescence weak orange. Iron oxides rare. Pyrite sparse.)
Ctgs	$\overline{R}_I$max	1.41	1.06-2.04	0.293	10	
L0743	3370-3375	0.51	0.41-0.60	0.048	25	Sparse sporinite and rare liptodetrinite yellow to dull orange, rare cutinite dull orange. (Sandstone>siltstone>shaly coal. Shaly coal rare, V>L, clarite. Dom common, I>V>L. Inertinite common, vitrinite sparse to common, liptinite sparse. Mineral fluorescence weak to moderate orange. Iron oxides rare. Pyrite common.)
Ctgs	$\overline{R}_I$max	1.29	0.90-1.92	0.300	10	
L0744	3465-3470	0.53	0.37-0.65	0.064	25	Sparse sporinite and rare liptodetrinite yellow to dull orange, rare to sparse cutinite orange to dull orange, rare resinite yellow. (Sandstone>siltstone>claystone>coal>shaly coal. Coal common, V>I>L, vitrite=duroclarite. Shaly coal rare, V>I>L, duroclarite. Dom common, V>I>L. Vitrinite and inertinite common, liptinite sparse. Mineral fluorescence weak orange in fine grained sediments. Iron oxides rare. Pyrite sparse.)
Ctgs	$\overline{R}_I$max	1.51	0.82-2.08	0.342	10	
L0745	3485-3490	0.58	0.48-0.69	0.051	25	Sparse sporinite and rare liptodetrinite orange to dull orange, rare to sparse cutinite orange. (Siltstone>sandstone>shaly coal. Shaly coal rare, I>V>L, vitrinertite(I)=clarite. Dom common, V>I>L. Vitrinite and inertinite common, liptinite sparse. Coalified leaf tissues present. Mineral fluorescence weak orange in fine grained sediments. Iron oxides rare. Pyrite sparse.)
Ctgs	$\overline{R}_I$max	1.33	0.86-2.28	0.404	10	
L0746	3750-3755	0.64	0.51-0.76	0.063	25	Sparse to common, sporinite and rare liptodetrinite orange to dull orange, rare cutinite orange, rare suberinite dull orange, rare resinite yellow. (Siltstone>sandstone>claystone>coal>carbonate=shaly coal. Coal abundant, V>I>L, Vitrite>clarite. Shaly coal common V>I>L, duroclarite. Dom common, V>L>I. Vitrinite common, liptinite sparse to common, inertinite sparse. Rare to sparse oil drops, yellow in siltstone. Mineral fluorescence weak orange in fine grained sediments. Iron oxides rare. Pyrite sparse.)
Ctgs	$\overline{R}_I$max	1.40	1.20-1.90	0.213	10	

The upper part of the section sampled is close to the top of the oil window, which probably occurs at about 3350m. The deeper section sampled is mid-mature for oil generation.

Organic matter is common in all of the samples. Coal and shaly coal are more common in the deepest two samples but even there represent less than 5% of each sample. The total amount of dom is relatively constant through the section. The main variations in organic matter content are due to increasing abundance of coal down-section.

Small amounts of oil drops are present in the deepest sample.

Table 3 Culverin-1 Solvent Extraction Data

DEPTH	Sample Type	Weight of Material Extd. (g)	Total Extract (mg)	Total Extract (ppm)
3605m-3610m	Cuttings	48.3	298.1	6171
3750m-3755m	Cuttings	45.6	269.9	5921

Table 4: Solvent Extract Liquid Chromatography Data

A. Yields (ppm)

		-------Hydrocarbons-------			------Non-hydrocarbons------			Loss
DEPTH	Sample Type	Sats	Aros	HC's	NSOs	Asph.	Non HC's	on column
3605m-3610m	Cuttings	238	238	477	150	nd	150	5544
3750m-3755m	Cuttings	188	240	428	736	nd	736	4758

B. Yields (%) and Selected Ratios

		------Hydrocarbons------			------Non-hydrocarbons------			Sats	Asph.	HC
DEPTH	Sample Type	Sats	Aros	HC's	NSOs	Asph.	Non HC's	Aros	NSO	Non HC
3605m-3610m	Cuttings	38.0	38.0	76	23.9	nd	24	1.0	nd	3.2
3750m-3755m	Cuttings	16.2	20.6	37	63.2	nd	63	0.8	nd	0.6

Table 5: Solvent Extract Analysis of Saturated Hydrocarbons by GC-MS

A. Selected Ratios

DEPTH	Sample Type	Prist./Phyt.	Prist./n-C17	Phyt./n-C18	CPI(1)	CPI(2)	(C21+C22)/(C28+C29)
3605m-3610m	Cuttings	8.93	1.99	0.20	1.50	1.38	0.72
3750m-3755m	Cuttings	9.86	5.77	0.53	1.66	1.54	0.35

B. n-Alkane Distributions

DEPTH	nC12	nC13	nC14	nC15	nC16	nC17	Pr	nC18	Ph	nC19	nC20	nC21	nC22	nC23	nC24	nC25	nC26	nC27	nC28	nC29	nC30	nC31
3605m-3610m	0.6	0.8	1.0	1.5	2.0	2.7	5.3	3.0	0.6	3.6	4.1	4.8	5.6	7.0	7.1	9.7	7.4	10.9	6.0	8.6	2.9	4.9
3750m-3755m	0.5	0.7	0.8	1.1	1.3	1.5	8.8	1.7	0.9	2.1	2.4	2.9	3.7	5.2	5.9	9.6	7.7	14.1	7.3	11.6	3.9	6.6

CULVERIN-1
Delta-Log R

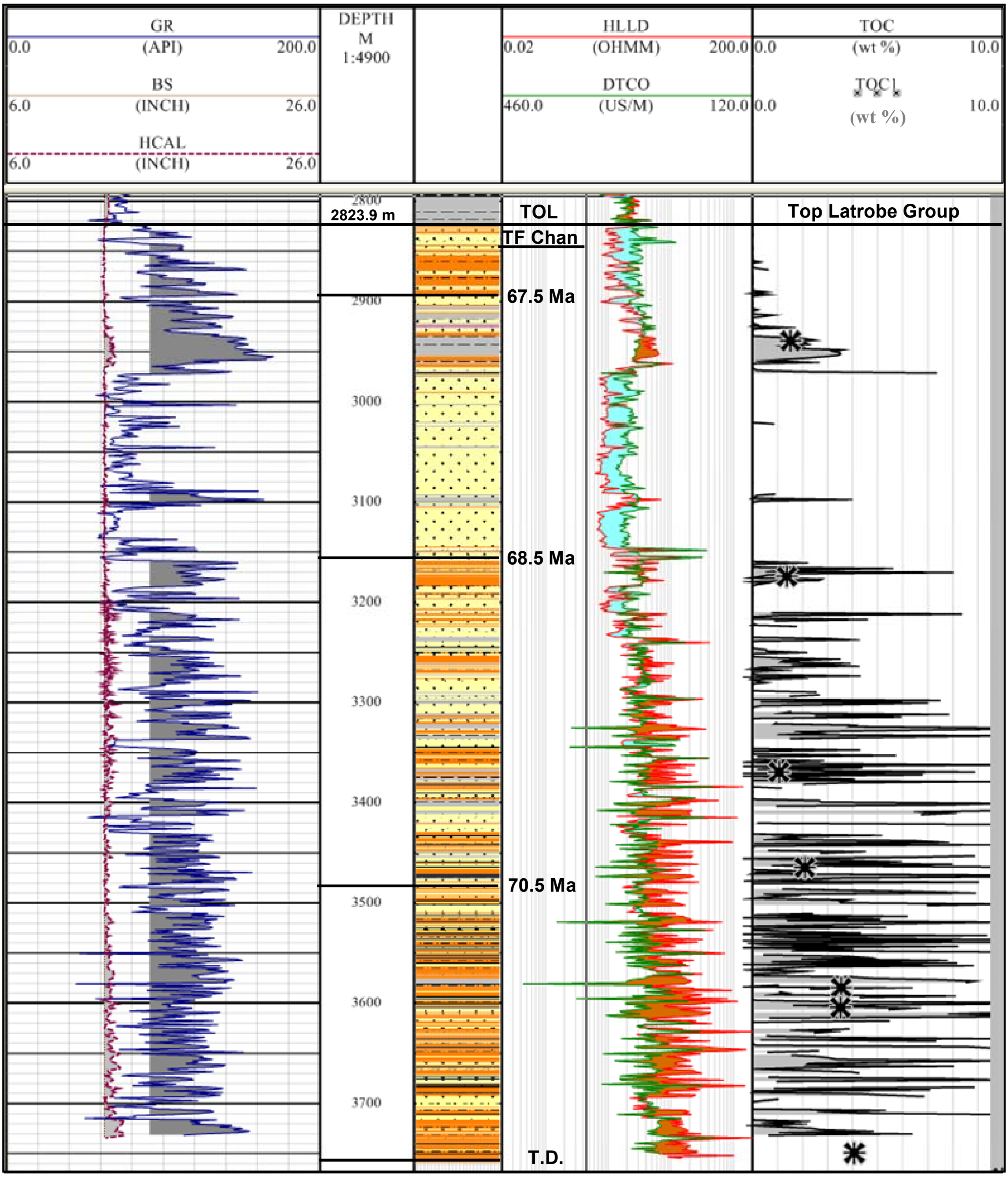

Figure 1: Culverin-1 Delta-Log R Analysis Plot.

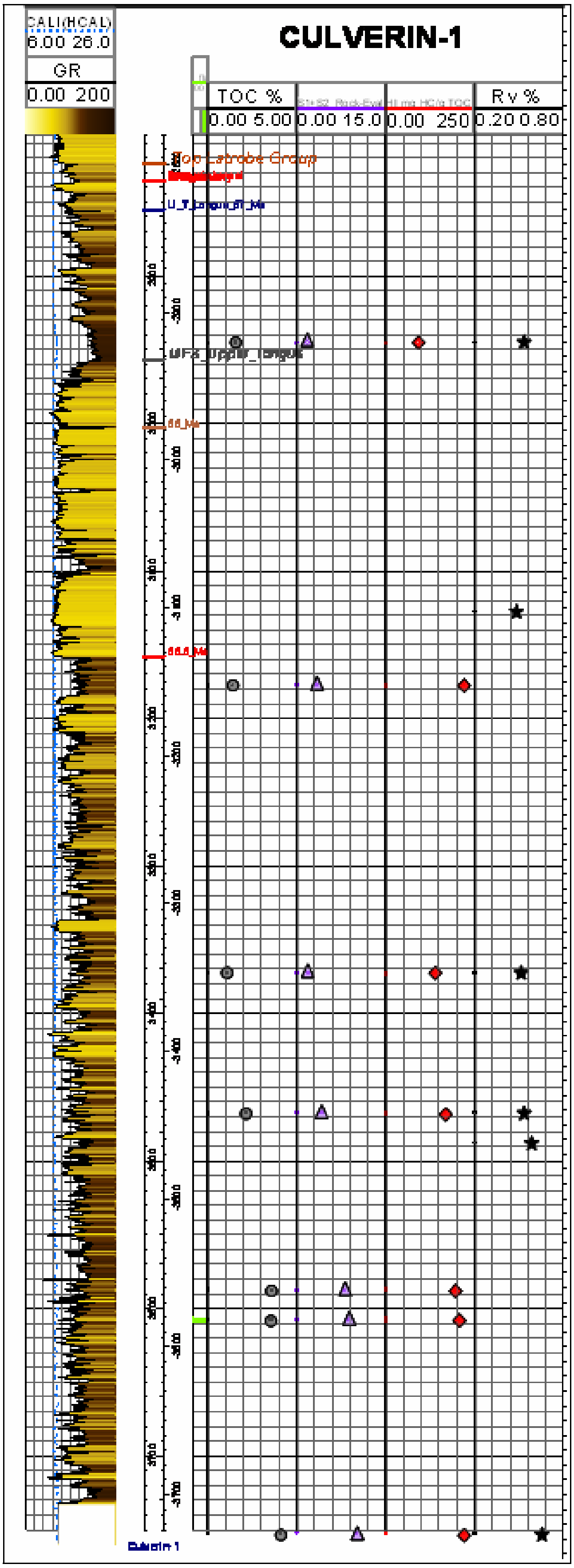

Figure 2: Sequence stratigraphic location of analysed samples and results of TOC %, hydrocarbon potential (S1+S2 mg HC/G TOC), Hydrogen Index HI, and Vitrinite Reflectance %.

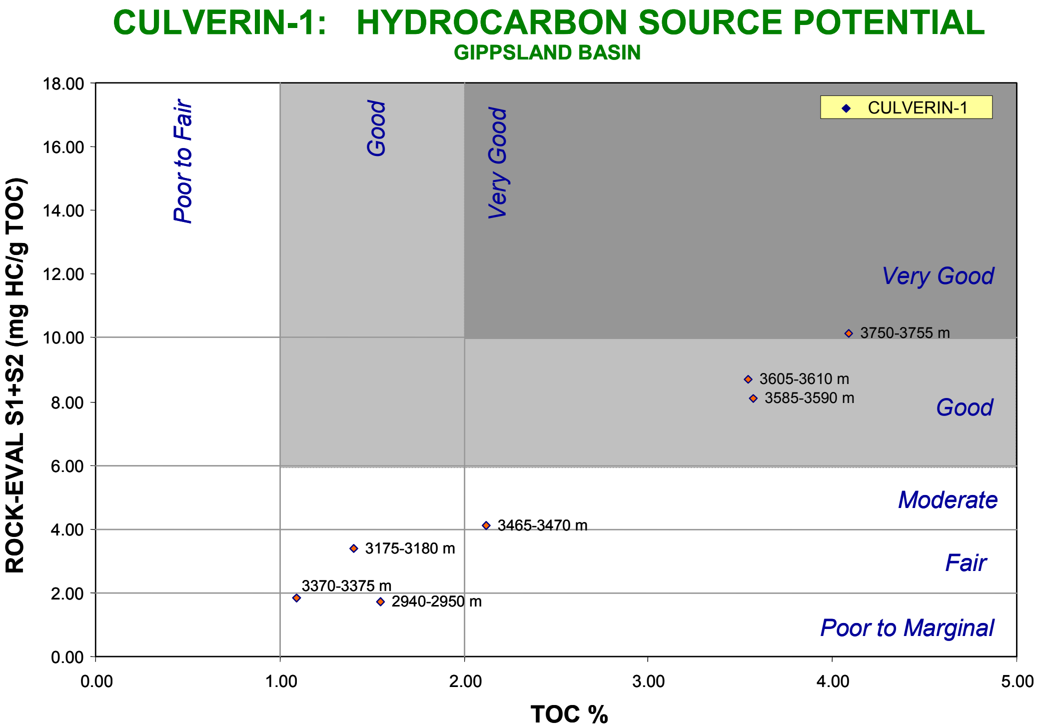

Figure 3: Culverin-1 TOC vs Rock-Eval Hydrocarbon source potential (S1+S2)

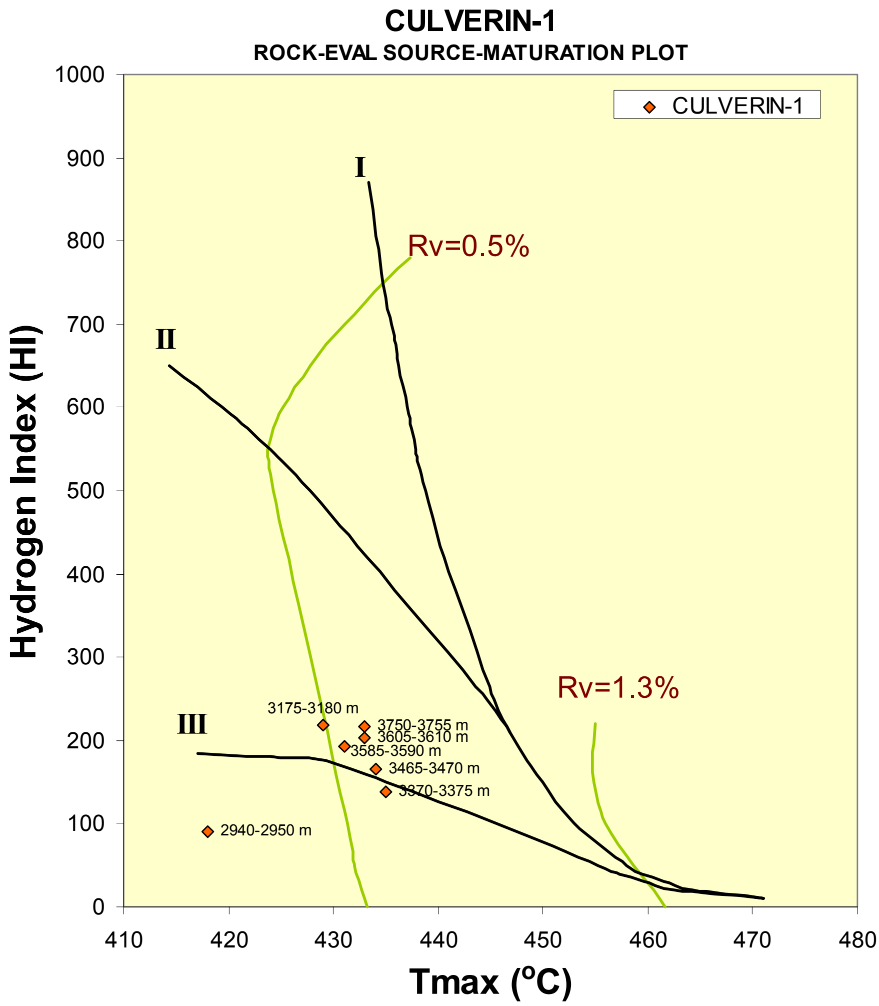

Figure 4: Culverin-1 Rock-Eval HI vs Tmax source rock maturity plot

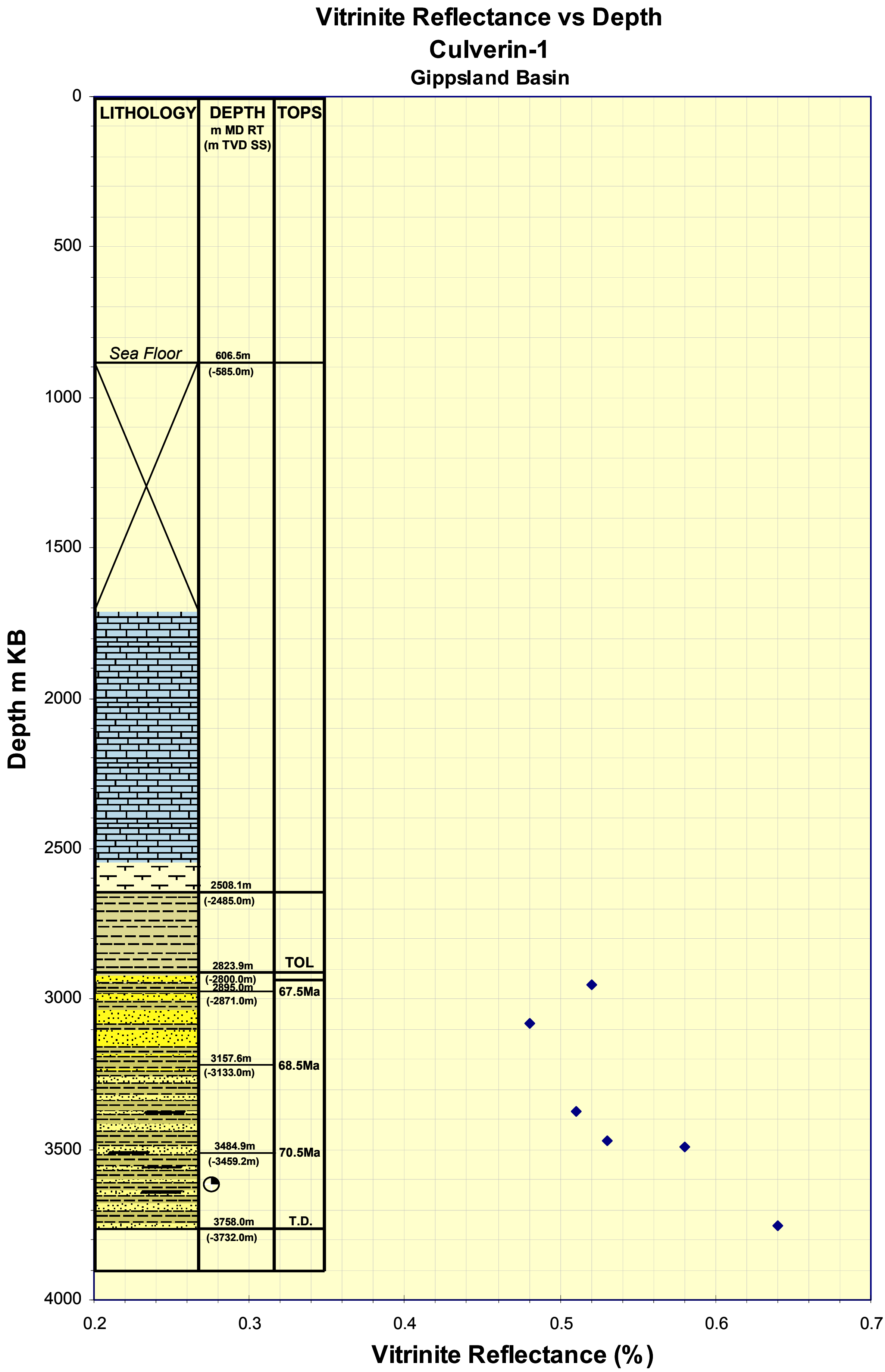

Figure 5: Culverin-1 Vitrinite Reflectance vs Depth plot

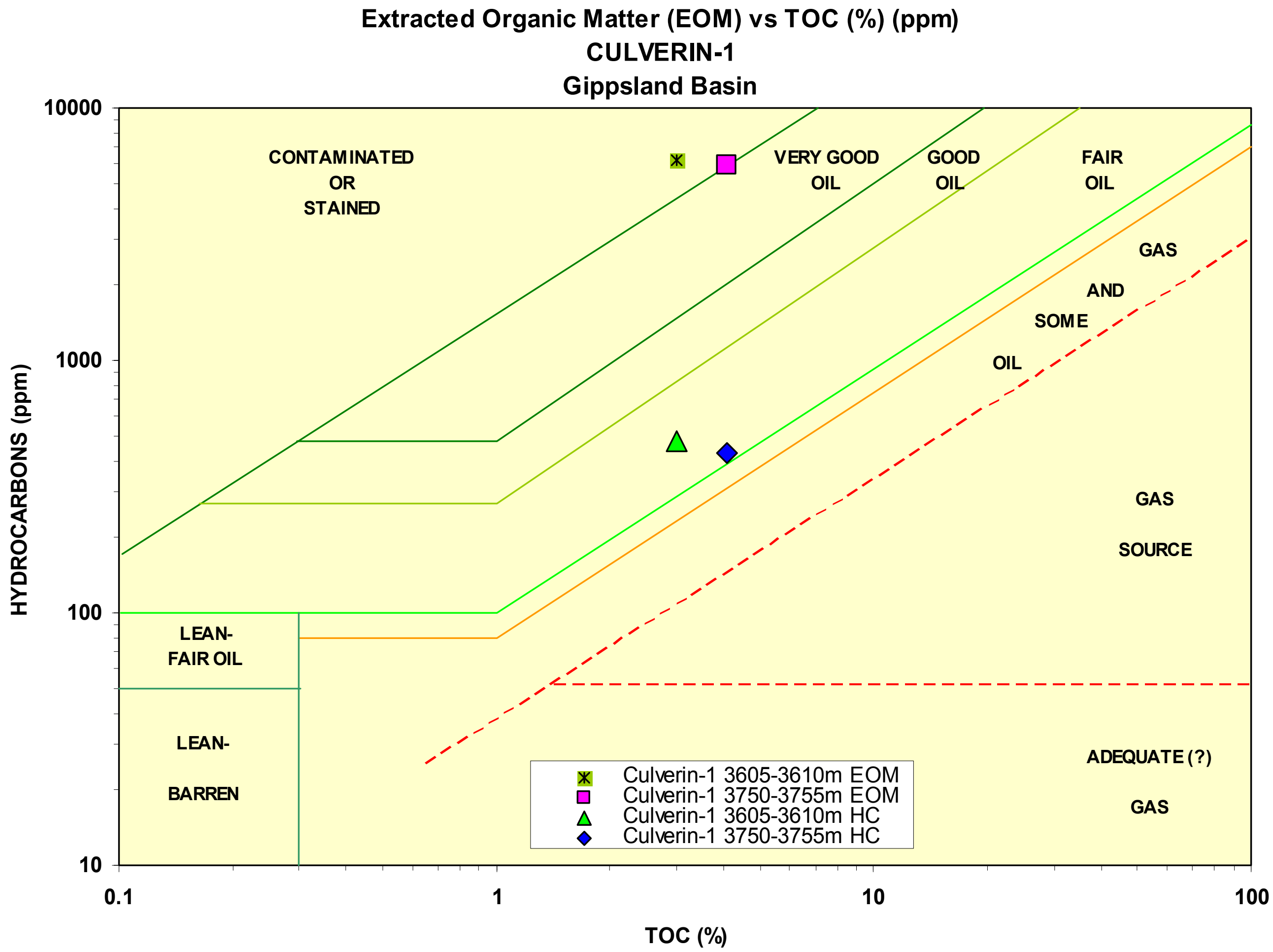

Figure 6: Amount of solvent extracted organic matter (EOM) vs sample TOC.

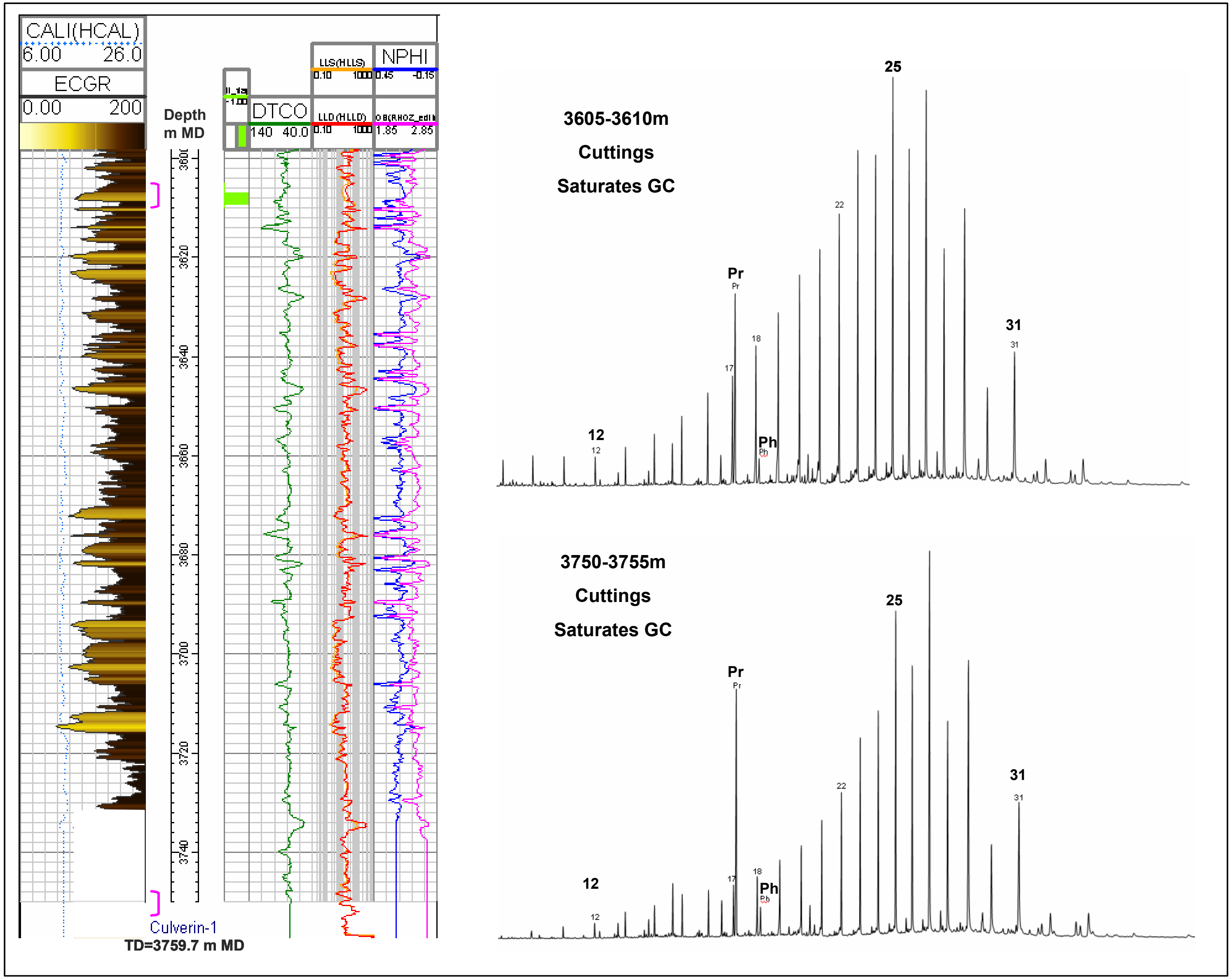

Figure 7: Saturate fraction gas chromatograms from solvent extracts of cuttings at 3605-3610 m MD and 3750-3755 m MD.

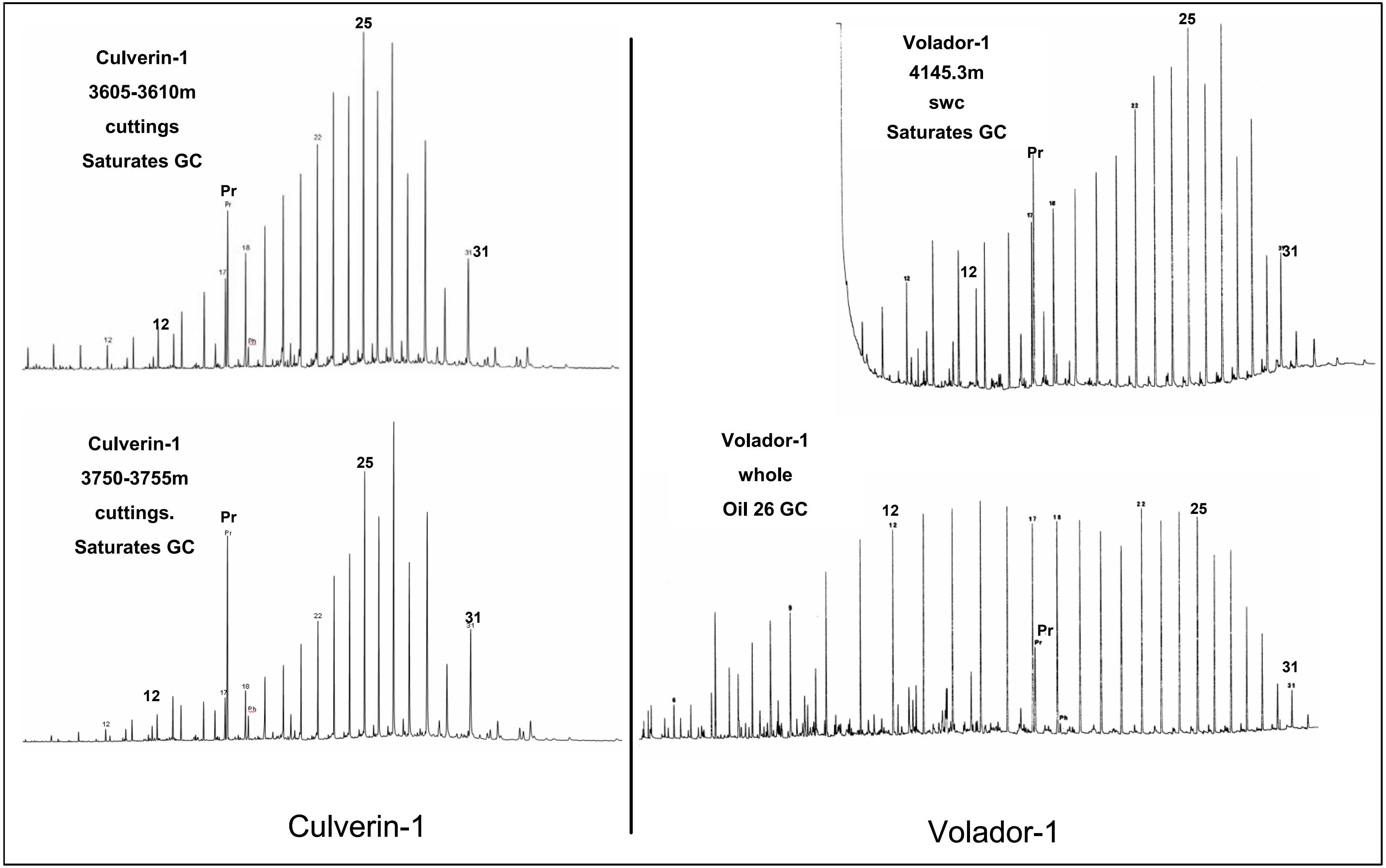

Figure 8: Comparison of cuttings extract saturate fraction gas chromatograms from Culverin-1 with source rock extract and tested whole oil chromatograms from Volador-1.

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Appendix 1: Details and histograms of vitrinite reflectance measurements for Culverin-1.

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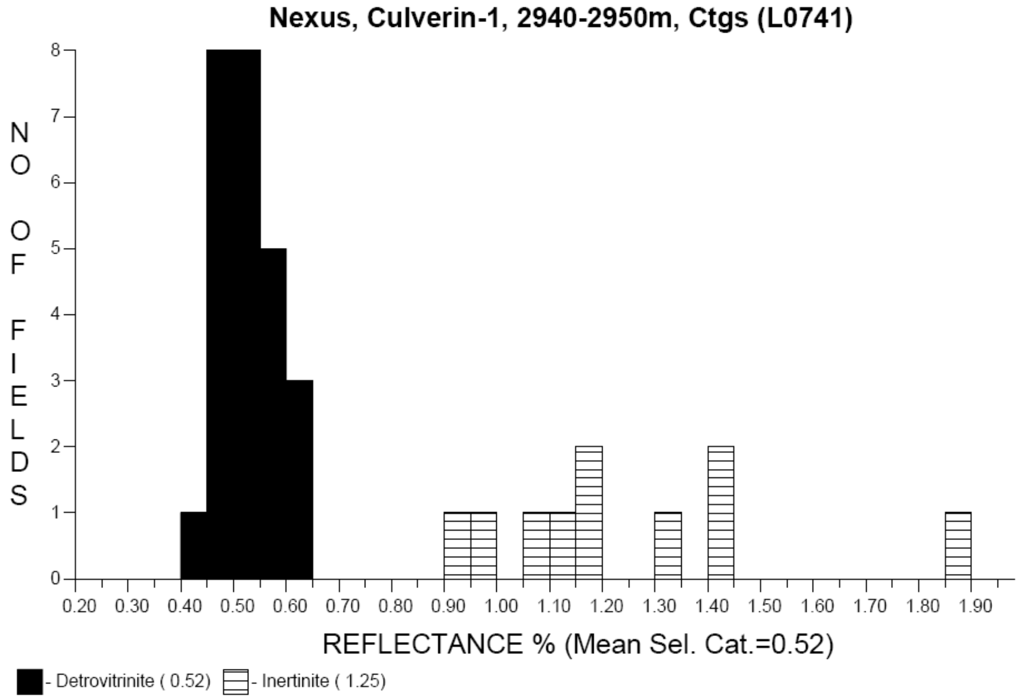

Category	No. of Readings	Mean	Standard Deviation
Detrovitrinite	25	0.52	0.053
Inertinite	10	1.25	0.264
Total:	35	0.73	0.360

Selected categories: Detrovitrinite,

No. of readings:	25
Mean of selected categories:	0.52
Standard deviation of selected categories:	0.053

R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range
0.10			0.40			0.70			1.00			1.30			1.60			1.90			2.20			2.50		
0.11			0.41			0.71			1.01			1.31			1.61			1.91			2.21			2.51		
0.12			0.42			0.72			1.02			1.32			1.62			1.92			2.22			2.52		
0.13			0.43			0.73			1.03			1.33			1.63			1.93			2.23			2.53		
0.14			0.44	1	↑	0.74			1.04			1.34	1		1.64			1.94			2.24			2.54		
0.15			0.45	3	FGV	0.75			1.05			1.35			1.65			1.95			2.25			2.55		
0.16			0.46			0.76			1.06	1		1.36			1.66			1.96			2.26			2.56		
0.17			0.47			0.77			1.07			1.37			1.67			1.97			2.27			2.57		
0.18			0.48	4		0.78			1.08			1.38			1.68			1.98			2.28			2.58		
0.19			0.49	1		0.79			1.09			1.39			1.69			1.99			2.29			2.59		
0.20			0.50	1		0.80			1.10			1.40	1		1.70			2.00			2.30			2.60		
0.21			0.51	2		0.81			1.11			1.41			1.71			2.01			2.31			2.61		
0.22			0.52	2		0.82			1.12			1.42	1		1.72			2.02			2.32			2.62		
0.23			0.53	2		0.83			1.13			1.43			1.73			2.03			2.33			2.63		
0.24			0.54	1		0.84			1.14	1		1.44			1.74			2.04			2.34			2.64		
0.25			0.55	1		0.85			1.15			1.45			1.75			2.05			2.35			2.65		
0.26			0.56	1		0.86			1.16			1.46			1.76			2.06			2.36			2.66		
0.27			0.57			0.87			1.17			1.47			1.77			2.07			2.37			2.67		
0.28			0.58	1		0.88			1.18	2		1.48			1.78			2.08			2.38			2.68		
0.29			0.59	2		0.89			1.19			1.49			1.79			2.09			2.39			2.69		
0.30			0.60	1		0.90			1.20			1.50			1.80			2.10			2.40			2.70		
0.31			0.61	1	FGV	0.91			1.21			1.51			1.81			2.11			2.41			2.71		
0.32			0.62	1	↓	0.92			1.22			1.52			1.82			2.12			2.42			2.72		
0.33			0.63			0.93			1.23			1.53			1.83			2.13			2.43			2.73		
0.34			0.64			0.94	1	↑	1.24			1.54			1.84			2.14			2.44			2.74		

0.35			0.65			0.95		Inert	1.25			1.55			1.85			2.15			2.45			2.75		
0.36			0.66			0.96	1		1.26			1.56			1.86			2.16			2.46			2.76		
0.37			0.67			0.97			1.27			1.57			1.87		Inert	2.17			2.47			2.77		
0.38			0.68			0.98			1.28			1.58			1.88	1	↓	2.18			2.48			2.78		
0.39			0.69			0.99			1.29			1.59			1.89			2.19			2.49			2.79		

VITRINITE 0.4%		INERTINITE 1.0%						LIPTINITE 0.2%								OIL DROPS	BITUMEN
TV	DV	Sfus	Scler	Fus	Macr	ID	Micr	Spor	Cut	Sub	Res	Ld	Bituminite	Telalginite	Lamalginite	Oil cut	
								0.2	<0.1		<0.1	<0.1					

Sample Number..L0741.....Well Name...NEXUS,...CULVERIN-1... Depth...2940-2950m...................................... ....

SampleType....Ctgs....

Date. ..19/.02/ 2006.. Op..SPR......... FGV - First Generation Vitrinite, RV - Reworked Vitrinite, BTT - Bituminite, B - Bitumen, Inert - Inertinite, Cav - Cavings, DA - Drilling Mud Additives MICR D:\RWORK.ms6\NEXVRW06.doc

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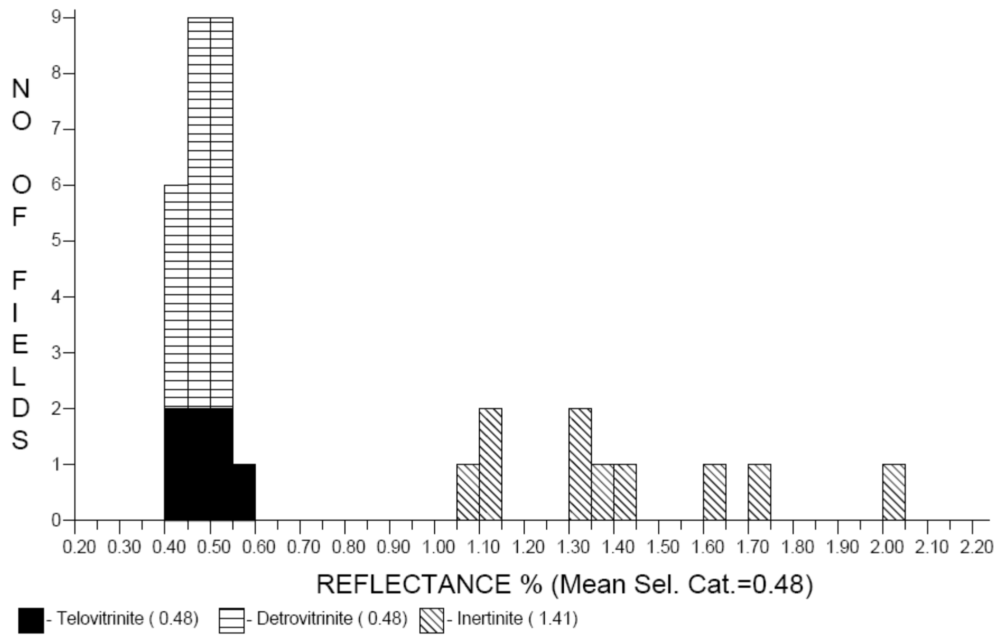
Nexus, Culverin-1, 3175-3180m, Ctgs (L0742)



Category	No. of Readings	Mean	Standard Deviation
Telovitrinite	7	0.48	0.044
Detrovitrinite	18	0.48	0.041
Inertinite	10	1.41	0.293
Total:	35	0.75	0.449

Selected categories: Telovitrinite, Detrovitrinite,

No. of readings:	25
Mean of selected categories:	0.48
Standard deviation of selected categories:	0.042

R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range
0.10			0.40	1	↑	0.70			1.00			1.30	1		1.60			1.90			2.20			2.50		
0.11			0.41	1	FGV	0.71			1.01			1.31			1.61			1.91			2.21			2.51		
0.12			0.42	2		0.72			1.02			1.32			1.62	1		1.92			2.22			2.52		
0.13			0.43	1		0.73			1.03			1.33			1.63			1.93			2.23			2.53		
0.14			0.44	1		0.74			1.04			1.34	1		1.64			1.94			2.24			2.54		
0.15			0.45	1		0.75			1.05			1.35			1.65			1.95			2.25			2.55		
0.16			0.46	1		0.76			1.06	1	↑	1.36			1.66			1.96			2.26			2.56		
0.17			0.47	1		0.77			1.07		Iner	1.37			1.67			1.97			2.27			2.57		
0.18			0.48	3		0.78			1.08			1.38	1		1.68			1.98			2.28			2.58		
0.19			0.49	3		0.79			1.09			1.39			1.69			1.99			2.29			2.59		
0.20			0.50	3		0.80			1.10	2		1.40			1.70	1		2.00			2.30			2.60		
0.21			0.51	2		0.81			1.11			1.41			1.71			2.01			2.31			2.61		
0.22			0.52	1		0.82			1.12			1.42			1.72			2.02			2.32			2.62		
0.23			0.53	1		0.83			1.13			1.43			1.73			2.03		Iner	2.33			2.63		
0.24			0.54	2	FGV	0.84			1.14			1.44	1		1.74			2.04	1	↓	2.34			2.64		
0.25			0.55	1	↓	0.85			1.15			1.45			1.75			2.05			2.35			2.65		
0.26			0.56			0.86			1.16			1.46			1.76			2.06			2.36			2.66		
0.27			0.57			0.87			1.17			1.47			1.77			2.07			2.37			2.67		
0.28			0.58			0.88			1.18			1.48			1.78			2.08			2.38			2.68		
0.29			0.59			0.89			1.19			1.49			1.79			2.09			2.39			2.69		
0.30			0.60			0.90			1.20			1.50			1.80			2.10			2.40			2.70		
0.31			0.61			0.91			1.21			1.51			1.81			2.11			2.41			2.71		
0.32			0.62			0.92			1.22			1.52			1.82			2.12			2.42			2.72		
0.33			0.63			0.93			1.23			1.53			1.83			2.13			2.43			2.73		
0.34			0.64			0.94			1.24			1.54			1.84			2.14			2.44			2.74		

0.35			0.65			0.95			1.25			1.55			1.85			2.15			2.45			2.75		
0.36			0.66			0.96			1.26			1.56			1.86			2.16			2.46			2.76		
0.37			0.67			0.97			1.27			1.57			1.87			2.17			2.47			2.77		
0.38			0.68			0.98			1.28			1.58			1.88			2.18			2.48			2.78		
0.39			0.69			0.99			1.29			1.59			1.89			2.19			2.49			2.79		

VITRINITE 0.4%		INERTINITE 0.1%						LIPTINITE 0.1%								OIL DROPS	BITUMEN
TV	DV	Sfus	Scler	Fus	Macr	ID	Micr	Spor	Cut	Sub	Res	Ld	Bituminite	Telalginite	Lamalginite	Oil cut	
								<0.1	<0.1			<0.1					

Sample Number..L0742.....Well Name...NEXUS,...CULVERIN-1.. Depth...3175-3180m..................................... ....
SampleType....Ctgs....
Date. ..19/.02/ 2006.. Op..SPR......... FGV - First Generation Vitrinite, RV - Reworked Vitrinite, BTT - Bituminite, B - Bitumen, Inert - Inertinite, Cav - Cavings, DA - Drilling Mud Additives

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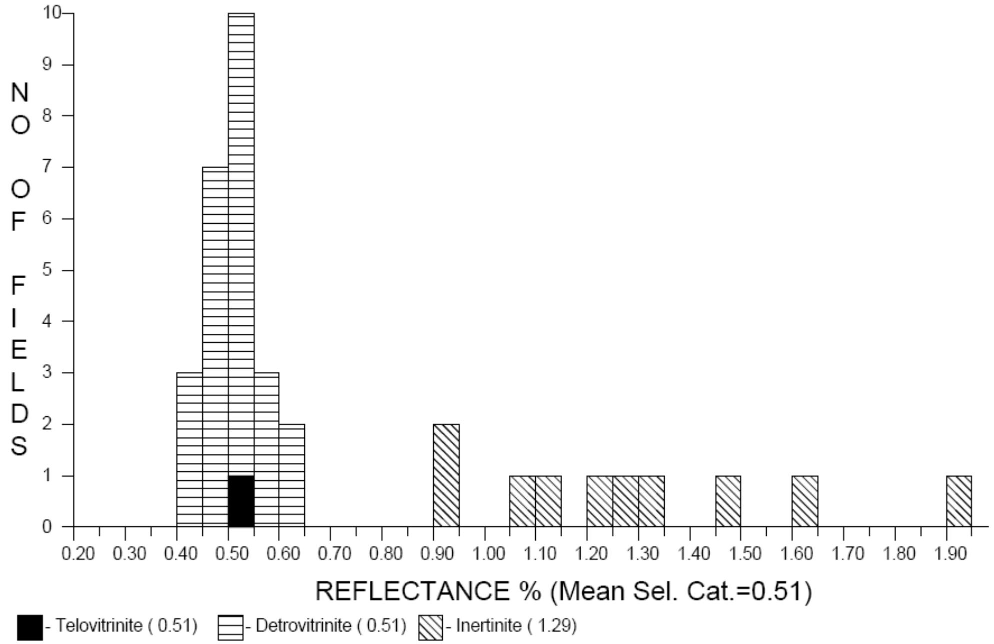
Nexus, Culverin-1, 3370-3375m, Ctgs (L0743)



Category	No. of Readings	Mean	Standard Deviation
Telovitrinite	1	0.51	0.000
Detrovitrinite	24	0.51	0.049
Inertinite	10	1.29	0.300
Total:	35	0.73	0.391

Selected categories: Telovitrinite, Detrovitrinite,

No. of readings: 25

Mean of selected categories: 0.51

Standard deviation of selected categories: 0.048

R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range
0.10			0.40			0.70			1.00			1.30	1		1.60			1.90			2.20			2.50		
0.11			0.41	1	↑	0.71			1.01			1.31			1.61			1.91		Iner	2.21			2.51		
0.12			0.42	1	FGV	0.72			1.02			1.32			1.62			1.92	1	↓	2.22			2.52		
0.13			0.43			0.73			1.03			1.33			1.63			1.93			2.23			2.53		
0.14			0.44	1		0.74			1.04			1.34			1.64	1		1.94			2.24			2.54		
0.15			0.45			0.75			1.05			1.35			1.65			1.95			2.25			2.55		
0.16			0.46	1		0.76			1.06			1.36			1.66			1.96			2.26			2.56		
0.17			0.47	2		0.77			1.07			1.37			1.67			1.97			2.27			2.57		
0.18			0.48	2		0.78			1.08	1		1.38			1.68			1.98			2.28			2.58		
0.19			0.49	2		0.79			1.09			1.39			1.69			1.99			2.29			2.59		
0.20			0.50	2		0.80			1.10			1.40			1.70			2.00			2.30			2.60		
0.21			0.51	4		0.81			1.11			1.41			1.71			2.01			2.31			2.61		
0.22			0.52			0.82			1.12			1.42			1.72			2.02			2.32			2.62		
0.23			0.53	3		0.83			1.13			1.43			1.73			2.03			2.33			2.63		
0.24			0.54	1		0.84			1.14	1		1.44			1.74			2.04			2.34			2.64		
0.25			0.55	1		0.85			1.15			1.45			1.75			2.05			2.35			2.65		
0.26			0.56			0.86			1.16			1.46			1.76			2.06			2.36			2.66		
0.27			0.57	2		0.87			1.17			1.47			1.77			2.07			2.37			2.67		
0.28			0.58			0.88			1.18			1.48	1		1.78			2.08			2.38			2.68		
0.29			0.59		FGV	0.89			1.19			1.49			1.79			2.09			2.39			2.69		
0.30			0.60	2	↓	0.90	1	↑	1.20			1.50			1.80			2.10			2.40			2.70		
0.31			0.61			0.91		Iner	1.21			1.51			1.81			2.11			2.41			2.71		
0.32			0.62			0.92			1.22	1		1.52			1.82			2.12			2.42			2.72		
0.33			0.63			0.93			1.23			1.53			1.83			2.13			2.43			2.73		
0.34			0.64			0.94	1		1.24			1.54			1.84			2.14			2.44			2.74		

0.35			0.65			0.95			1.25			1.55			1.85			2.15			2.45			2.75		
0.36			0.66			0.96			1.26			1.56			1.86			2.16			2.46			2.76		
0.37			0.67			0.97			1.27			1.57			1.87			2.17			2.47			2.77		
0.38			0.68			0.98			1.28	1		1.58			1.88			2.18			2.48			2.78		
0.39			0.69			0.99			1.29			1.59			1.89			2.19			2.49			2.79		

VITRINITE 0.5 %		INERTINITE 0.6%						LIPTINITE 0.3%								OIL DROPS	BITUMEN
TV	DV	Sfus	Scler	Fus	Macr	ID	Micr	Spor	Cut	Sub	Res	Ld	Bituminite	Telalginite	Lamalginite	Oil cut	
								0.3	<0.1			<0.1					

Sample Number..L0743.....Well Name...NEXUS,...CULVERIN-1.. Depth...3370-3375m...................................... ....
SampleType....Ctgs....
Date. ..19/.02/ 2006.. Op..SPR......... FGV - First Generation Vitrinite, RV - Reworked Vitrinite, BTT - Bituminite, B - Bitumen, Inert - Inertinite, Cav - Cavings, DA - Drilling Mud Additives MICR D:\RWORK.ms6\NEXVRW06.doc

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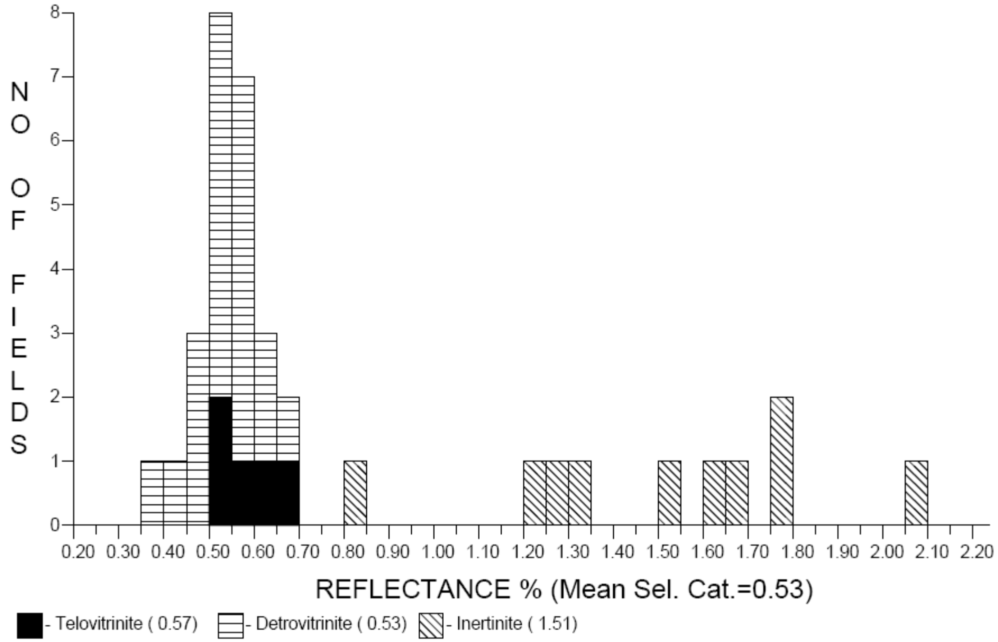
Nexus, Culverin-1, 3465-3470m, Ctgs (L0744)



Category	No. of Readings	Mean	Standard Deviation
Telovitrinite	5	0.57	0.052
Detrovitrinite	20	0.53	0.064
Inertinite	10	1.51	0.342
Total:	35	0.81	0.479

Selected categories: Telovitrinite, Detrovitrinite,

No. of readings:	25
Mean of selected categories:	0.53
Standard deviation of selected categories:	0.064

R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range
0.10			0.40			0.70			1.00			1.30			1.60			1.90			2.20			2.50		
0.11			0.41			0.71			1.01			1.31			1.61			1.91			2.21			2.51		
0.12			0.42	1		0.72			1.02			1.32			1.62			1.92			2.22			2.52		
0.13			0.43			0.73			1.03			1.33			1.63			1.93			2.23			2.53		
0.14			0.44			0.74			1.04			1.34	1		1.64	1		1.94			2.24			2.54		
0.15			0.45			0.75			1.05			1.35			1.65			1.95			2.25			2.55		
0.16			0.46	1		0.76			1.06			1.36			1.66			1.96			2.26			2.56		
0.17			0.47			0.77			1.07			1.37			1.67			1.97			2.27			2.57		
0.18			0.48	2		0.78			1.08			1.38			1.68	1		1.98			2.28			2.58		
0.19			0.49			0.79			1.09			1.39			1.69			1.99			2.29			2.59		
0.20			0.50			0.80			1.10			1.40			1.70			2.00			2.30			2.60		
0.21			0.51	5		0.81			1.11			1.41			1.71			2.01			2.31			2.61		
0.22			0.52	2		0.82	1		1.12			1.42			1.72			2.02			2.32			2.62		
0.23			0.53			0.83		Iner	1.13			1.43			1.73			2.03			2.33			2.63		
0.24			0.54	1		0.84			1.14			1.44			1.74			2.04			2.34			2.64		
0.25			0.55	4		0.85			1.15			1.45			1.75			2.05			2.35			2.65		
0.26			0.56	2		0.86			1.16			1.46			1.76	1		2.06			2.36			2.66		
0.27			0.57	1		0.87			1.17			1.47			1.77			2.07		Iner	2.37			2.67		
0.28			0.58			0.88			1.18			1.48			1.78	1		2.08	1		2.38			2.68		
0.29			0.59			0.89			1.19			1.49			1.79			2.09			2.39			2.69		
0.30			0.60	1		0.90			1.20	1		1.50	1		1.80			2.10			2.40			2.70		
0.31			0.61	2		0.91			1.21			1.51			1.81			2.11			2.41			2.71		
0.32			0.62			0.92			1.22			1.52			1.82			2.12			2.42			2.72		
0.33			0.63			0.93			1.23			1.53			1.83			2.13			2.43			2.73		
0.34			0.64		FGV	0.94			1.24			1.54			1.84			2.14			2.44			2.74		

0.35			0.65	2	↓	0.95			1.25			1.55			1.85			2.15			2.45			2.75		
0.36			0.66			0.96			1.26	1		1.56			1.86			2.16			2.46			2.76		
0.37	1	↑	0.67			0.97			1.27			1.57			1.87			2.17			2.47			2.77		
0.38		FGV	0.68			0.98			1.28			1.58			1.88			2.18			2.48			2.78		
0.39			0.69			0.99			1.29			1.59			1.89			2.19			2.49			2.79		

VITRINITE 0.7%		INERTINITE 0.6%						LIPTINITE 0.3%								OIL DROPS	BITUMEN
TV	DV	Sfus	Scler	Fus	Macr	ID	Micr	Spor 0.2	Cut 0.1	Sub	Res <0.1	Ld <0.1	Bituminite	Telalginite	Lamalginite	Oil cut	

Sample Number..L0744.....Well Name...NEXUS,...CULVERIN-1.. Depth...3465-3470m...................................... ....
SampleType....Ctgs....
Date. ..25/.02/ 2006.. Op..SPR......... FGV - First Generation Vitrinite, RV - Reworked Vitrinite, BTT - Bituminite, B - Bitumen, Inert - Inertinite, Cav - Cavings, DA - Drilling Mud Additives MICR D:\RWORK.ms6\NEXVRW06.doc

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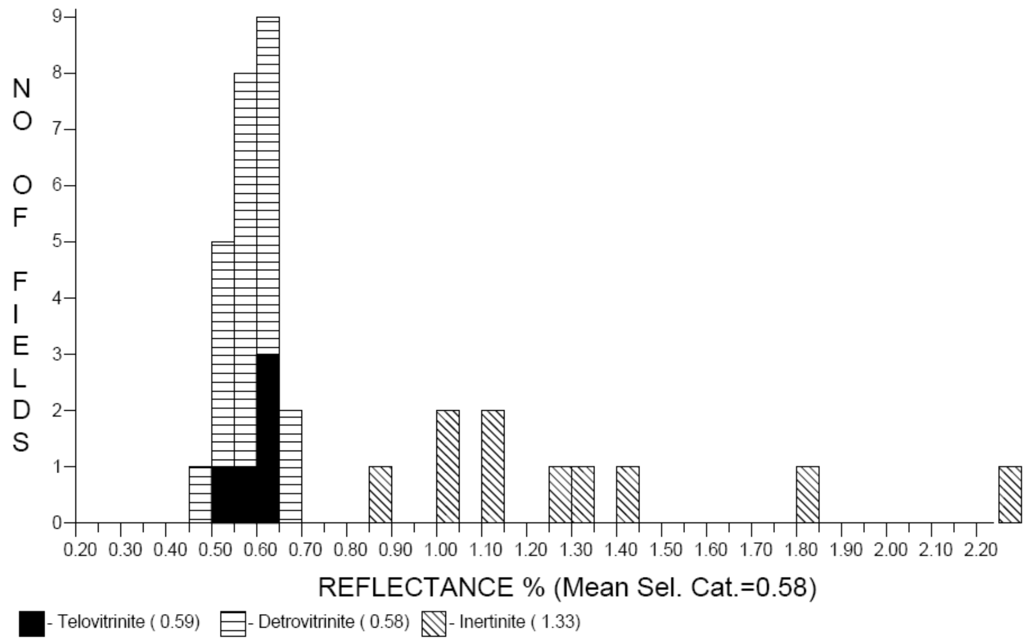
Nexus, Culverin-1, 3485-3490m, Ctgs (L0745)



Category	No. of Readings	Mean	Standard Deviation
Telovitrinite	5	0.59	0.031
Detrovitrinite	20	0.58	0.055
Inertinite	10	1.33	0.404
Total:	35	0.79	0.402

Selected categories: Telovitrinite, Detrovitrinite,

No. of readings:	25
Mean of selected categories:	0.58
Standard deviation of selected categories:	0.051

R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range
0.10			0.40			0.70			1.00	1		1.30			1.60			1.90			2.20		
0.11			0.41			0.71			1.01			1.31			1.61			1.91			2.21		
0.12			0.42			0.72			1.02	1		1.32			1.62			1.92			2.22		
0.13			0.43			0.73			1.03			1.33			1.63			1.93			2.23		
0.14			0.44			0.74			1.04			1.34	1		1.64			1.94			2.24		
0.15			0.45			0.75			1.05			1.35			1.65			1.95			2.25		
0.16			0.46			0.76			1.06			1.36			1.66			1.96			2.26		
0.17			0.47			0.77			1.07			1.37			1.67			1.97			2.27		Inert
0.18			0.48	1	↑	0.78			1.08			1.38			1.68			1.98			2.28	1	↓
0.19			0.49		FGV	0.79			1.09			1.39			1.69			1.99			2.29		
0.20			0.50	1		0.80			1.10			1.40	1		1.70			2.00			2.30		
0.21			0.51	2		0.81			1.11			1.41			1.71			2.01			2.31		
0.22			0.52	1		0.82			1.12			1.42			1.72			2.02			2.32		
0.23			0.53			0.83			1.13			1.43			1.73			2.03			2.33		
0.24			0.54	1		0.84			1.14	2		1.44			1.74			2.04			2.34		
0.25			0.55	1		0.85			1.15			1.45			1.75			2.05			2.35		
0.26			0.56	1		0.86	1	↑	1.16			1.46			1.76			2.06			2.36		
0.27			0.57	1		0.87		Inert	1.17			1.47			1.77			2.07			2.37		
0.28			0.58	5		0.88			1.18			1.48			1.78			2.08			2.38		
0.29			0.59			0.89			1.19			1.49			1.79			2.09			2.39		
0.30			0.60	3		0.90			1.20			1.50			1.80	1		2.10			2.40		
0.31			0.61	2		0.91			1.21			1.51			1.81			2.11			2.41		
0.32			0.62	2		0.92			1.22			1.52			1.82			2.12			2.42		
0.33			0.63	2		0.93			1.23			1.53			1.83			2.13			2.43		
0.34			0.64			0.94			1.24			1.54			1.84			2.14			2.44		

R	No Read	Pop Range
2.50		
2.51		
2.52		
2.53		
2.54		
2.55		
2.56		
2.57		
2.58		
2.59		
2.60		
2.61		
2.62		
2.63		
2.64		
2.65		
2.66		
2.67		
2.68		
2.69		
2.70		
2.71		
2.72		
2.73		
2.74		

0.35			0.65			0.95			1.25			1.55			1.85			2.15			2.45			2.75		
0.36			0.66			0.96			1.26			1.56			1.86			2.16			2.46			2.76		
0.37			0.67			0.97			1.27			1.57			1.87			2.17			2.47			2.77		
0.38			0.68	1	FGV	0.98			1.28	1		1.58			1.88			2.18			2.48			2.78		
0.39			0.69	1	↓	0.99			1.29			1.59			1.89			2.19			2.49			2.79		

VITRINITE 0.8%		INERTINITE 0.7%						LIPTINITE 0.4%								OIL DROPS	BITUMEN
TV	DV	Sfus	Scler	Fus	Macr	ID	Micr	Spor 0.3	Cut 0.1	Sub	Res	Ld <0.1	Bituminite	Telalginite	Lamalginite	Oil cut	

Sample Number..L0745.....Well Name...NEXUS,...CULVERIN-1.. Depth...3485-3490m...................................... ....
SampleType....Ctgs....
Date. ..25/.02/ 2006.. Op..SPR......... FGV - First Generation Vitrinite, RV - Reworked Vitrinite, BTT - Bituminite, B - Bitumen, Inert - Inertinite, Cav - Cavings, DA - Drilling Mud Additives MICR D:\RWORK.ms6\NEXVRW06.doc

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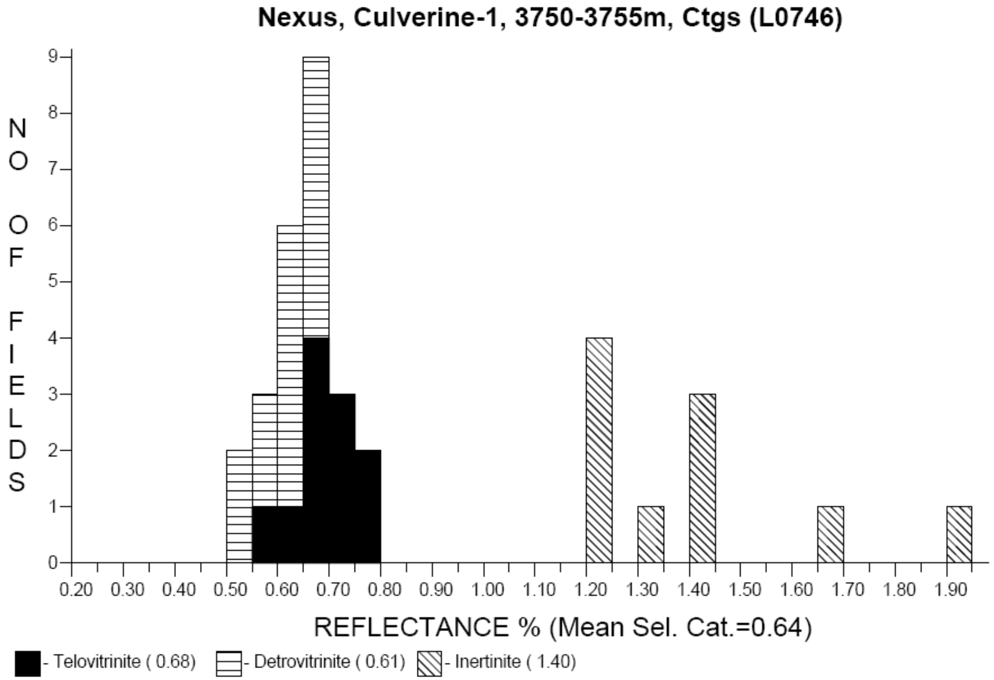

Category	No. of Readings	Mean	Standard Deviation
Telovitrinite	11	0.68	0.053
Detrovitrinite	14	0.61	0.051
Inertinite	10	1.40	0.213
Total:	35	0.86	0.366

Selected categories: Telovitrinite, Detrovitrinite,

No. of readings:	25
Mean of selected categories:	0.64
Standard deviation of selected categories:	0.063

R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range	R	No Read	Pop Range
0.10			0.40			0.70	1		1.00			1.30	1		1.60			1.90	1	↓	2.20			2.50		
0.11			0.41			0.71	2		1.01			1.31			1.61			1.91			2.21			2.51		
0.12			0.42			0.72			1.02			1.32			1.62			1.92			2.22			2.52		
0.13			0.43			0.73			1.03			1.33			1.63			1.93			2.23			2.53		
0.14			0.44			0.74			1.04			1.34			1.64			1.94			2.24			2.54		
0.15			0.45			0.75		FGV	1.05			1.35			1.65			1.95			2.25			2.55		
0.16			0.46			0.76	2	↓	1.06			1.36			1.66	1		1.96			2.26			2.56		
0.17			0.47			0.77			1.07			1.37			1.67			1.97			2.27			2.57		
0.18			0.48			0.78			1.08			1.38			1.68			1.98			2.28			2.58		
0.19			0.49			0.79			1.09			1.39			1.69			1.99			2.29			2.59		
0.20			0.50			0.80			1.10			1.40	1		1.70			2.00			2.30			2.60		
0.21			0.51	1	↑	0.81			1.11			1.41			1.71			2.01			2.31			2.61		
0.22			0.52	1	FGV	0.82			1.12			1.42			1.72			2.02			2.32			2.62		
0.23			0.53			0.83			1.13			1.43			1.73			2.03			2.33			2.63		
0.24			0.54			0.84			1.14			1.44	2		1.74			2.04			2.34			2.64		
0.25			0.55			0.85			1.15			1.45			1.75			2.05			2.35			2.65		
0.26			0.56	1		0.86			1.16			1.46			1.76			2.06			2.36			2.66		
0.27			0.57	1		0.87			1.17			1.47			1.77			2.07			2.37			2.67		
0.28			0.58	1		0.88			1.18			1.48			1.78			2.08			2.38			2.68		
0.29			0.59			0.89			1.19			1.49			1.79			2.09			2.39			2.69		
0.30			0.60	2		0.90			1.20	1	↑	1.50			1.80			2.10			2.40			2.70		
0.31			0.61	1		0.91			1.21		Iner	1.51			1.81			2.11			2.41			2.71		
0.32			0.62	1		0.92			1.22	1		1.52			1.82			2.12			2.42			2.72		
0.33			0.63			0.93			1.23			1.53			1.83			2.13			2.43			2.73		
0.34			0.64	2		0.94			1.24	2		1.54			1.84			2.14			2.44			2.74		

0.35			0.65	4		0.95			1.25			1.55			1.85			2.15			2.45			2.75		
0.36			0.66			0.96			1.26			1.56			1.86			2.16			2.46			2.76		
0.37			0.67	3		0.97			1.27			1.57			1.87			2.17			2.47			2.77		
0.38			0.68	2		0.98			1.28			1.58			1.88			2.18			2.48			2.78		
0.39			0.69			0.99			1.29			1.59			1.89		Inert	2.19			2.49			2.79		

VITRINITE 0.7%		INERTINITE 0.4%						LIPTINITE 0.5%								OIL DROPS	BITUMEN
TV	DV	Sfus	Scler	Fus	Macr	ID	Micr	Spor	Cut	Sub	Res	Ld	Bituminite	Telalginite	Lamalginite	Oil	cut
								0.5	<0.1	<0.1	<0.1	<0.1					

Sample Number..L0746.....Well Name...NEXUS,...CULVERIN-1.. Depth...3750-3755m...................................... ....
SampleType....Ctgs....
Date. ..25/.02/ 2006.. Op..SPR......... FGV - First Generation Vitrinite, RV - Reworked Vitrinite, BTT - Bituminite, B - Bitumen, Inert - Inertinite, Cav - Cavings, DA - Drilling Mud Additives

APPENDIX 3: CULVERIN-1 PETROPHYSICAL ANALYSIS REPORT

CULVERIN-1

OPEN-HOLE WIRE LINE LOG ANALYSIS

Angie Cernovskis
Petrophysicst
February 2006

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Executive Summary

Culverin-1 was drilled as an exploration well in the Gippsland Basin in Permit Area VIC/P56. The well spudded on 16 December 2005 and reached a total depth in 12.25” hole at 3758mMDRT on 6 January 2006.

During drilling of the 12.25” open-hole Sperry Drilling Services LWD logging system recorded GR-Resistivity-Neutron-Density in real time from 2700 to 3714mMD, at which depth communication with the tool was lost (subsequent recovery of tool memory data yielded only Neutron and Density data to 3732m and Resistivity data to 3697m). After total depth was reached wireline logging services were provided by Schlumberger using the PEX system.

For the purpose of formation evaluation the logs acquired by the Schlumberger PEX system have been used with Crocker Data Processing Petrolog Modules. The results obtained and methods used are summarised in this report.

Based on reservoir parameter cut-offs PHIE>=10%, VCL<=50% and SWE<100%, Culverin-1 intersected 1.52m net oil reservoir sand across the interval 3607.00-3609.29mMDRT. Reservoir properties across this zone are good with average PHIE 17.29%, average VCL 10.11% and average SWE 34.1%. An OWC cannot be resolved with log data; 3609.29mMDRT is Lowest Known Oil.

No other hydrocarbon bearing zones were identified from petrophysical analysis of the wireline (or LWD) log data.

The results are presented in Table 2.

General Information

All depths quoted in this report are mMDKB.

Well Name	**Culverin-1**				
Country	Australia				
Company	Nexus Energy				
Location	VIC/P56				
State	Victoria				
Permanent Dat.	LAT				
Elevation of DF (M)	21.5				
Depth to SF (M)	585				
Logging Co.	SCHLUMBERGER				
Logging Date	7 Jan 2006				
Logs Recorded	PEX-HALS-GR-DSI				
Run Number	1				
Bottom depth (M)	3757				
Top depth (M)	1511				
Casing shoe (M)	13.375@15 11.8				
Bit size (inch)	12.25				
Fluid Type	Mix Salt-Glydrill				
Density Ib/gal	10.15				
RM (Ohmm) @ TEMP (DegC)	0.068 @ 20.0				
RM (Ohmm) @ TEMP (DegC)	0.060 @ 21.0				
RM (Ohmm) @ TEMP (DegC)	0.083 @19.0				
Recorded by	N Sabanegh/Kasian S				

Table 1 General Information

Deviation

The maximum hole deviation measured was 4.30° at 2428-2457mMD. The final measured deviation survey was 2.98° at 3641m.

Data Acquisition and Quality Control

Digital data received was of acceptable quality, no further processing undertaken (other than correction to the TNPH). Due to different lengths back to measure points for the various logging tools, full log analysis was only possible down to 3731.5mMDRT.

Log Editing

Depth offsets occur between LWD curve data and PEX-HALS-GR curve data, but no depth alignments have been carried out between the two data sets. The PEX-GR has been assigned as the depth reference log and all PEX curves were examined for alignment using this reference.

All PEX log curves are sufficiently on depth..

All curves were recorded in the same run, there were no cycle skips observed on the sonic log.

A composite display of input logs is presented together with the results composite plot (Enclosure 1).

Environmental corrections

Borehole corrections were undertaken at wellsite. A further correction was applied to the neutron (TNPH) curve to reduce the effect of KCL in the mud system. No other corrections were applied.

Logs Used

The primary logs used in the interpretation were GR, HLLG, HLLS, RXO8, RHO8, HTNP, HDRA, PEF8, and DTCO.

Temperature Gradient

Using the Horner method the extrapolated BHT is 96.2^{0} C (Figure 1).

Run No.	TYPE OF LOG	Time Since Last Circ / BHT
1	PEX-HALS-DSI	22 hours 15mins/87.8C
1	PEX-HALS-DSI	22 hours 15mins/88.9C
2	VSI(4)	34hours 10mins/91C

	T	tL	log(tc+tL)/tL
Run 1	87.8	22.25	0.03594664
Run 1	88.9	22.25	0.03594664
Run 2	91	34.17	0.0237419

Note: Time circulated on bottom = 1.92 hours

T = measured temp
t_L = time since circ stopped
Tt_c = time circulated on bottom

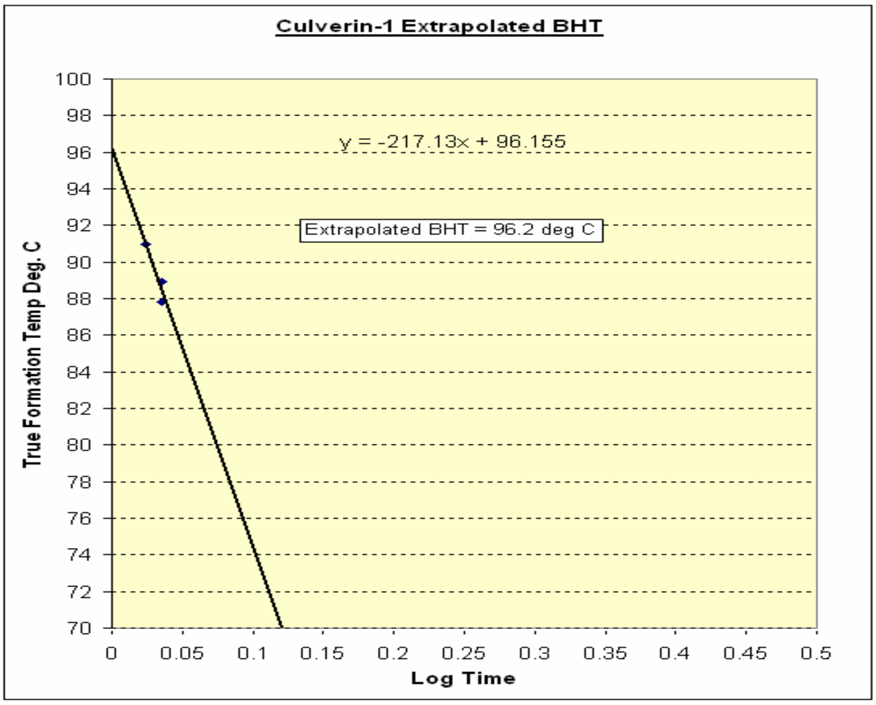

Figure 1. Culverin-1 Horner Plot

Hydrocarbon Type Identification

A combination of the neutron-density log character, resistivity anomaly, total density near and far counts, ditch gas readings and fluorescence shows described from cuttings shows were used to determine hydrocarbon types present for oil or gas.

A significant resistivity anomaly occurs across the interval 3605-3609mMDRT which has associated increases in ditch gas RESERVAL C_1-C_5 readings (Figure 2). This zone has been interpreted as oil bearing.

No other hydrocarbon-bearing intervals were identified by this petrophysical analysis.

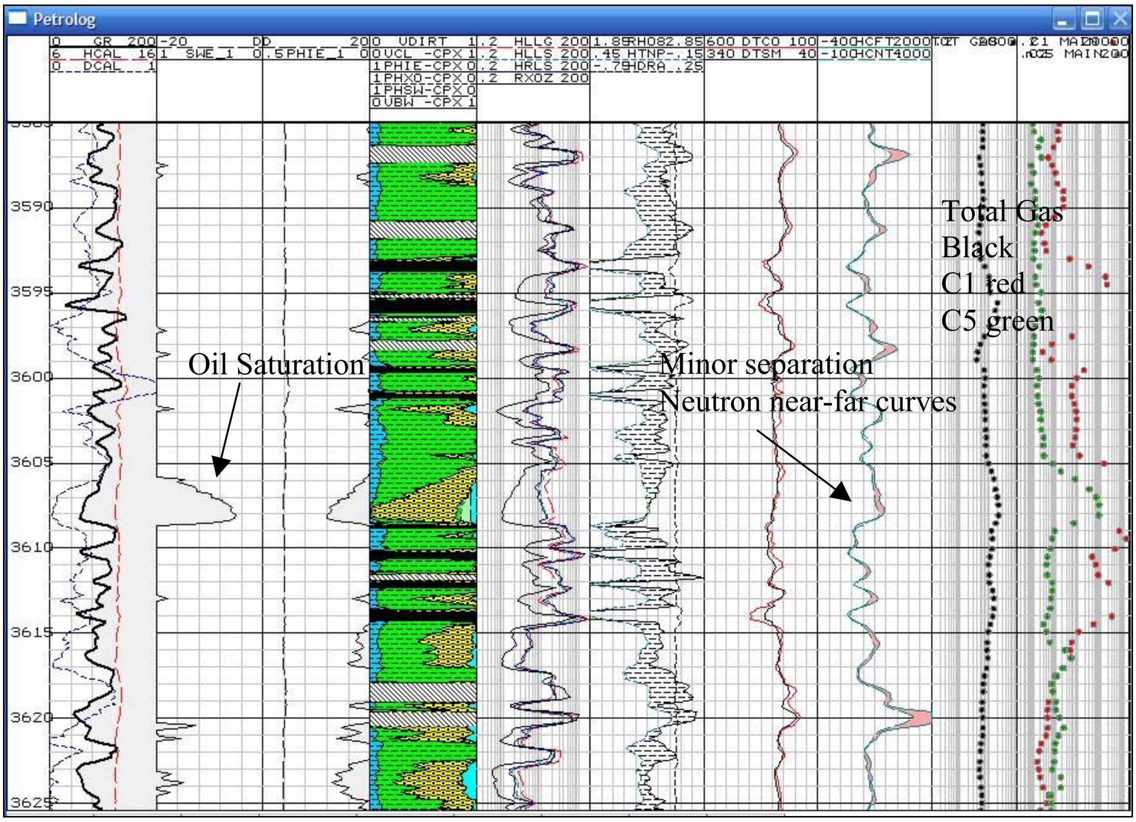

Figure 2. Culverin-1 Log and Reserval Gas anomalies

Petrolog Model Selection

The Complex Lithology Model (CPX) was selected for the interpretation. This is a deterministic model that computes Vclay, Vsilt, Vsand, Porosity (PHIT and PHIE) and Water Saturation (SWT, SWE).

Vclay, Vsilt, Vsand Determination

The CPX program used VGR, VN, VS, and VD-N to compute Vclay, Vsilt and Vsand.

Porosity Determination

Total porosity (PHIT) was calculated using input logs Density and Neutron.

Effective porosity was calculated after Vcl determination.

PHIE = PHIT (1-Vcl)

Rw Determination

An Rw (0.09@ formation temperature) equivalent to 25000ppm NaCl salinity was used. A PHIT-RT cross-plot across the water sand interval 3502-3509mMD (Figure 3) supports the use of this value.

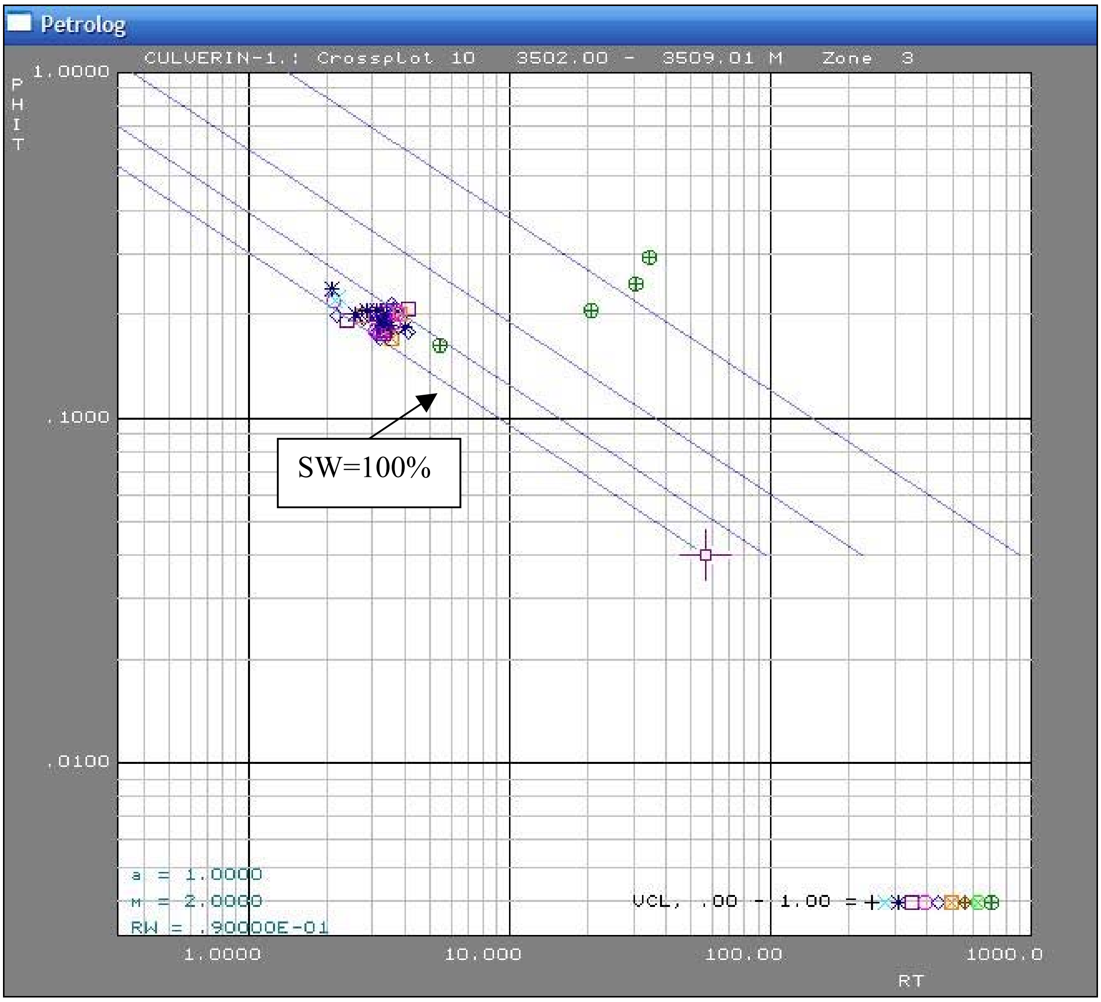

Figure 3. Culverin-1 PHIT-RT crossplot interval 3502-3509mMD

Determination of Sw, a, m, n

For this interpretation the **Indonesia equation** was used to compute water saturation (Sw) and is defined as follows:

Swe = (1.0 / (Y*SQRT(RT)))(2.0/n)**

And Y = VCL(1.0-VCL/2)/ SQRT(RCL) + PHIE**(m/2)/SQRT(a*Rw)**

In this interpretation a=1, m= 2.0 and n=2.0.

Results

Based on reservoir parameter cut-offs PHIE>=10%, VCL<=50% and SWE<100%, Culverin-1 intersected 1.52m net oil reservoir sand across the interval 3607.0-3609.29mMDRT.

Reservoir properties across this zone are good with average PHIE 17.29%, average VCL 11.11% and average SWE 34.1%. An OWC cannot be identified on the log data; 3609.29mMDRT is Lowest Known Oil (Figure 4).

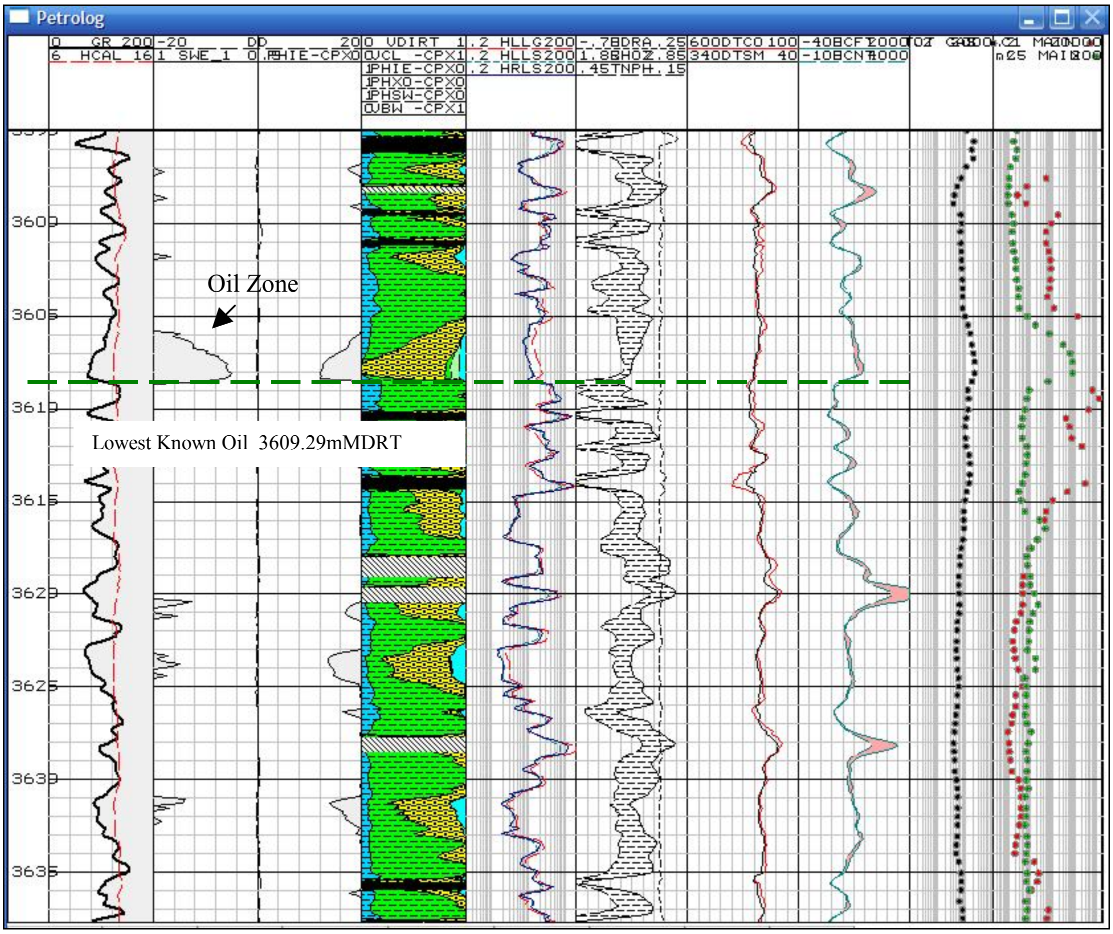

Figure 4. Culverin-1 oil zone.

No other hydrocarbon bearing zones were identified by petrophysical analysis in the well.

A summary of the results is presented in Table 2.

The input parameters are presented in Attachment 1.

A 1:500 scale Log Interpretation Plot spanning the entire Latrobe Group section is presented in ENCLOSURE 1.

Table 2: Culverin-1 Reservoir Summary across main zones of interest

FROM	TO	NET	AVERG	AVERG	AVERG	
		INTERVAL	VCL	PHIE	SWE	
mMD	mMD	m	%	%	%	Comments
2826.26	2829.46	3.20	17.44	19.00	100.0	Water Saturated
2829.92	2831.59	1.68	26.22	15.32	100.0	Water Saturated
2831.90	2835.55	3.66	25.00	16.19	100.0	Water Saturated
2837.84	2839.97	2.13	13.70	17.08	100.0	Water Saturated
2841.65	2844.09	2.44	7.30	21.03	100.0	Water Saturated
2845.31	2847.29	1.98	29.01	16.50	100.0	Water Saturated
2847.75	2849.27	1.52	26.43	14.91	100.0	Water Saturated
2849.73	2860.09	10.36	18.16	17.95	100.0	Water Saturated
2862.38	2865.88	3.51	16.67	18.67	100.0	Water Saturated
2869.54	2874.72	5.18	19.47	19.59	100.0	Water Saturated
2885.08	2888.89	3.81	22.72	18.78	100.0	Water Saturated
2895.60	2897.73	2.13	6.98	19.96	100.0	Water Saturated
2897.89	2902.31	4.42	17.34	21.64	100.0	Water Saturated
2918.00	2919.68	1.68	33.59	13.83	100.0	Water Saturated
2928.06	2929.13	1.07	34.90	12.61	100.0	Water Saturated
2966.62	2968.60	1.98	31.62	15.46	100.0	Water Saturated
2972.56	2974.54	1.98	8.94	19.48	100.0	Water Saturated
2975.15	2991.00	15.85	7.65	23.48	100.0	Water Saturated
2991.92	3002.43	10.21	8.44	25.62	99.9	Water Saturated
3003.35	3021.03	17.68	4.50	23.75	100.0	Water Saturated
3022.09	3023.77	1.68	36.03	15.74	100.0	Water Saturated
3025.44	3033.98	8.53	6.87	23.18	100.0	Water Saturated
3034.28	3044.65	10.36	8.05	23.44	100.0	Water Saturated
3047.85	3071.93	24.08	8.17	24.96	100.0	Water Saturated
3072.84	3081.22	8.38	11.52	21.70	100.0	Water Saturated
3081.83	3086.40	4.57	12.50	20.86	100.0	Water Saturated
3086.56	3091.89	5.33	9.17	24.28	100.0	Water Saturated
3103.78	3145.69	41.91	6.76	24.41	100.0	Water Saturated
3150.11	3154.98	4.88	2.80	22.57	100.0	Water Saturated
3156.66	3158.49	1.83	5.10	17.60	97.4	Water Saturated
3163.21	3164.59	1.37	20.29	19.25	99.8	Water Saturated
3167.94	3169.62	1.68	26.81	15.65	100.0	Water Saturated
3185.31	3190.95	5.64	10.86	24.35	100.0	Water Saturated
3196.89	3206.34	9.45	9.22	24.24	100.0	Water Saturated
3206.50	3207.56	1.07	17.94	19.65	100.0	Water Saturated
3207.72	3209.24	1.52	20.54	20.44	100.0	Water Saturated
3218.08	3219.30	1.22	26.78	19.07	100.0	Water Saturated
3219.60	3221.28	1.68	20.46	18.58	100.0	Water Saturated
3221.74	3223.26	1.52	27.26	19.00	99.9	Water Saturated
3229.36	3234.69	5.33	14.37	24.38	99.0	Water Saturated
3242.16	3243.83	1.68	17.33	20.20	98.7	Water Saturated
3284.68	3286.20	1.52	15.39	19.33	99.2	Water Saturated
3286.51	3288.18	1.68	19.09	20.99	97.1	Water Saturated
3294.13	3297.33	1.68	5.88	22.26	95.1	Water Saturated
3337.56	3344.27	6.71	13.01	19.31	96.8	Water Saturated

Cut-offs: :OIL= PHIE >=0.10%; Vcl <=50%; Swe <100%

Table 2 continued. Culverin-1 Reservoir Summary across main zones of interest

FROM	TO	NET	AVERG	AVERG	AVERG	
		INTERVAL	VCL	PHIE	SWE	
mMD	mMD	m	%	%	%	**Comments**
3362.86	3364.08	1.22	29.80	13.92	99.0	Water Saturated
3391.20	3393.34	2.13	17.16	16.03	99.9	Water Saturated
3422.14	3425.34	3.20	14.77	18.36	100.0	Water Saturated
3426.87	3429.91	3.05	13.34	19.23	96.1	Water Saturated
3450.49	3451.86	1.37	13.22	17.52	100.0	Water Saturated
3482.19	3484.93	2.74	17.21	18.13	93.7	Water Saturated
3493.47	3494.53	1.07	37.52	11.43	99.6	Water Saturated
3504.29	3505.35	1.07	35.78	11.92	100.0	Water Saturated
3507.03	3508.40	1.37	28.32	12.32	100.0	Water Saturated
3607.00	3609.29	1.52	10.11	17.29	34.1	Oil Saturated
3623.16	3624.68	1.52	29.10	13.83	95.5	Water Saturated

Cut-offs: :OIL= PHIE >=0.10%; Vcl <=50%; Swe <100%

Attachment 1: Petrolog Input Parameters

Petrolog

Zone no.		1	2	3	4
Top depth	M	601.523	2825.191	3502.000	3509.162
Bottom depth	M	2825.039	3501.847	3509.010	3759.708
Formation Name					
Top depth	M	601.523	2825.191	3502.000	3509.162
Bottom depth	M	2825.039	3501.847	3509.010	3759.708
Model(CPX,SS		CPX	CPX	CPX	CPX
Facies		.000	.000	.000	.000
No logs					
RM	ohmm	.0680000	.0680000	.0680000	.0680000
Temp. RM	degC	20.000	20.000	20.000	20.000
RMF	ohmm	.0600000	.0600000	.0600000	.0600000
Temp. RMF	degC	21.000	21.000	21.000	21.000
RMC	ohmm	.0830000	.0830000	.0830000	.0830000
Temp. RMC	degC	19.000	19.000	19.000	19.000
Bit size	inch	12.500	12.500	12.500	12.500
Mud wt	gm/cc	1.220	1.220	1.220	1.220
Mud pres PSI		2969.350	5482.811	6075.519	6298.972
SSP		.000	.000	.000	.000
RW (SP)	ohmm	.0261366	.0190747	.0179322	.0175362
Temperature	degC	64.140	95.860	103.340	106.160
RW @ FT	ohmm	.112	.0900000	.0900000	.0900000
RW@75F(23.9C	ohmm	.212	.233	.247	.253
RW salinity	ppm	30000	27069	25281	24665
RMF @ FT	ohmm	.0297895	.0217407	.0204385	.0199871
RMF salinity	parts	.147	.147	.147	.147
RM @ FT	ohmm	.0329678	.0240602	.0226191	.0221196
RHO H	gm/cc	.800	.800	.800	.800
Gas Flag		.000	.000	.000	.000
RHO F	gm/cc	1.098	1.094	1.093	1.092
t F	us/ft	188.961	188.961	188.961	188.961
RHOMA	gm/cc	2.650	2.650	2.650	2.650
PHIN min		-.0350000	-.0350000	-.0350000	-.0350000
t MA	us/ft	55.500	55.500	55.500	55.500
t MA min	us/ft	48.000	48.000	48.000	48.000
Sonic option		1.000	1.000	1.000	1.000
Compact/Ovrt		1.000	1.000	1.000	1.000
CAL cut off	inch	16.000	16.000	16.000	16.000
RUGO.cut off	inch	1.000	1.000	1.000	1.000
DRHO cut off	gm/cc	.150	.150	.150	.150

Attachment 1 continued

Petrolog

Zone no.		1	2	3	4
Top depth	M	601.523	2825.191	3502.000	3509.162
Bottom depth	M	2825.039	3501.847	3509.010	3759.708
Formation Name					
Bad Hole		1.000	1.000	1.000	1.000
No clay		SP GR RT	SP GR RT	SP GR RT	SP GR RT
Vclay Flag		.000	.000	.000	.000
Vclay type		.000	.000	.000	.000
Vclay inp1		.200	.200	.200	.200
Vclay out1		.150	.150	.150	.150
Vclay inp2		.800	.800	.800	.800
Vclay out2		.800	.800	.800	.800
Vclay 50%		.500	.500	.500	.500
VclayGR type		1.000	1.000	1.000	1.000
GR clean		20.000	20.000	20.000	20.000
GR clay		100.000	100.000	100.000	100.000
GR1		36.000	36.000	36.000	36.000
VGR1		.100	.100	.100	.100
GR2		84.000	84.000	84.000	84.000
VGR2		.800	.800	.800	.800
GR50%		70.000	70.000	70.000	70.000
R clay		2.000	20.000	20.000	20.000
R limit		1000.000	1000.000	1000.000	1000.000
Rclay1 flag		.000	.000	.000	.000
Rclay1		1.000	1.000	1.000	1.000
Vcl @ Rclay1		.150	.150	.150	.150
RHOB sand	gm/cc	2.150	2.150	2.150	2.150
RHOB silt	gm/cc	2.680	2.680	2.680	2.680
RHOB clay	gm/cc	2.400	2.400	2.400	2.400
RHO Dry Clay	gm/cc	2.700	2.700	2.700	2.700
Rhob Calcite		2.850	2.850	2.850	2.850
PHIN Sand		.250	.250	.250	.250
PHIN silt		.0200000	.0200000	.0200000	.0200000
PHIN clay		.270	.270	.270	.270
Phin Calcite		.100	.100	.100	.100
PHISILT		.000	-.0192763	-.0192638	-.0192591
Calcite Flag		.000	.000	.000	.000
t clay	us/ft	100.000	100.000	100.000	100.000
M clay		.682	.681	.680	.680
N clay		.560	.559	.558	.558

Attachment 1 continued

Petrolog

Zone no.		1	2	3	4
Top depth	M	601.523	2825.191	3502.000	3509.162
Bottom depth	M	2825.039	3501.847	3509.010	3759.708
Formation Name					
PHIN 2.2		.235	.235	.235	.235
t 2.2	us/ft	90.000	90.000	90.000	90.000
a		1.000	1.000	1.000	1.000
A1		1.000	1.000	1.000	1.000
m		2.000	2.000	2.000	2.000
m1		2.000	2.000	2.000	2.000
m Function		1.000	1.000	1.000	1.000
n		2.000	2.000	2.000	2.000
n1		2.000	2.000	2.000	2.000
B from BQV		9.747	13.694	14.379	14.622
A(QV)		.0003050	.0003050	.0003050	.0003050
B(QV)		-3.450	-3.450	-3.450	-3.450
SXO limit		.200	.200	.200	.200
PHI max		.400	.400	.400	.400
PHI min c.o.		.0100000	.0100000	.0100000	.0100000

Attachment 2: Culverin-1 DLIS Header File

```
~VERSION INFORMATION
VERS.          2.0   :CWLS Log ASCII Standard - VERSION 2.0
WRAP.          NO    :One Line per depth step
PROD.  Schlumberger   :LAS Producer
PROG.  DLIS to ASCII 2.2                    :LAS Program name and version
CREA.      2006/02/22 15:18                 :LAS Creation date {YYYY/MM/DD hh:mm}
SOURCE.    Culverin-1_TD-2775m_HighRes_PUC.DLIS       :DLIS File Name
FILE-ID.    HALS_DSI_TLD_MCFL_044PUC                :File Identification Number
#--------------------------------------------------
~WELL INFORMATION
#MNEM.UNIT      DATA          DESCRIPTION
#---- ------ --------------   -----------------------------
STRT .F        12335.0       :START DEPTH
STOP .F         9056.5       :STOP DEPTH
STEP .F           -0.5       :STEP
NULL .          -999.25      :NULL VALUE
COMP .       Nexus Energy                    :COMPANY
WELL .       Culverin 1                      :WELL
FLD  .       Exploration                     :FIELD
LOC  .       VIC / P56                       :LOCATION
CNTY .       Ocean Patriot                   :COUNTY
STAT .       Victoria                        :STATE
CTRY .       Australia                       :COUNTRY
API  .                                       :API NUMBER
UWI  .                                       :UNIQUE WELL ID
DATE .       07-Jan-2006                     :LOG DATE {DD-MMM-YYYY}
SRVC .       Schlumberger                    :SERVICE COMPANY
LATI .DEG     38 24' 8.14" S                 :LATITUDE
LONG .DEG     148 39' 41.92" E               :LONGITUDE
GDAT .                                       :GeoDetic Datum
#----------------------------------------------------------------------------
~PARAMETER INFORMATION
#MNEM.UNIT    VALUE                  DESCRIPTION
#---- -----   --------------------      ------------------------
RUN  .         1                  :RUN NUMBER
PDAT .       LAT                  :Permanent Datum
EPD  .M         0.000000          :Elevation of Permanent Datum above Mean Sea Level
EPD  .M         0.000000          :Elevation of tool zero above Mean Sea Level
LMF  .       Drill Floor          :Logging Measured From (Name of Logging Elevation Reference)
APD  .M        21.500000          :Elevation of Depth Reference (LMF) above Permanent Datum
#----------------------------------------------------------------------------
~CURVE INFORMATION
#MNEM.UNIT   API CODE                      DESCRIPTION
#---- -----  --------                 -----------------------
DEPT .F                               :DEPTH (BOREHOLE) {F10.1}
DTCO .US/F                            :Delta-T Compressional {F13.4}
DTSM .US/F                            :Delta-T Shear {F13.4}
PR   .                                :Poisson's Ratio {F13.4}
VPVS .                                :Compressional to Shear Velosity Ratio {F13.4}
HCAL .IN                              :HRCC Cal. Caliper {F13.4}
HRLD .OHMM                            :HALS High Resolution Deep Resistivity {F13.4}
HRLS .OHMM                            :HALS High Resolution Shallow Resistivity {F13.4}
HDI  .IN                              :HALS Computed Diameter of Invasion {F13.4}
HDRA .G/C3                            :HRDD Density Correction {F13.4}
PEF8 .                                :HRDD High Resolution Formation Photoelectric Factor {F13.4}
RHO8 .G/C3                            :HRDD High Resolution Formation Density {F13.4}
```

Attachment 2 continued

```
RXO8 .OHMM          :MCFL High Resolution Invaded Zone Resistivity {F13.4}
EHGR .GAPI          :HiRes Gamma-Ray {F13.4}
HGR  .GAPI          :HiRes Gamma-Ray {F13.4}
HTNP .V/V           :HiRes Thermal Neutron Porosity {F13.4}
HCFT .HZ            :HiRes Corrected Far Thermal Count Rate {F13.4}
HCNT .HZ            :HiRes Corrected Near Thermal Count Rate {F13.4}
#-----------------------------------------------------------------------------
```

CULVERIN-1: OPEN-HOLE WIRE LINE LOG ANALYSIS

ENCLOSURE 1: 1:500 scale Log Interpretation Plot
(see ENCLOSURE 2: CULVERIN-1 PETROPHYSICAL ANALYSIS LOG of main report)

APPENDIX 4: SEISMIC INTERPRETATION AND DEPTH CONVERSION

CULVERIN-1 WELL:
POST-DRILL SEISMIC INTERPRETATION AND DEPTH CONVERSION ANALYSIS REPORT

By

Ian G. Ward
Basian Enterprises

Culverin-1 Well: Post-drill Seismic Interpretation and Depth Conversion Analysis.

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LIST OF FIGURES

Introduction

The Culverin-1 (3758m MDRT) well was drilled in VIC/P56, a small rectangular permit (9.2km x 14.4km) situated on the eastern flank of the main play fairway within the Gippsland Basin (Figure 1).

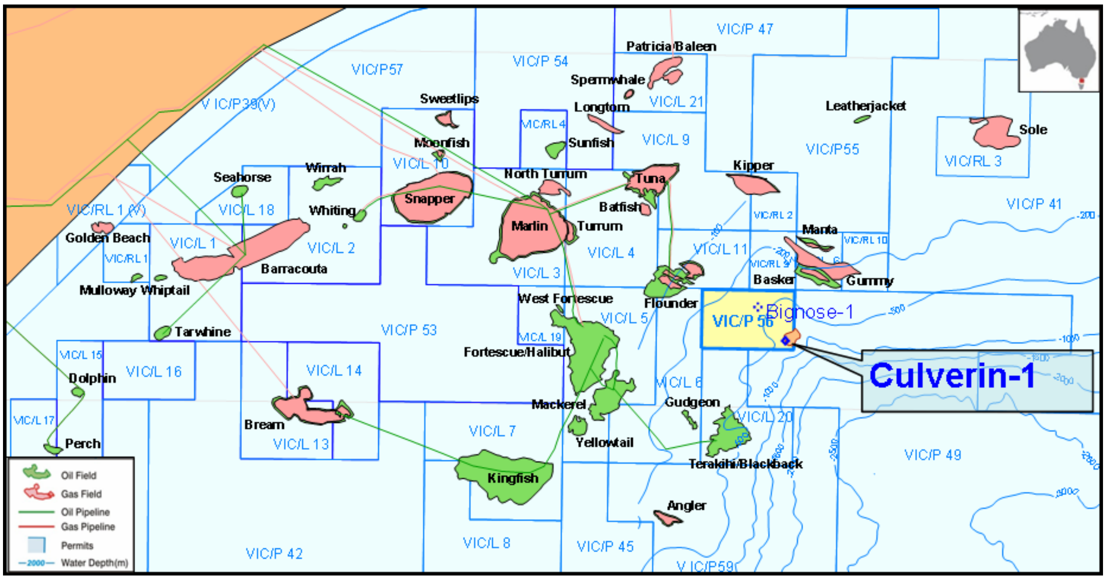

Figure 1: Culverin-1 well, Gippsland Basin, Location Map.

The well was located in the south eastern corner of VIC/P56 in 585m of water (Figure 2).

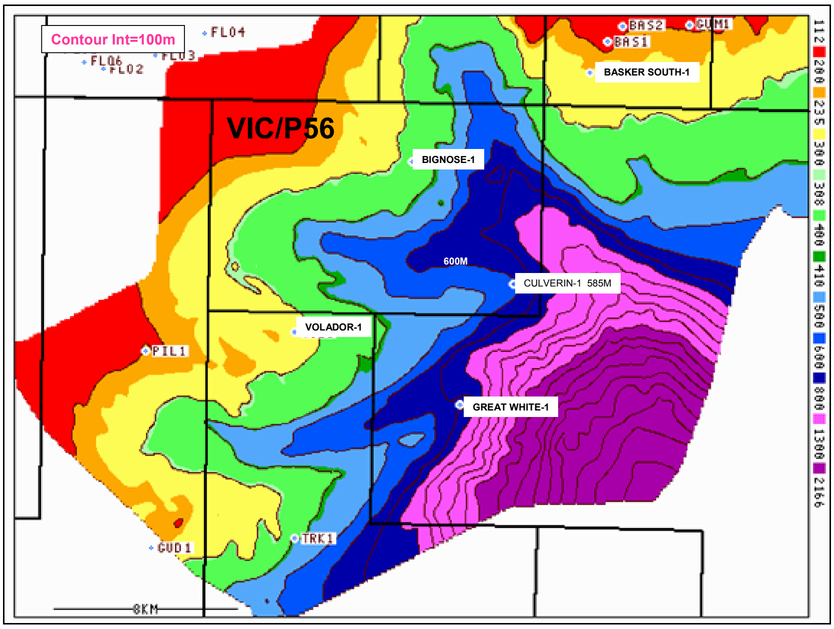

Figure 2: VIC/P56 Region Water Depth Map (contour interval 100 m).

The irregular water bottom across the area, and the various attempts to rectify the effects of this on the seismic data, has resulted in a set of non compatible seismic data being generated. The problem was addressed during the prospect generation work phase, by producing a uniform seismic data set using post stack processes.

The well was prognosed to intersect a range of targets beginning at the highly eroded Top Latrobe Formation, followed by a series of interbedded sandstone reservoir sections separated by sealing shales. The intra formational traps beneath the Top Latrobe Formation were proposed to be combinations of small four way dip closures, fault traps and erosional truncations (Figure 3). As a result of this complexity, it was not possible to drill the crest at each target level, and a well location based on best overall trap configuration was used. The reservoir section beneath the Top Latrobe Formation and Base Tuna Flounder Channel section was interpreted to be shale prone and therefore it was not considered critical, to penetrate the crest at these levels.

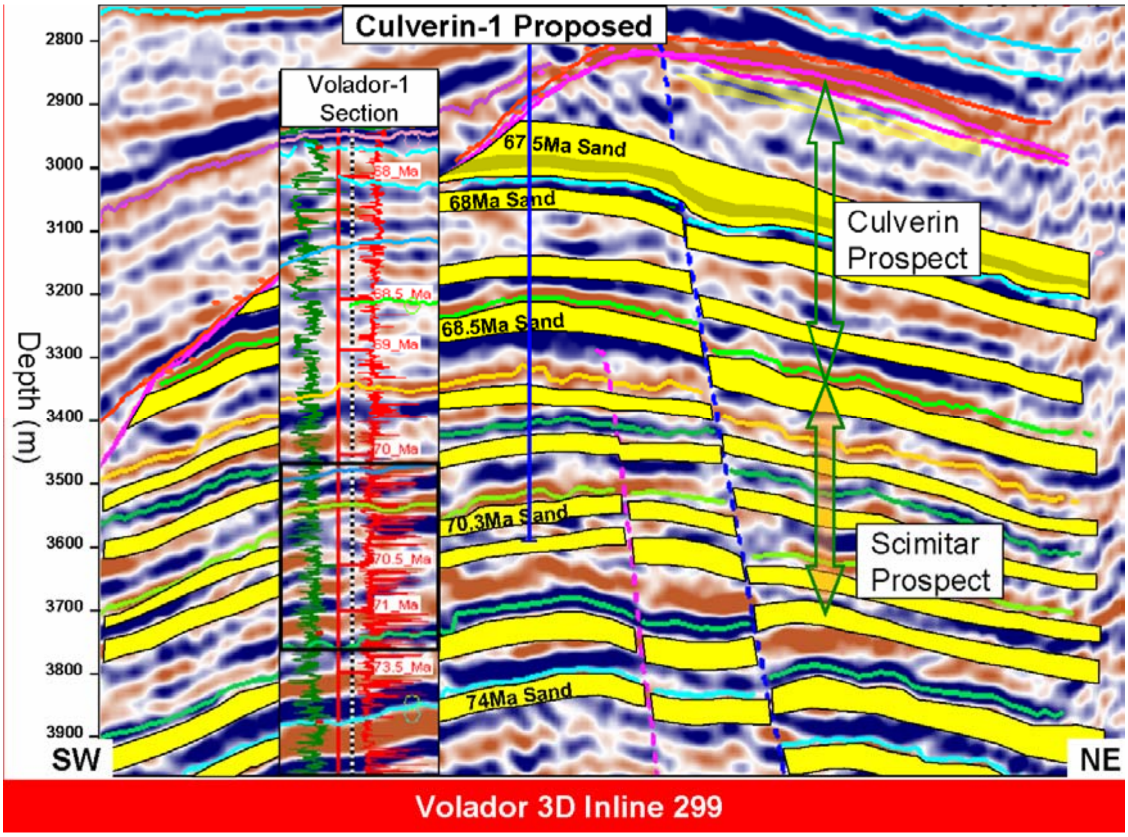

Figure 3: Culverin and Scimitar Prospects Definition.

Prospect Generation Process

Three vintages of seismic data were used in the seismic interpretation and mapping for the generation of the Culverin/Scimitar prospect (Figure 4).

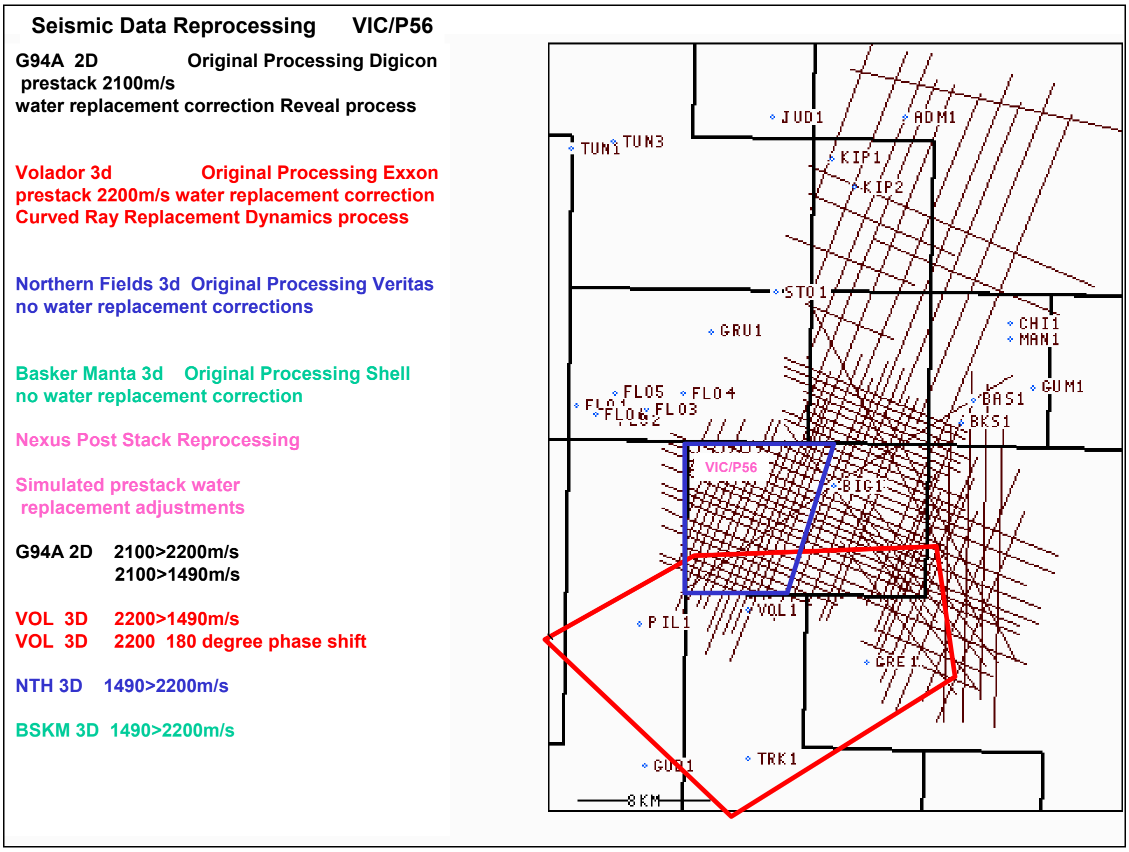

Figure 4: VIC/P56 Seismic Data Reprocessing.

<u>G94A 2D Seismic Survey</u>
Original processing performed by Digicon. A 2100m/sec pre-stack water replacement correction was applied to the data using the Digicon proprietary Reveal process. This process not only replaces the 1490m/sec water layer, but attempts to correct the distortion within moveout gathers caused by water bottom variations, to produce true geological velocities. The time migration of this water replaced data is also more accurately performed than non water replaced seismic data.

<u>Volador 3D Seismic Survey</u>
Original processing performed by Exxon. A 2200m/sec pre stack water replacement correction was applied to the data using a proprietary process similar to the Digicon method.

<u>Northern Fields 3D Seismic Survey</u>
Original processing by Veritas. No water replacement corrections applied.

The three data sets were made compatible by using a process of simulated pre stack water replacement corrections to generate data sets with water replacement corrections of 2200m/sec.

In the case of the Volador 3D the data was left unchanged except for a polarity reversal to phase match the other two surveys.
The G94A 2D was shifted from 2100m/sec to 2200m/sec water replacement correction, and the Northern Fields 3D from 1490m/sec to 2200m/sec.
The data was shifted by first calculating the average water bottom time contained within a notional straight ray path for the seismic mute, for each sample on each seismic trace (Figure 5).
The seismic stacking velocity data files were correspondingly adjusted to compensate for the changes.

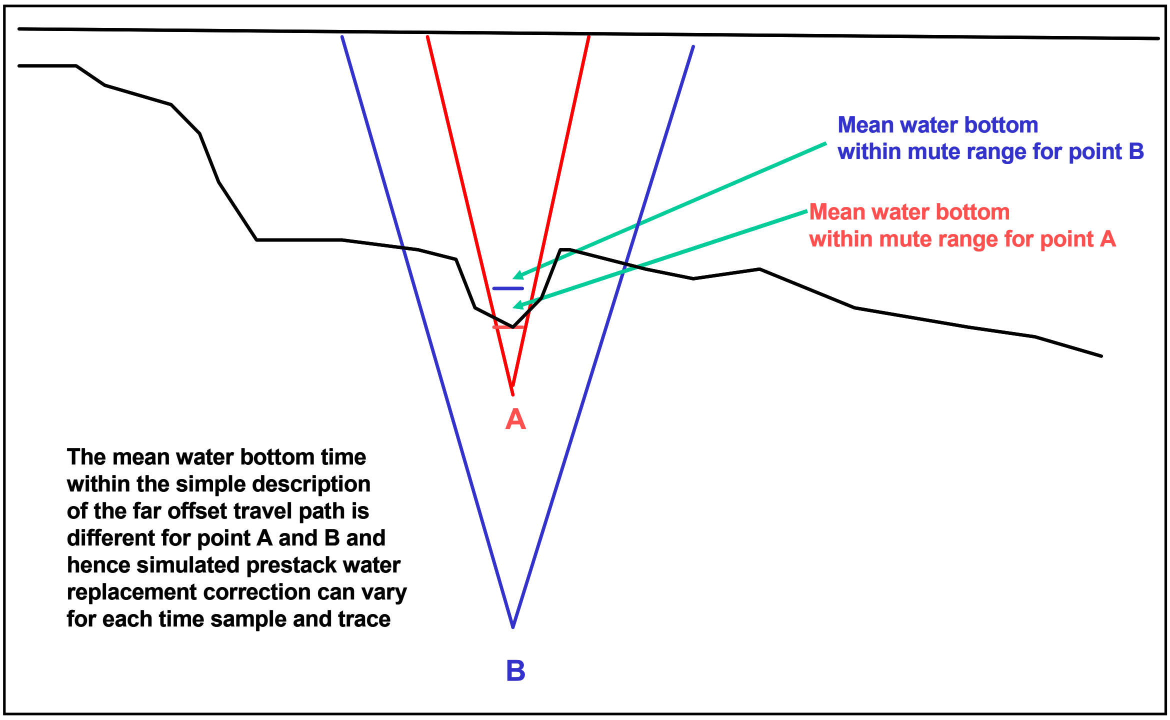

Figure 5: Simulated Prestack Water Replacement Corrections

Seismic time maps were constructed from the seismic interpretation of seven key seismic horizons;
Base High Velocity Channeling
Top Latrobe Group (Figure 6)
Base Tuna Flounder Channel (Figure 7)
67.5 my marker
68.5my marker (Figure 8)
70.3my marker (Figure 9)
74my marker

The depth conversion of these time horizons was done using smoothed Dix corrected stacking velocities to the Top Latrobe Formation. This velocity grid was calibrated to the well ties as a final step using a velocity error ratio with 1/R^2 distribution. Depth conversion to other horizon levels was based on well interval velocities.

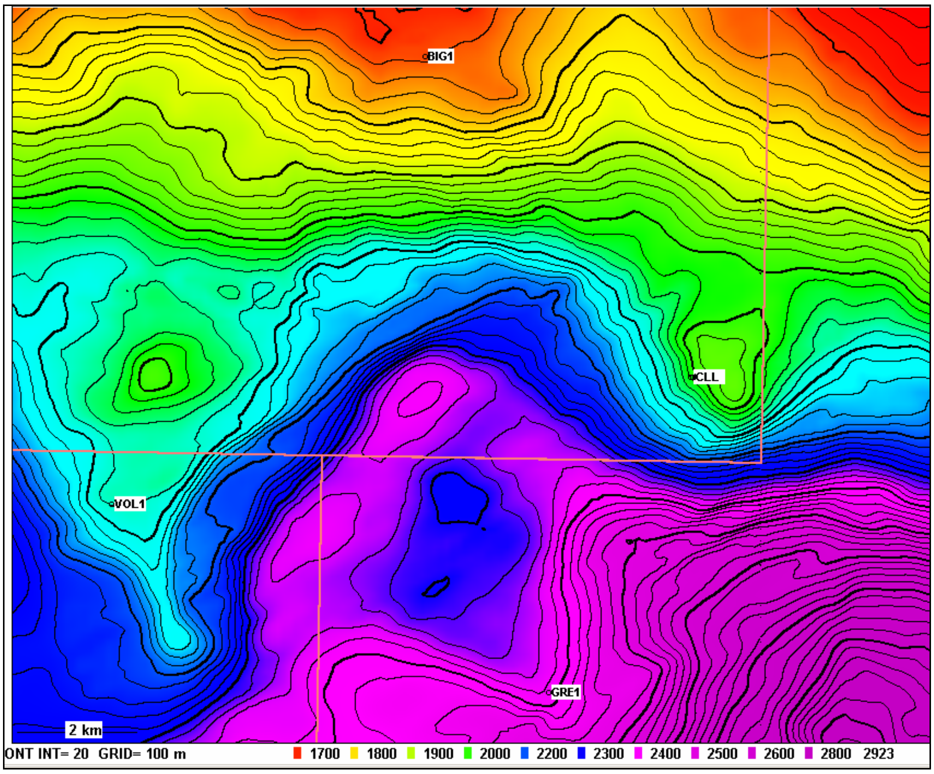

Figure 6: Top Latrobe Time Map (contour interval = 20 msec).

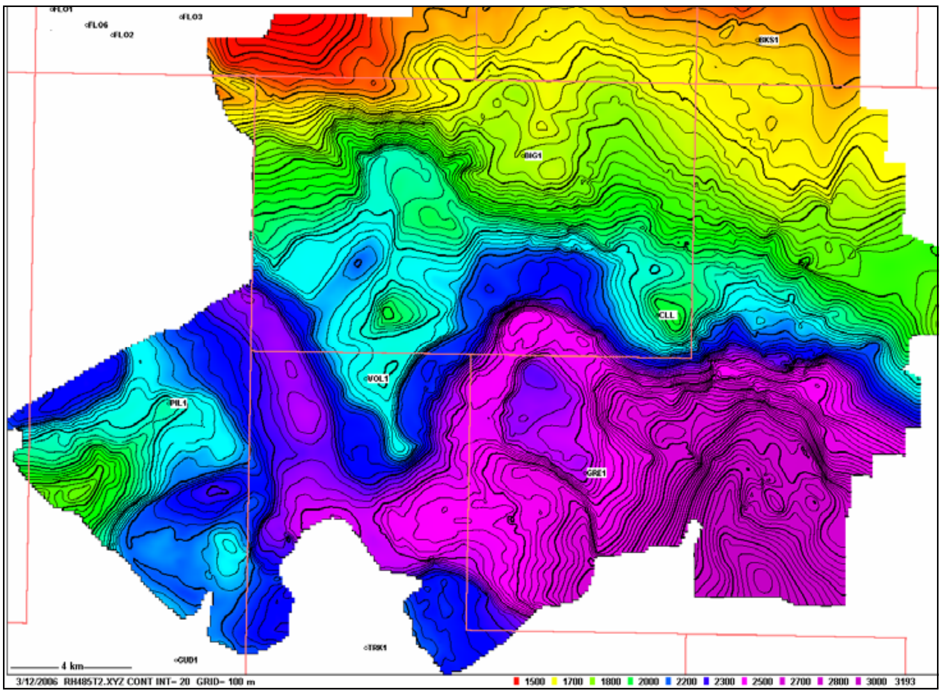

Figure 7: Base Tuna Flounder Channel Time Map (contour interval = 20 msec)

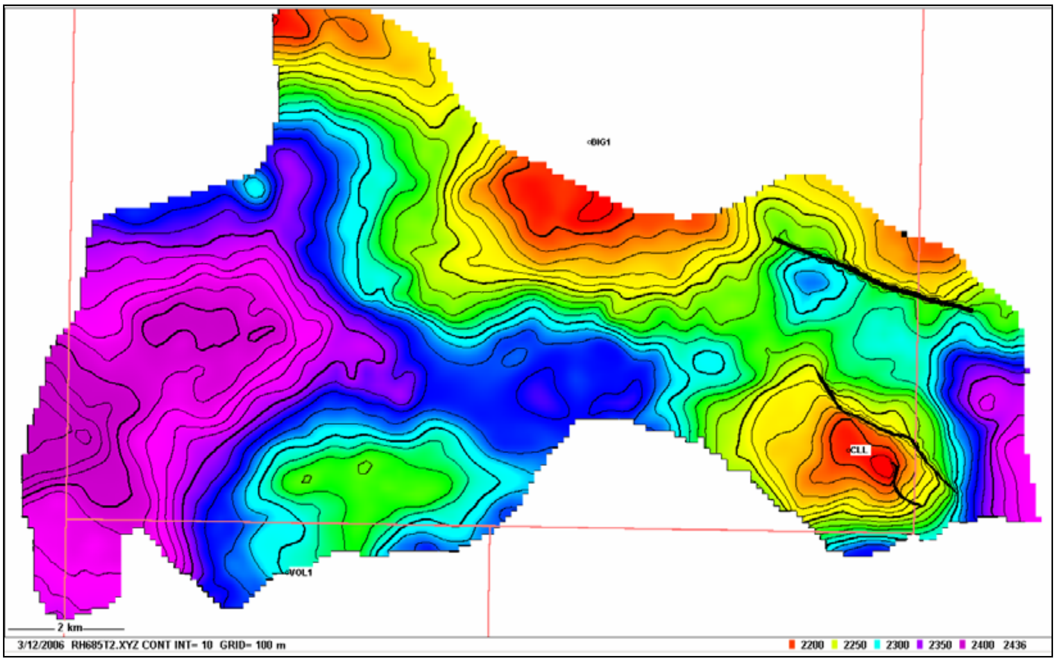

Figure 8: 68.5 Ma Maker Time Map (contour interval = 10 msec)

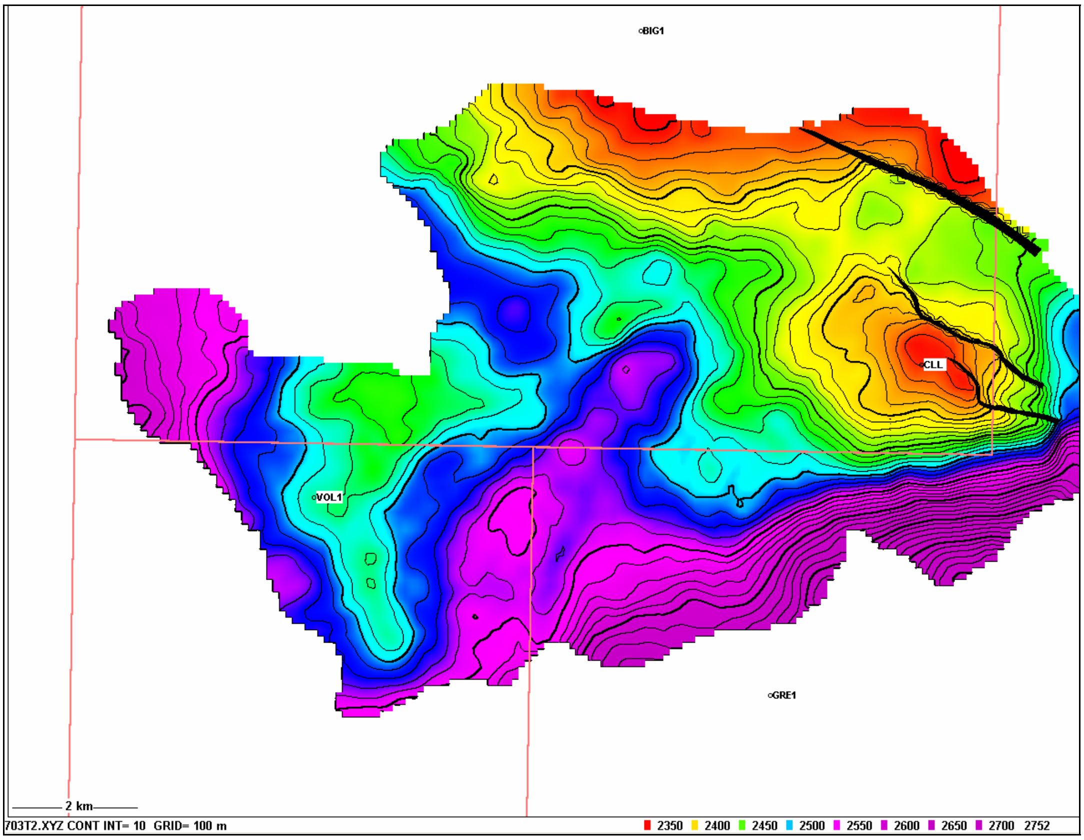

Figure 9: 70.3 Ma Maker Time Map (contour interval = 10 msec).

The stacking velocity data showed a significant regional anomalous velocity variation, that in part was supported by the well velocities. This velocity variation was from low velocities in the south to higher towards the north and most notably north of the Culverin/Scimitar prospect. The net effect of this velocity variation was to enhance the structural closure of the prospect. Figure 10 is a Dix corrected, unsmoothed, uncalibrated average velocity grid to the Top Latrobe formation, overlain by the water bottom contours. The water replacement corrections have removed most of the low velocity effects of the water bottom channels and it also can be seen that there is no significant regional correlation of the velocity field with the water bottom shape (except in the very deep water to the southeast). The high velocity zone passing partly through and supported by the Bignosel-1 well results, is from a velocity variation within the shallow carbonates section and above all mapped horizons.

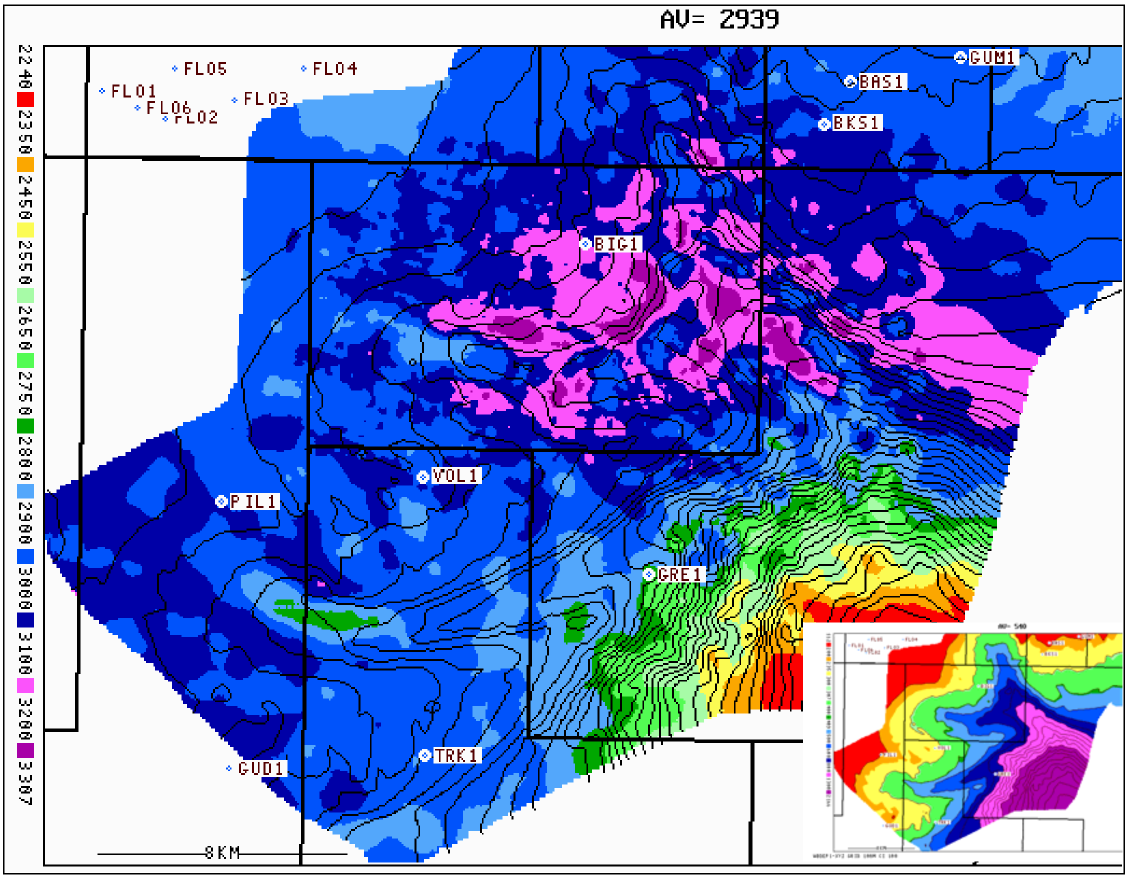

Figure 10: Dix corrected, unsmoothed, uncalibrated average velocity grid to the Top Latrobe formation, overlain by the water bottom.

Depth maps for Top Latrobe, Base Tuna Flounder Channel, 68.5my Marker and 70.3my marker are displayed in Figure 11, Figure 12, Figure 13 and Figure 14.

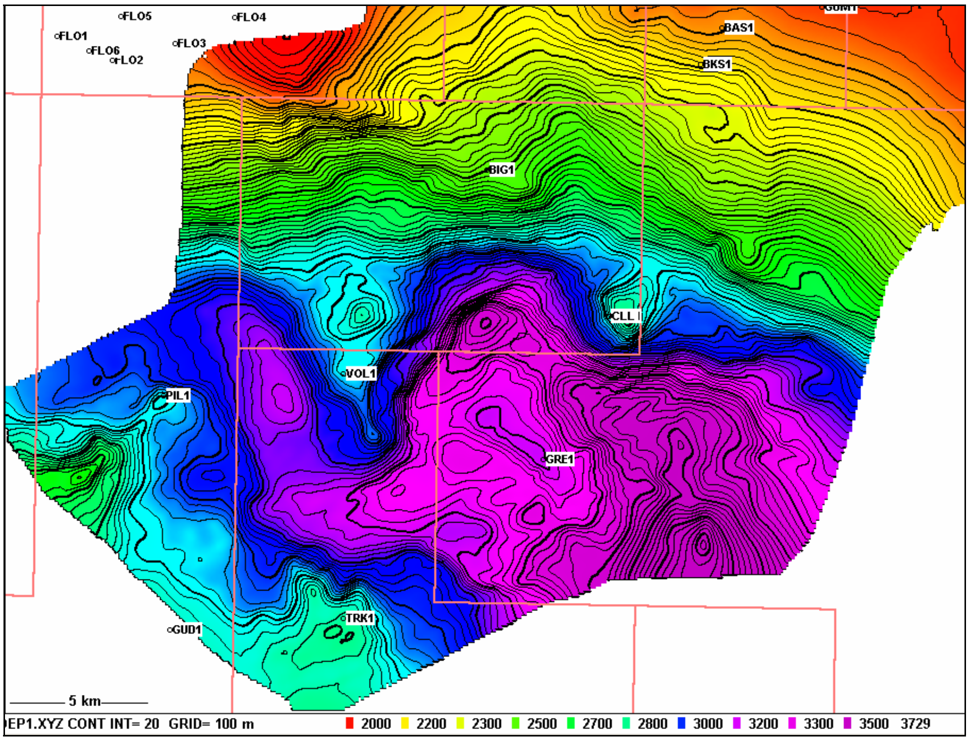

Figure 11: Top Latrobe depth map pre-drilling of Culverin-1 (contour interval = 20 m)

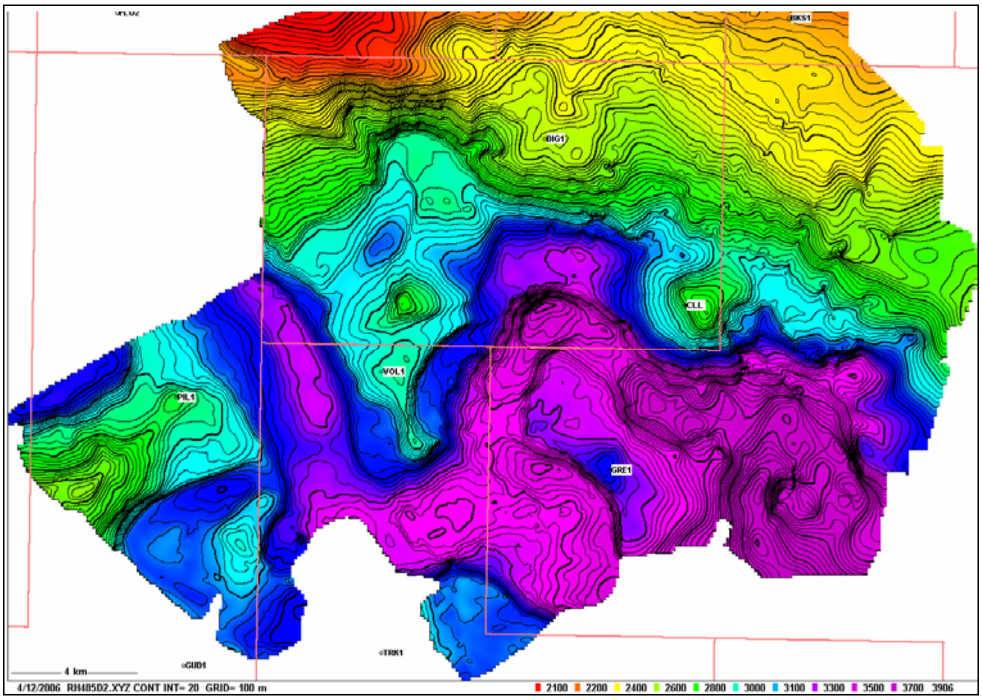

Figure 12: Base Tuna Flounder Channel depth map pre-drilling of Culverin-1 (contour interval = 20 m).

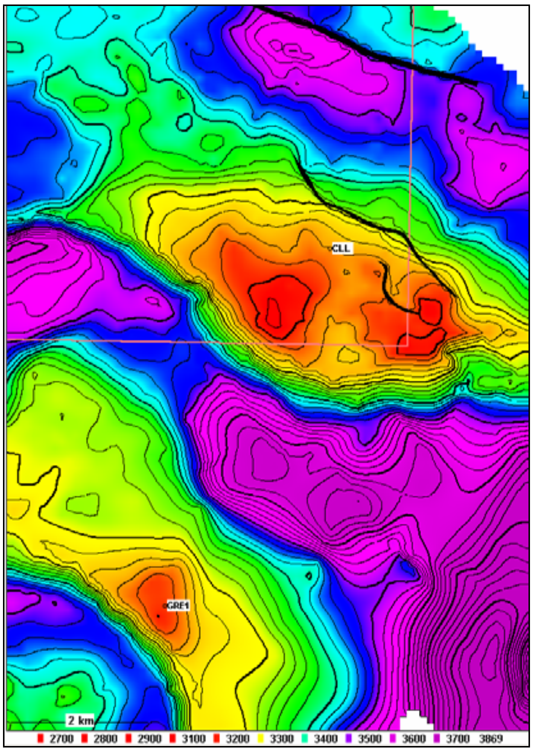

Figure 13: 68.5 Ma Marker depth map pre-drilling of Culverin-1 (contour interval = 20 m).

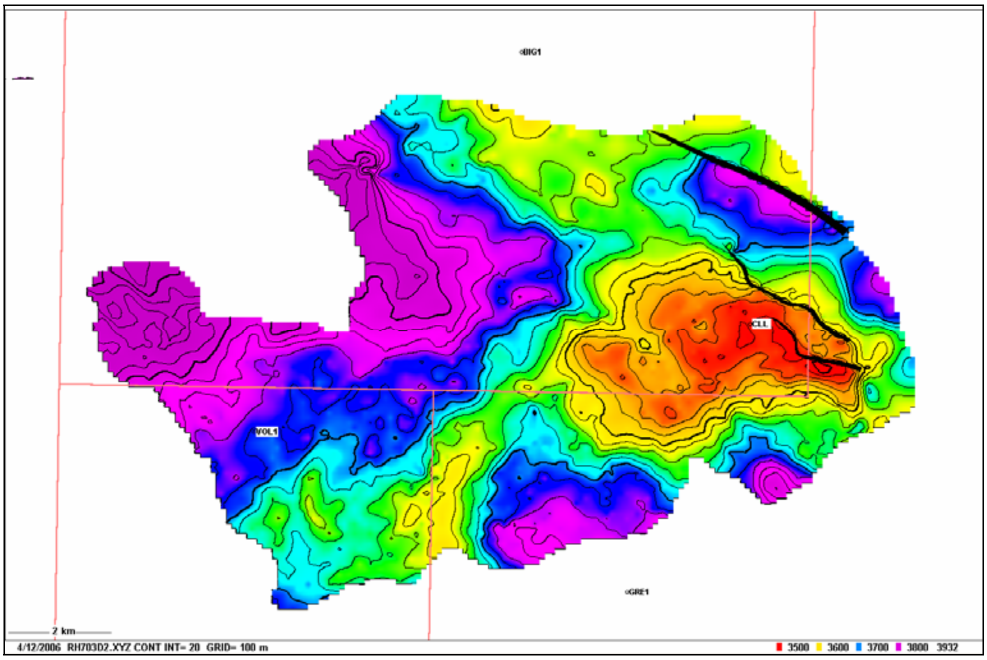

Figure 14: 70.3 Ma Marker depth map pre-drilling of Culverin-1 (contour interval = 20 m).

Results

The Culverin-1 well was drilled to 3758 metres MDRT . No Significant hydrocarbon accumulation was encountered and the geological equivalents of all seismic horizons came in shallow to prognosis.

A synthetic seismogram with quadrature phase was generated from the sonic and checkshot data (Figure 15). The synthetic seismogram was a good match to the seismic data when shifted down 17msecs. (Figure 16). The tie was good for all seismic markers except in the close proximity of the eroded slope of the Top Latrobe Group and Base Tuna Flounder Channel (Figure 17). This 11msec deep mis-tie is most likely an artifact of the seismic migration, rather than a general mis-pick at these levels. Both of these time shifts contributed to the well coming in shallow at these levels. Figure 18, Figure 19 and Figure 20 show a breakdown of the depth prognosis errors for the Top Latrobe, Base Tuna Flounder Channel and 68.5 my year markers.

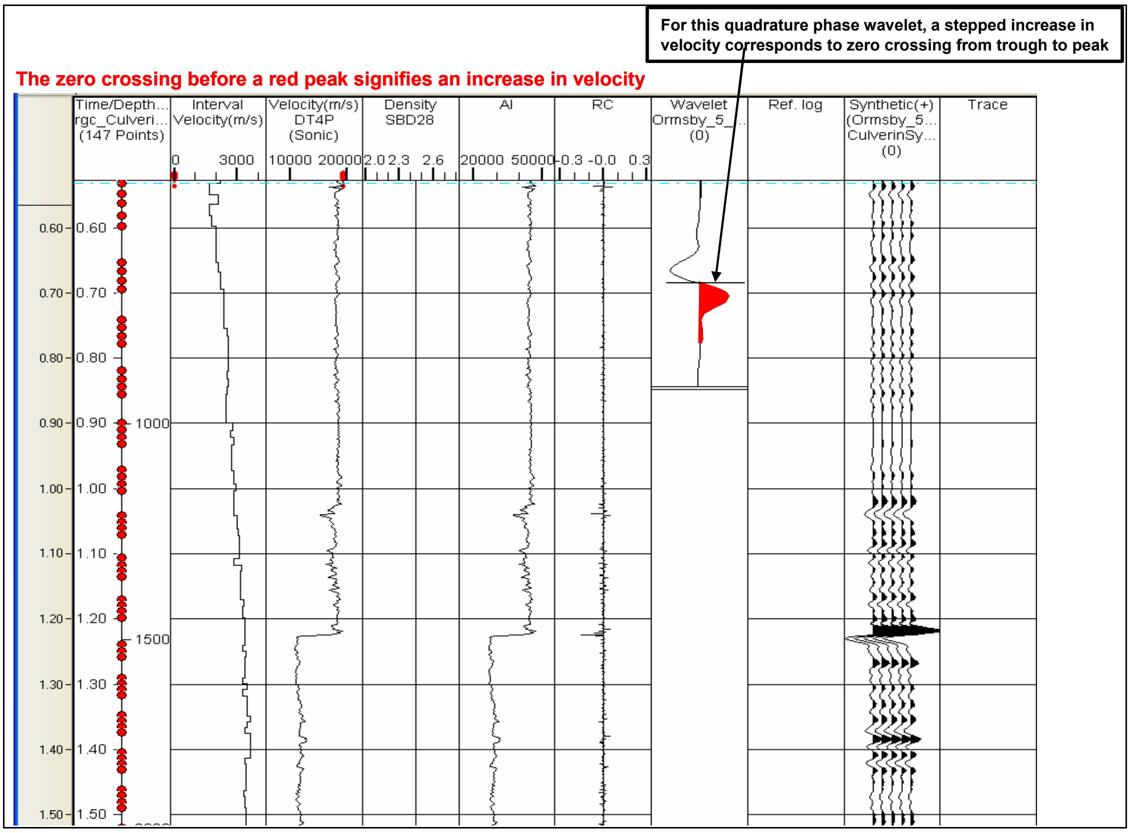

Figure 15: Culverin-1 Synthetic Seismogram (Quadrature Phase).

As a first pass analysis of the prognosis errors at the various seismic marker levels, the prognosis errors were distributed as a linear error in interval velocity between the seafloor and the mapped horizon. This resulted in increase in vertical relief at all levels;

Top Latrobe	80m >100m
Base Tuna Flounder Channel	160m>180m

68.5 MY Marker	220m >280m
70.3 MY Marker	120m >180m

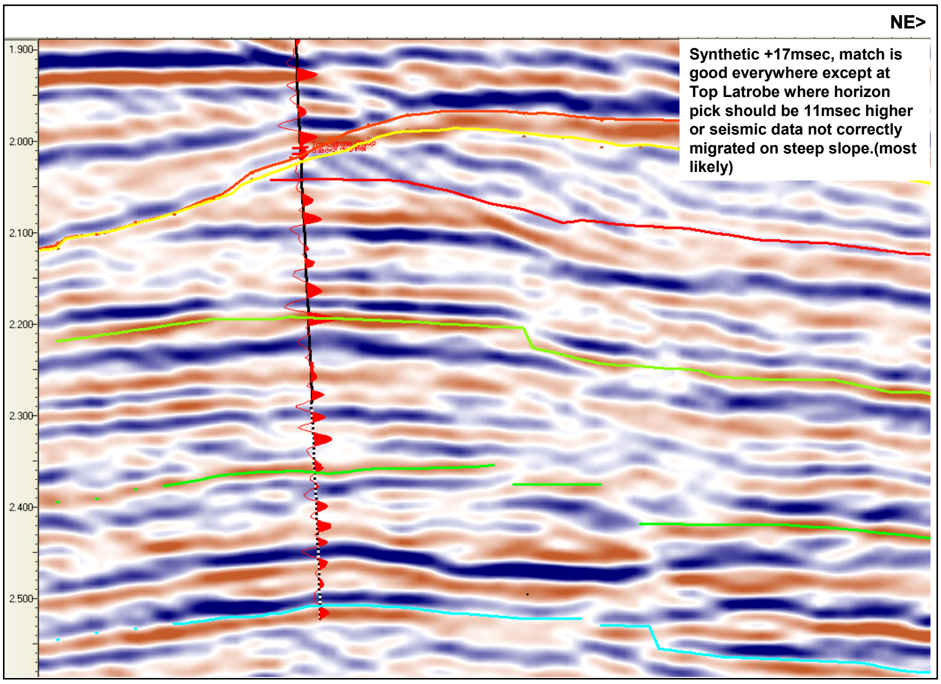

Figure 16: Volador 3D Inline-297 with Culverin-1 synthetic seismogram with 17msec added.

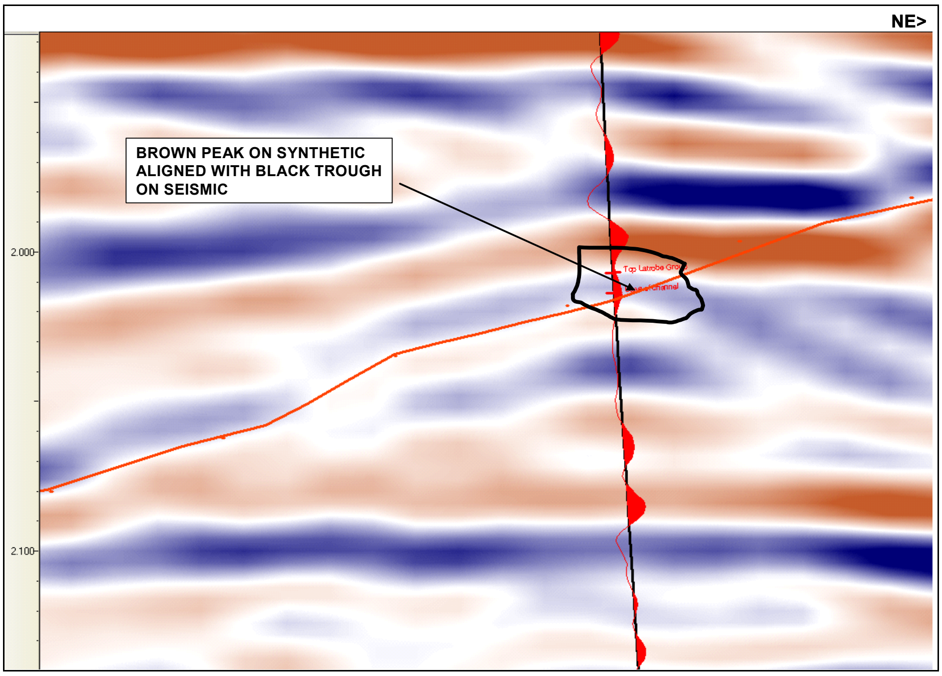

Figure 17: Volador 3D Inline-297 Top Latrobe 11msec deep mismatch.

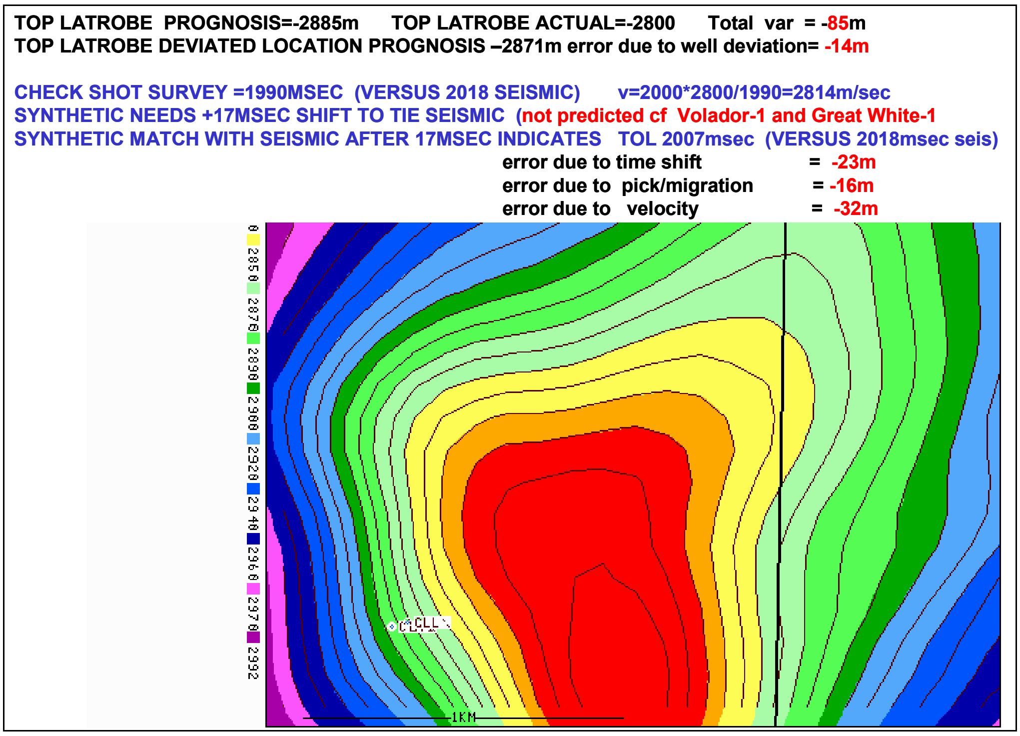

Figure 18: Breakdown of the depth prognosis errors for the Top Latrobe Group.

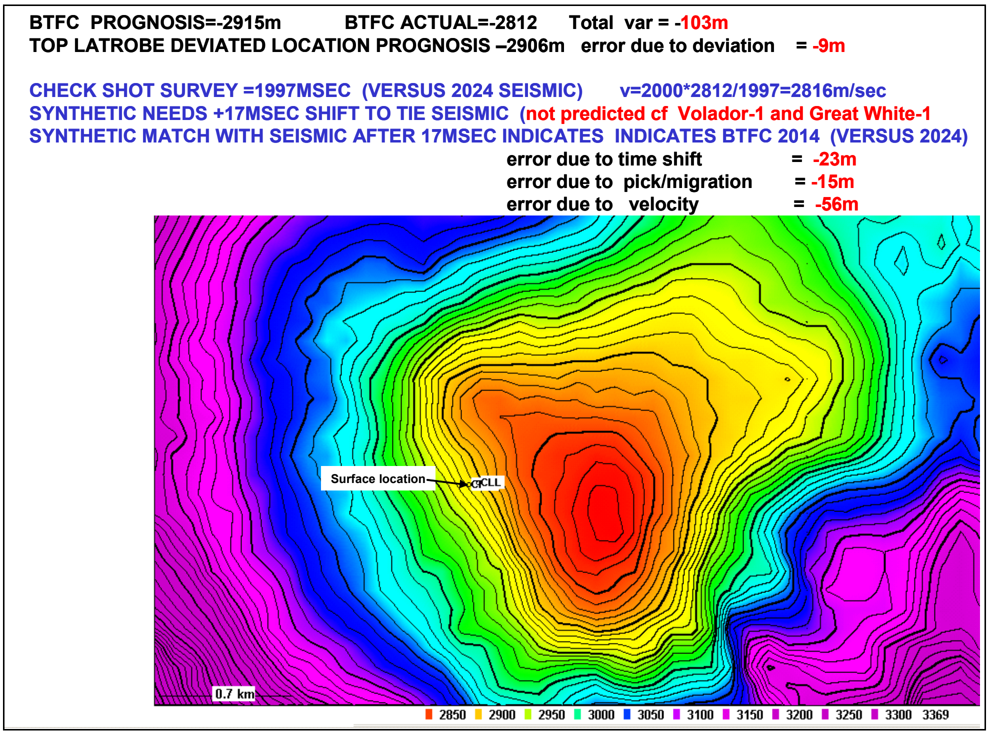

Figure 19: Breakdown of the depth prognosis errors for the Base Tuna-Flounder Channel.

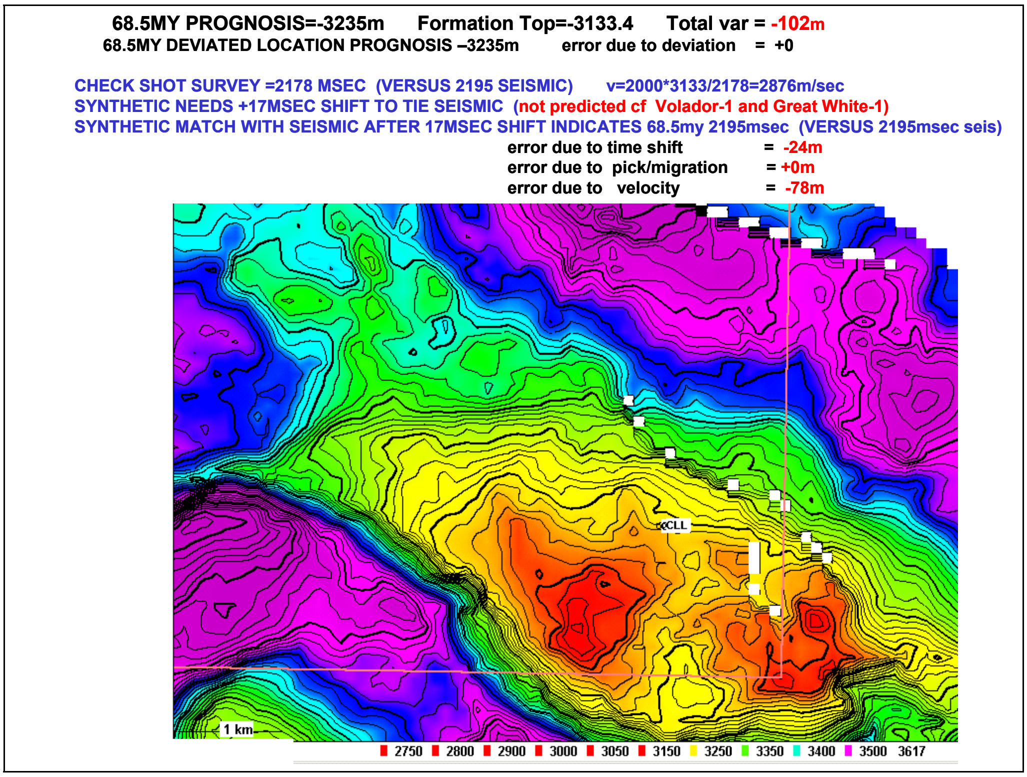

Figure 20: Breakdown of the depth prognosis errors for the 68.5 Ma Marker.

As part of a more regional analysis of the area the depth conversion was redone using two different methods. A stacking velocity method similar to the original method, and an interval velocity layer method using well interval velocities and depth of burial functions. Both methods are different to the original method in that they include Culverin-1 results as a significant control point. Depth Maps for the well interval velocity method are presented in Figure 21, Figure 22 and Figure 23 for the Top Latrobe, Base Tuna Flounder Channel and an 80 my marker (deeper than that presented in the Culverin/Scimitar prospect generation maps). Similarly Figure 24, Figure 25 and Figure 26 are the results for the stacking velocity depth conversion method.
Both these depth conversion methods show the well outside of closure at Top Latrobe and Base Tuna Flounder Channel levels and reduced closure at the deeper level. More work is required on the intermediate intra-formational levels to confirm the validity of the structure at the primary targets of the well.

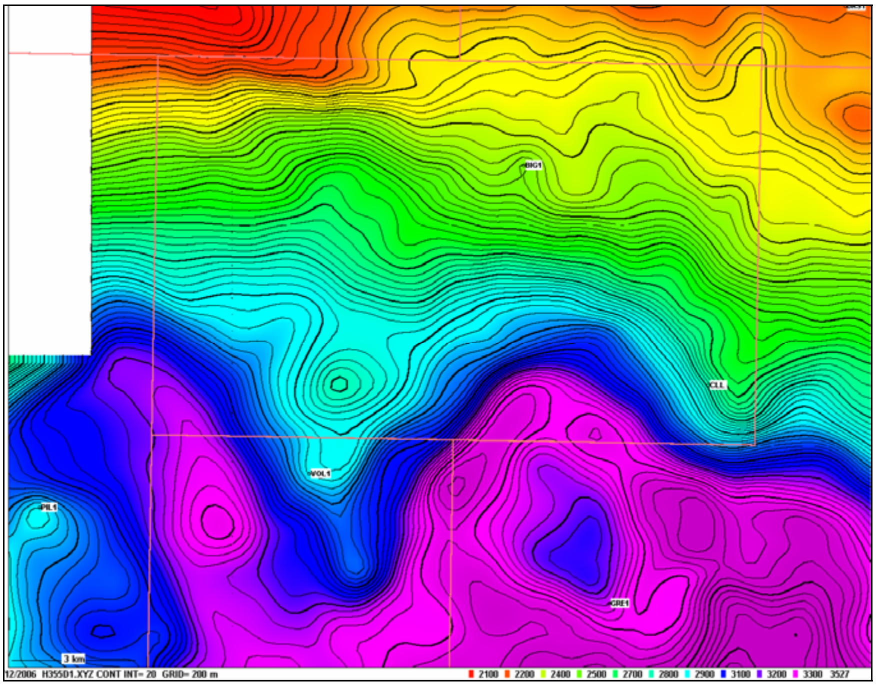

Figure 21: Top Latrobe Depth Map (from well interval velocities and depth of burial functions).

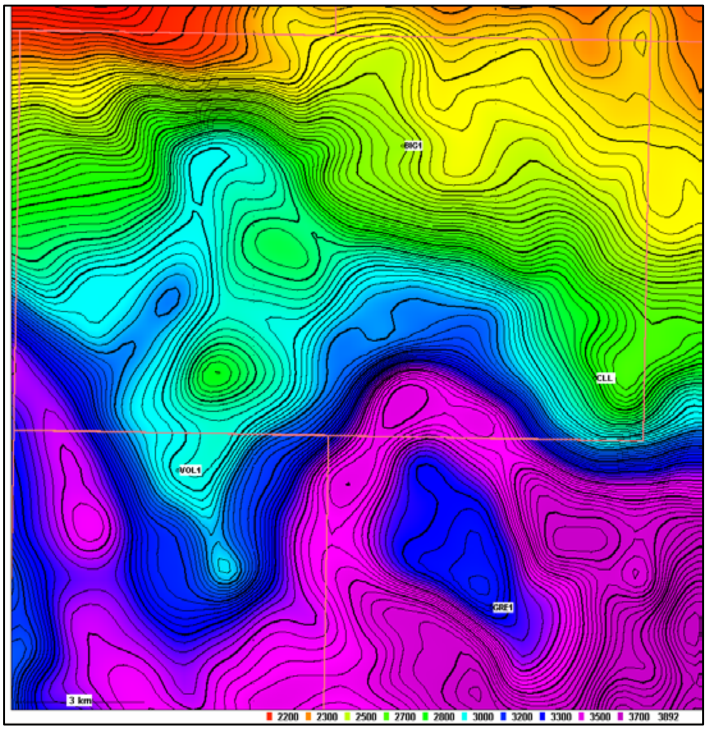

Figure 22: Base Tuna Flounder Channel Depth Map (from well interval velocities and depth of burial functions).

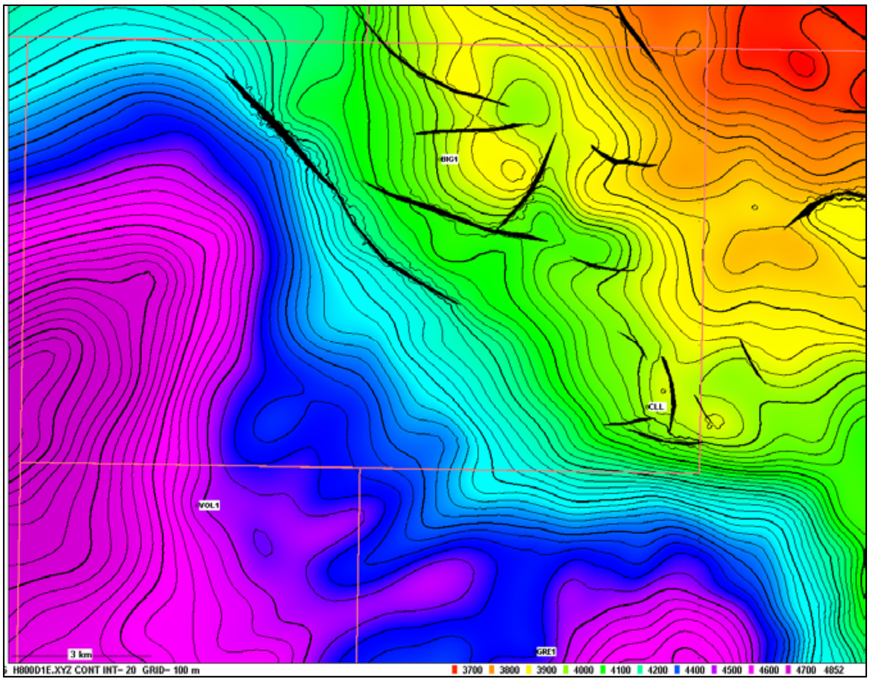

Figure 23: 80 Ma Marker Depth Map (from well interval velocities and depth of burial functions).

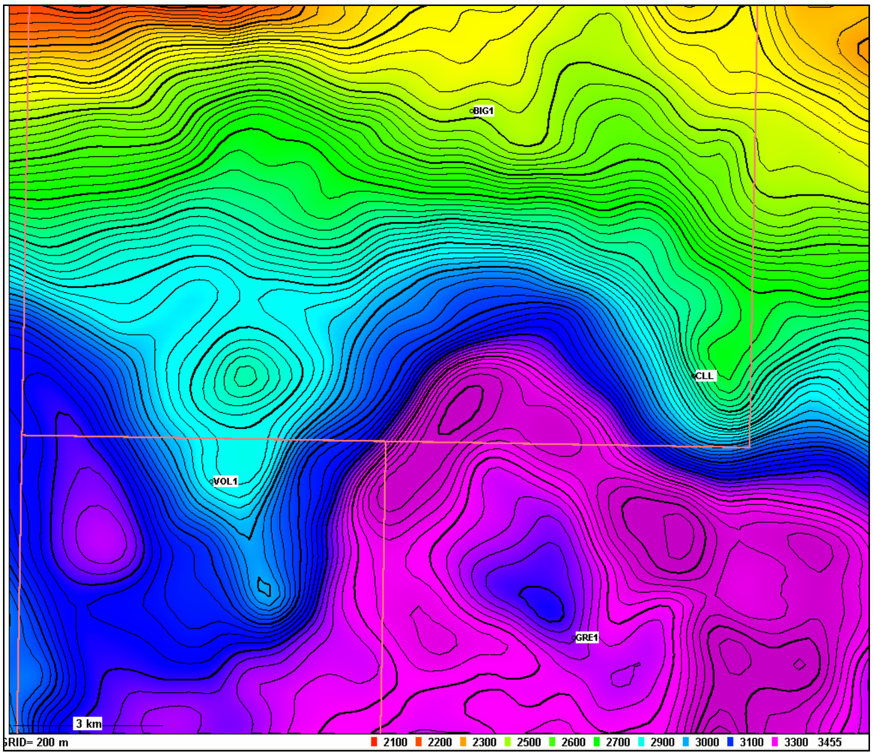

Figure 24: Top Latrobe Depth Map (from smoothed Dix corrected stacking velocities calibrated to wells).

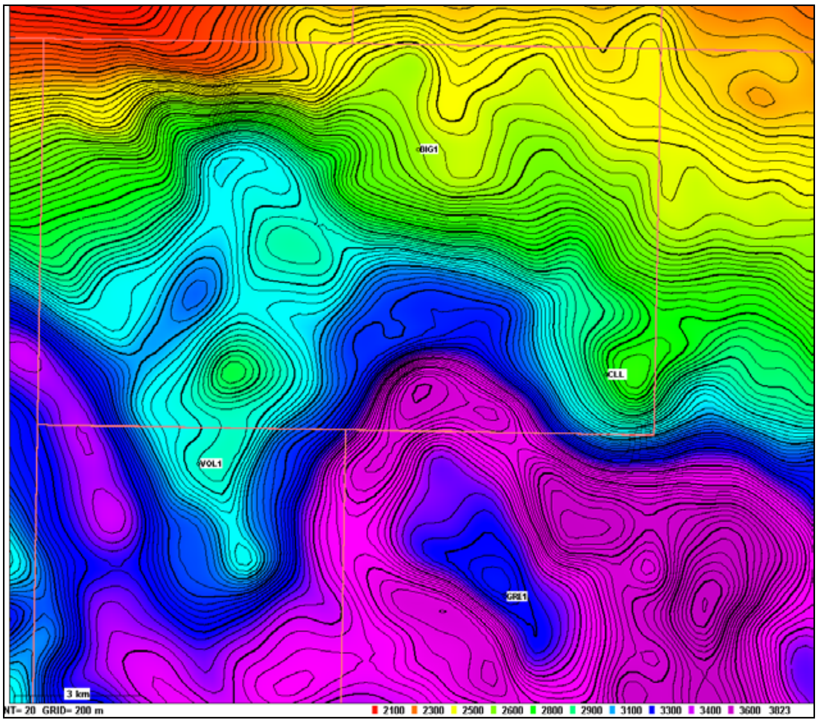

Figure 25: Base Tuna Flounder Channel Depth Map (from smoothed Dix corrected stacking velocities calibrated to wells).

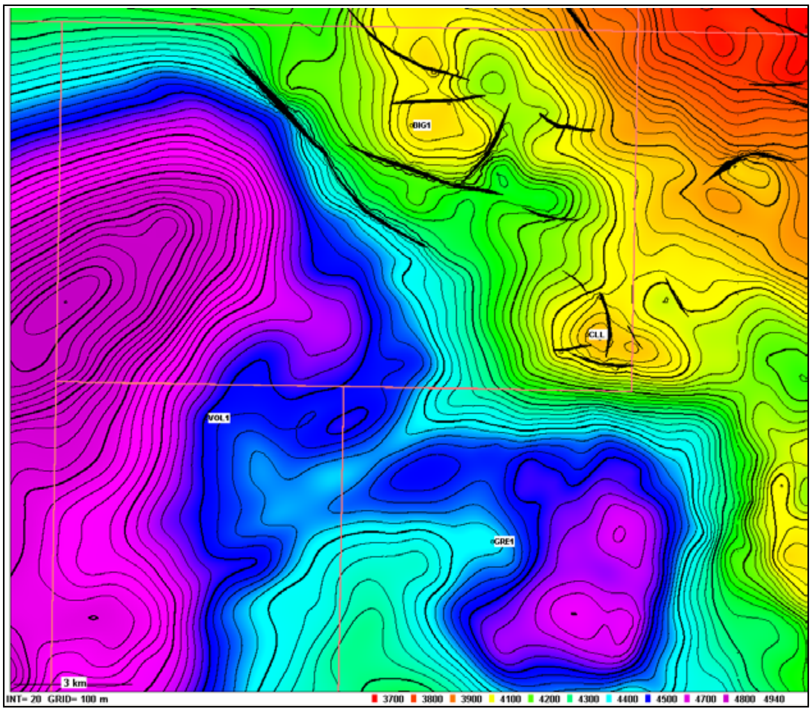

Figure 26: 80 Ma Marker Depth Map (from smoothed Dix corrected stacking velocities calibrated to wells).

ENCLOSURE 1: CULVERIN-1 COMPOSITE WELL LOG

ENCLOSURE 2: CULVERIN-1 PETROPHYSICAL ANALYSIS LOG

ENCLOSURE 3: CULVERIN-1 WELL SYNTHETIC SEISMOGRAM