WELL COMPLETION REPORT
INTERPRETATIVE

BANGANNA 1
PEP 159

ONSHORE OTWAY BASIN

K.Bierbrauer

Origin Energy Resources Limited
ABN 66 007 845 338
John Oxley Centre, 339 Coronation Drive
MILTON QLD 4064

December 2004

TABLE OF CONTENTS

1. WELL INDEX SHEET 3
2. WELL SUMMARY 5
3. DRILLING OBJECTIVE 5
4. HYDROCARBONS 5
5. STRATIGRAPHY 6
6. PETROPHYSICAL SUMMARY 10
7. GEOPHYSICAL DISCUSSION 11
   7.1 Seismic Data 11
   7.2 Structure 11
   7.3 Seismic Amplitudes and AVO Response 11
   7.4 Depth Prognosis 12
8. GEOLOGICAL DISCUSSION 13
   8.1 Regional Geology 13
   8.2 Previous Exploration Drilling 14
   8.3 Contribution to Geological Concepts and Conclusions 17

TABLES

1. Reservoir Summary
2. Formation Tops - Actual Versus Prognosed
3. PEP 159 - Drilling History
4. PEP 159 - Seismic Data

FIGURES

1. Banganna 1 - Location Map
2. Structural Overview
3. Seismic Line obe00a-05 - AVO Anomaly
4. Seismic Line obe00a-06 - AVO Anomaly
5. Areal Extent of AVO Anomaly on Gypsy Creek Seismic Survey
6. Composed Seismic Section from Banganna 1 to Killara 1
7. Strike Line Data Quality in Proximity to Tyrendarra Fault
8. Closure Size for Volumetric Calculations
9. Banganna 1 - Logs and Zero-Offset Synthetic
10. Schematic Cross-section for PEP 159
11. Stratigraphic Column for PEP 159

ENCLOSURES

1. Composite Well Log 1:500 – Banganna 1
2. Composite Well Log 1:200 – Banganna 1
3. Repeated Reservoir Log Section with Standard Lithological Model Interpretation (Banganna 1 Composite & Petrophysical Summary Log)

1. WELL INDEX SHEET

Permit Interests:	Origin Energy Resources Ltd (50%) – OPERATOR Essential Petroleum Resources Ltd (50%)	**Well Name:**	Banganna 1
		Basin:	Onshore Otway
		Permit:	PEP 159
		Type:	Vertical Exploration Well
Rig on Location:		**Elevation (RT)**	68.9m A.M.S.L
Spud:	5/2/2003	**Elevation (GL)**	63.7m A.M.S.L
Reached TD:	15/2/2003	**Latitude:**	38° 12' 27.66"S
Rig Released:	18/2/2003	**Longitude:**	142° 10' 50.62"E
Total Rig Days:	14	**Easting:**	603373.4 metres
Rig Name:	CDL Rig#11	**Northing:**	5770482.7 metres
Drilling Contractor:	Century Drilling Ltd	(GDA 94; AMG Zone 54, Central Meridian 141° East). Deviation from intended location = 5.6m toward 240°	
Total Depth:	2125.0m MDRT	**Seismic Reference:**	60 m west of SP 423 Line obe00a-06
Well Status:	Plugged and Abandoned	**Actual Well Cost:**	A$ 1,343,150

Formation Tops:

FORMATION / *SEISMIC MARKER*	**TOPS (m)**			**REMARKS/SHOWS**
	MDRT	SUBSEA	THICK	
Newer Volcanics	5.2	63.7	31.7	
Port Campbell Limestone	36.9	32.0	116.8	
Gellibrand Marl	153.7	-84.8	222.3	
Clifton Formation	376.0	-307.1	27.0	
Dilwyn Formation	403.0	-334.1	95.5	
Pember Mudstone	498.5	-429.6	38.0	
Pebble Point Formation	536.5	-467.6	45.0	
Paaratte Formation	581.5	-512.6	70.7	
Skull Creek Mudstone	652.5	-583.3	15.4	
Belfast Mudstone	687.8	-618.9	117.3	
Intra-Belfast Sandstone (top)	733.9	-665.0	16.0	
Intra-Belfast Sandstone (base)	750.8	-681.9		
Waarre Formation	805.1	-736.2	15.6	
Eumeralla Formation	820.7	-751.8	1036.3	
Killara Coals	1771.4	-1702.5	85.6	
Laira Formation	1857.0	-1788.1	67.2	
Pretty Hill Formation	1924.0	-1855.3	200.8+	primary objective, no shows
TOTAL DEPTH	2125.0	-2056.1		

Wireline Logs:

Suite #	Run #	Interval (mMDRT)	Logs Acquired
1	1	25.0 – 2124.0	PEX-DSI-NGT-GR-CAL (Schlumberger)
1	2		CSAT-GR (Reeves)

Conventional Core: None acquired

Sidewall Core: None acquired

Pressure Testing and Fluid Sampling: No MDT tests were run.

Hole & Casing Details:

Hole Size	Interval (mMDRT)	Casing Size	Shoe Setting Depth (mMDRT)
251 mm	12.0 – 520.0	194 mm	520.0
171 mm	520.0 – 2125.0		

Abandonment Plugs:

Abandonment Plug #	Interval (mMDRT)
1	1960 - 1885
2	1885 - 1810
3	780 - 700
4	690 - 630
5	580 – 490

2. WELL SUMMARY

Banganna 1 was drilled as a vertical gas exploration well in the southwest corner of PEP 159 approximately 3.3 km northwest of Taralea 1, 4.4 km southwest of Killara 1 and 5.3 km east-northeast of Pretty Hill 1 (Figure 1). The well was designed to test a fault dependent dip closure with up to 100 m of relief at top Pretty Hill Sandstone level which was identified in the footwall block of the Tyrendarra Fault. The prospect was associated with a noticeable AVO anomaly that was seen to coincide with the interpreted "base of the Laira Formation/top Pretty Hill Formation" seismic event. The observed AVO response was comparable in appearance and strength to the AVO responses known from the Penola Trough gas fields. In the Penola Trough strong amplitudes and related AVO effects primarily occur at the top of the gas columns rather than over the entire gas saturated interval. This suggested that a potential gas accumulation at Banganna could also have extended much deeper into the underlying Pretty Hill Formation.

Banganna 1 spudded on 5 February 2003 using Century Drilling Limited Rig #11 and reached total depth of 2125 mMDRT on 15 February 2003. No fluorescence and no gas peaks were encountered. The background gas content was also very low throughout the upper section down to the reservoir target. The well was plugged and abandoned on the basis of an absence of hydrocarbon shows and the initial log interpretation which clearly indicated the presence of water wet reservoirs. CDL Rig #11 was released on 18 August 2003.

3. DRILLING OBJECTIVE

The Banganna prospect was identified as a fault related Pretty Hill Formation target in the footwall of the Tyrendarra Fault (Figure 2). Following the acquisition of the Spring Creek Seismic Survey in 2001 the prospect was also seen to coincide with a marked AVO-anomaly. However, the newly observed AVO-anomaly straddled the interpreted top Pretty Hill seismic event on line 05 (Figure 3) and occurred above the base of the interpreted Laira Formation on line obe00a-06 (Figure 4). The areal extent of the AVO-anomaly defined by the Spring Creek 2D-Seismic Survey is illustrated in Figure 5. A composed seismic section from Banganna 1 to Killara 1 is shown in Figure 6. The composed section indicated that the AVO anomaly seen on line obe00a-06 could correlate with a sandstone layer at the base of the interpreted Laira Formation at Killara 1.

The Banganna prospect was dependent on the sealing of two faults, the main EW-striking Tyrendarra Fault in the south and a second, NW/SE-striking fault in the west (Fault B in Figure 5). Towards the north and east the prospect was controlled by dip closure. The fault dependent trap also required a sealing Laira Formation above the reservoir units as well as the Eumeralla Formation to act as the cross-fault seal in the hanging wall of the Tyrendarra Fault. Since the observed AVO anomaly was directly underlying the base of the Eumeralla Formation the presence of adequate top seal was viewed as most critical for the Banganna prospect.

4. HYDROCARBONS

No significant gas peaks and no hydrocarbon fluorescence were observed during the drilling of Banganna 1. Background gas readings remained relatively steady (0.01 - 0.14%) at all times.

5. STRATIGRAPHY

The stratigraphic section encountered at Banganna 1 is summarized below:

PORT CAMPBELL LIMESTONE	
36.9 - 153.7 metres Thickness : 116.8 metres	
No samples collected due to lost circulation.	

GELLIBRAND MARL	
153.7 – 376.0 metres Thickness : 222.3 metres	
153.7 – 290m	MARL (calcareous silty claystone), 100%, medium grey, light grey to white in places, very fine, trace silt, abundant fine to very coarse calcite aggregates and fossiliferous material, trace fine quartz, trace glauconite very soft, sticky, non fissile, very poor visual porosity. Nil hydrocarbon fluorescence (trace mineral fluorescence).
290.0 – 376.0m	MARL, light to medium grey, off white in places, very fine, fine in places, abundant fine to very coarse calcite grains, predominately calcarenite, common fossil material, trace fine quartz, soft, sticky, non fissile, calcite grains firm to hard, poor visual porosity, grading to limestone in places. Nil hydrocarbon fluorescence.

CLIFTON FORMATION	
376.0 – 403.0 metres Thickness : 27 metres	
376.0. – 403.0m	LIMESTONE, white to pale yellow/orange, moderate to bright orange in places, fine to medium, trace coarse and very coarse grains, abundant fossil material, common crystalline and microcrystalline carbonate cement, iron stained, firm to hard, minor grey clay matrix, silty in places, trace fine to coarse loose quartz, fair inferred porosity, good in places. Nil fluorescence.

DILWYN FORMATION	
403.0 – 498.5 metres Thickness : 95.0 metres	
403.0 – 440.0m	SANDSTONE, interbedded with limestone and claystone. SANDSTONE, translucent to transparent, white to light grey, fine to very coarse, predominately fine to medium, moderate sorted, sub angular to rounded, trace argillaceous matrix, rare mica, trace pyrite, loose, good inferred porosity, Nil fluorescence. LIMESTONE, white to pale orange, fine to coarse calcite grains, commonly fossiliferous, trace microcrystalline cement, firm to hard, minor iron stained grains, fair to good inferred porosity. Nil fluorescence. CLAYSTONE, light to moderate grey, silty in places, carbonaceous specks, soft, amorphous to subfissile, dispersive.
440.0 – 498.5m	SANDSTONE, translucent to transparent, white to light grey, fine to very coarse, poorly sorted, subangular to rounded, loose, trace moderate hard aggregates, trace pyrite and mica, minor calcareous cement, trace argillaceous matrix, good inferred porosity. Nil fluorescence.

PEMBER MUDSTONE	
498.5 – 536.5 metres Thickness : 38.0 metres	
498.5 – 536.5m	CLAYSTONE, with rare to trace sandstone. CLAYSTONE, medium to dark brown, grey in places, arenaceous, rare calcareous fragments, trace carbonaceous specks, trace mica and pyrite, very soft to soft, amorphous, highly dispersive, grades to siltstone in places. SANDSTONE, translucent to transparent, white to light grey, fine to very coarse, poorly sorted, subangular to rounded, loose, trace pyrite and mica, minor calcareous cement, trace argillaceous matrix, fair inferred porosity. Nil fluorescence.

PEBBLE POINT FORMATION	
536.5 – 581.5 metres Thickness : 45.0 metres	
536.5 – 581.5m	CLAYSTONE, interbedded with sandstone. CLAYSTONE, dark brown green, medium green in places, silty, minor carbonaceous specks and fragments, soft to firm, trace moderate hard, amorphous to sub blocky. SANDSTONE, translucent to transparent, fine to very coarse, predominately coarse, poorly sorted, subangular, minor subrounded, minor argillaceous matrix, predominately loose, poor to fair porosity. Nil fluorescence.

PAARATTE FORMATION	
581.5 – 652.2 metres Thickness : 70.7 metres	
581.5 – 652.2m	CLAYSTONE, interbedded with sandstone. CLAYSTONE, dark grey, grey brown, arenaceous, minor carbonaceous, soft to firm, amorphous, common dispersive, darker harder fragments grade to siltstone. SANDSTONE, translucent to transparent, light grey, fine to medium , trace coarse, moderate to well sorted, subangular to subrounded, argillaceous, trace calcareous grains and mica, loose, fair inferred porosity. Nil fluorescence.

SKULL CREEK MUDSTONE	
652.2 – 667.6 metres Thickness : 15.4 metres	
652.2 – 667.6m	CLAYSTONE, interbedded with trace sandstone. SANDSTONE, translucent and white, very fine to fine aggregates, fine to medium loose, trace coarse, poor sorting, subangular to subrounded, trace white argillaceous matrix, minor calcareous cement, trace carbonaceous specks, aggregates firm, very poor visual porosity, poor inferred porosity, Nil fluorescence. CLAYSTONE, medium to dark brown, grey brown, minor white argillaceous material, minor arenaceous fine to medium, trace coarse and very coarse, trace carbonaceous, trace pyrite, rare calcareous cement and fragments, soft to firm, amorphous, dispersive in places, commonly grades to siltstone.

NULLAWARRE GREENSAND	
667.6 – 687.8 metres Thickness : 20.2 metres	
667.6 – 687.8m	CLAYSTONE, interbedded with sandstone. CLAYSTONE, medium brown, grey brown, arenaceous in part, trace carbonaceous specks, trace mica, soft, amorphous, dispersive, trace grades to siltstone. SANDSTONE, translucent to translucent, light grey to off white, predominately loose, fine to coarse, generally medium, subangular, rounded in places, minor very fine to aggregates, trace white argillaceous matrix, minor calcareous grains and cement, rare pyrite, trace carbonaceous material, trace glauconite, very poor to poor visual porosity, poor inferred porosity. Nil fluorescence.

BELFAST MUDSTONE	
687.8 - 805.1 metres Thickness : 117.3 metres	
687.8 – 733.9m	CLAYSTONE, dark brown, brown grey, very fine arenaceous, trace medium and coarse loose quartz grains, trace pyrite, trace carbonaceous specks and fragments, trace mica, very occasional calcite, soft, amorphous, dispersive.
733.9 – 750.8	CLAYSTONE, interbedded with trace Sandstone. CLAYSTONE, medium to dark grey, brown grey, very fine arenaceous, trace medium and coarse loose quartz grains, trace pyrite, minor to common carbonaceous specks and fragments, trace mica, very occasional calcite, soft, amorphous, dispersive. SANDSTONE, translucent to translucent, light grey to off white, predominately loose, fine to coarse, generally medium, subangular, rounded in places, minor very fine to aggregates, trace white argillaceous matrix, minor calcareous grains and cement, rare pyrite, trace carbonaceous material, very poor to poor visual porosity, poor inferred porosity. Nil fluorescence.
750.8 – 805.1	SILTSTONE, interbedded with trace to minor claystone. SILTSTONE, medium to dark brown, dark green brown, argillaceous, trace medium loose quartz and lithics, trace carbonaceous, firm to moderately hard, subblocky. CLAYSTONE, medium to dark grey, silty in places, trace arenaceous, rare carbonaceous specks, trace mica and pyrite, trace calcareous fragments, soft, amorphous, dispersive.

WAARRE FORMATION	
805.1 – 820.7 metres Thickness : 15.6 metres	
805.1 – 820.7m	CLAYSTONE, interbedded with sandstone. SANDSTONE, light grey to off white, very fine to fine, trace medium, subangular to rounded, well sorted, minor white argillaceous matrix, trace calcareous cement, trace silica cement and overgrowths trace carbonaceous specks, soft to firm aggregates, poor visual porosity. Nil fluorescence. CLAYSTONE, light to medium grey, trace to rare carbonaceous specks, trace mica, soft to firm, amorphous to subblocky, minor dispersive, grades to very fine arenaceous in places.

EUMERALLA FORMATION	
820.7 – 1771.4 metres	Thickness : 950.7 metres
820.7 – 1350.0 m	CLAYSTONE interbedded with sandstone. SANDSTONE, light grey to off white, very fine to fine, trace medium, subangular to rounded, well sorted, minor white argillaceous matrix, trace calcareous cement, trace silica cement and overgrowths trace carbonaceous specks, soft to firm aggregates, poor visual porosity. Nil fluorescence. CLAYSTONE, light to medium grey, trace to rare carbonaceous specks, trace mica, soft to firm, amorphous to subblocky, minor dispersive, grades to very fine arenaceous in places.
1350.0 – 1771.4	SANDSTONE interbedded with claystone. SANDSTONE, off white to light grey, very fine to fine, trace medium, well sorted, subangular to subrounded, minor white argillaceous matrix, trace carbonaceous specks and mica, soft to firm aggregates, moderately calcareous, poor visual porosity. Nil fluorescence. CLAYSTONE, light to moderate grey to grey-brown, occasionally moderate brown, also dark grey and greenish grey, soft to firm, trace carbonaceous material, amorphous to sub-blocky, grades to siltstone.

KILLARA COALS	
1771.4 – 1857.0 metres	Thickness : 85.6 metres
1771.4 – 1857.0 m	SILTSTONE grading to claystone with interbedded sandstone and trace coal. SILTSTONE, off white, light to moderate brown, minor pale to moderate grey, soft to firm, argillaceous, common very fine carbonaceous specks / laminae, minor very dark green to black glauconite nodules. SANDSTONE, white to off white, very fine, sub-rounded, moderate to well sorted, feldspathic, abundant clay matrix, calcareous, friable to moderately hard, very poor porosity. Nil fluorescence. COAL, dark brown, black, sub-vitreous, brittle to firm, subfissile.

LAIRA FORMATION	
1857.0 – 1924.2 metres	Thickness :67.2 metres
1857.0 – 1924.2 m	SANDSTONE, with occasional minor siltstone interbeds. SANDSTONE, white to cream, very fine to coarse, occasionally very coarse, sub-angular to sub-rounded, poor to moderately sorted, rare pink garnet, rare pyrite, trace dark green to black glauconite nodules, moderate clay matrix, moderately calcareous, weak silica cement, friable to firm, fair porosity, good porosity in places. Nil fluorescence. SILTSTONE, light to moderate brown to grey-brown, soft to firm, sub-fissile to sub-blocky, common very fine carbonaceous specks and laminae, occasionally grading to very fine silty sandstone, occasionally dark brown and argillaceous with dark green-black glauconite nodules.

PRETTY HILL FORMATION	
1924.2 – 2125.0 metres (TD) Thickness :200.8 metres	
1924.2 – 2125.0 m	SANDSTONE, slightly argillaceous interbedded with trace siltstone. SANDSTONE, off white, cream, very fine to coarse, predominately fine to medium, poor to moderate sorting, sub rounded to angular, trace to minor argillaceous matrix, trace weak calcareous cement, trace carbonaceous specks and mica, loose, common friable aggregates, fair inferred porosity. Nil fluorescence. SILTSTONE, medium to dark grey, grey brown, carbonaceous, argillaceous matrix, trace carbonaceous specks and mica, soft to firm, trace moderate hard, amorphous to sub blocky, subfissile in places, grades to very fine arenaceous.

6. PETROPHYSICAL SUMMARY

Reservoir evaluation of the penetrated basal Laira Formation and Pretty Hill Formation reservoirs was limited to a standard well log analysis. The resulting reservoir summary is shown in Table 1. Enclosure 1 and 2 contain composite well log displays for Banganna 1 at the scale of 1: 500 and 1: 200 respectively. A repeated log run was measured over the reservoir interval from 1820 to 1975 m MDR. The data are included in Enclosure 3 which also contains a standard lithological model interpretation.

Formation Name [unit]	Interval From MD [m]	Interval to MD [m]	Gross Interval [m]	Net RES Interval [m]	AVE. VCL [%]	AVE. PHIE [%]	NET RES/ GROSS [%]	NET PAY Interval [%]
Eumeralla	1825.0	1853.7	28.7	1.5	35.5	14.7	5.2	0.0
Laira	1853.7	1926.9	73.2	56.3	24.3	17.6	76.9	0.0
Pretty Hill	1926.9	1962.0	35.1	26.6	29.3	15.8	75.8	0.0
Total	-------	-------	137.0	84.4	26.1	17.0	61.6	0.0

Cut-offs Applied		
Net Reservoir	VCL <	40.0 %
	PHIE >	10.0 %
Net Pay	SW <	65.0 %

Table 1: Reservoir Summary

7. GEOPHYSICAL DISCUSSION

7.1 Seismic Data

The Banganna prospect was identified and interpreted on 2D seismic data with a line spacing ranging from 0.3 to 0.8 kilometres. Despite the reasonably good seismic coverage the existing 2D-seismic grid contained several vintages of varying data quality. The latest 2001 Gypsy Creek Survey which had achieved a slightly improved seismic resolution at Pretty Hill level was acquired to mature the Banganna prospect to drilling status. The Gypsy Creek 2D Survey was also used for subsequent AVO work (see below).

7.2 Structure

Despite the enhanced resolution of the Gypsy Creek seismic survey, the correct identification of the top Pretty Hill Formation remained enigmatic on some of the existing seismic lines. The seismic identification of the top Pretty Hill reservoir was complicated by the fact that the newly acquired strike line of the Gypsy Creek Survey was located too close to the Tyrendarra Fault. As a result the line was of very poor seismic quality over the central portion of the Banganna prospect and thus did not provide the much needed correlation of relevant seismic picks across the existing dip lines over Banganna (see Figure 7). Moreover, the top of the Pretty Hill Formation, which was generally interpreted as the first higher amplitude event within the Crayfish Group, was seen to converge with the higher amplitude package that is related to the basal Killara Coals from the overlying Eumeralla Formation. Consequently the distinction between the base of the Eumeralla Formation and the top of the Pretty Hill Formation remained quite subjective and the uncertainties in the seismic interpretation were mainly related to the poor imaging of the low angle unconformity between the Killara Coals and the underlying Crayfish Group. The possible absence of a closure at Pretty Hill (or Intra Laira Sandstone) level had been realized by some workers. The encouragement to test the Banganna prospect was mainly driven by the newly recognized amplitude anomalies and supporting AVO-work that followed the acquisition of the Gypsy Creek seismic survey. The relevant top Pretty Hill Formation depth structure map is shown in Figure 5.

7.3 Seismic Amplitudes and AVO Response

Modelling was performed using the original log data as well as newly generated logs using fluid replacement modelling. The latter indicate that the AVO response would have been stronger if the sand was gas-charged. The high amplitude anomaly present below the base of the Eumeralla Formation at Banganna 1 is now believed to be related to an anomalously low density, high-porosity sandstone layer. A very large drop in density, P-wave velocity and hence P-impedance is observed from the high-porosity sand that directly underlies the Crayfish Unconformity (Figure 9). A slight decrease in Poisson's Ratio is also observed. The AVO response therefore reflects a strong lithological contrast. Based on the logs from Banganna 1, a similar AVO response was modelled that is consistent with the actual seismic data. The main modelling results are as follows:

- a “top sand” anomaly is present for both the seismic data and modelled log data
- a “base sand” anomaly is neither present in the real seismic data nor the modelled log response
- the modelling explains why the observed AVO anomaly is basically restricted to the contact surface between of the excellent reservoir sands and the truncating Killara Coals
- the limited lateral extent of the AVO anomaly is most likely caused by the changing lithology of Crayfish Group sediments underneath the Crayfish Unconformity

The modelling results highlight that while the apparent AVO anomaly may help to identify potential reservoir layers more quantitative modelling may be required to be able to distinguish a high quality reservoir unit and water wet sand from a gas filled reservoir.

7.4 Depth Prognosis

The surface location of Banganna 1 is situated 60 m west of shot point 423 from seismic line obe00a-06. The well location had to be moved off-line due to unsuitable surface conditions. Formation tops were predicted on the basis of a simple time depth relationship derived from the three closest wells Killara 1, Taralea 1 and Pretty Hill 1. The resulting depth prognosis was reasonably accurate and the Pretty Hill target sandstone was encountered 35 m high to prognosis (Table 1). A larger deviation from prognosis for the Flaxman/Waarre interval (80 m lower to prognosis) and the top of the Eumeralla Formation (58 m lower to prognosis) resulted from an erroneous seismic pick for the two formation tops. The error was actually caused by the presence of a high velocity layer within the Belfast Mudstone which is manifested as a strong peak/trough couplet in the seismic data, typical of a thin bed response for a normal polarity zero-phase wavelet. Generally, a strong peak/trough couplet appears to be characteristic for the top of the Eumeralla Formation elsewhere, especially where the interpretation is manifested by the presence of a true angular unconformity. In contrast the top of the Eumeralla Formation at Banganna 1 as well as in Pretty Hill 1 is seismically unresolved.

Prior to drilling an attempt to prognose the intersection of the well trajectory with the Tyrendarra Fault was made. While it was difficult to prognose the exact depth window at which the well trace would penetrate and/or run sub-parallel to the fault zone, an estimate of 998-1140 mMDRT (within the Eumeralla Formation) was given. During drilling it was not possible to locate the point of penetration of the Tyrendarra Fault during the drilling operation and no hazardous impact on the drilling resulted from the presence of the fault zone.

FORMATION	Prognosed (mRT)	Actual (mRT)	Difference (m) H /L
Surface Basalt	5.2	5.2	0.0
Port Campbell Limestone	45.2	36.9	8.3H
Gellibrand Marl	149.9	153.7	3.8L
Clifton Formation	380.9	376.0	4.9H
Dilwyn Formation	411.9	403.0	8.9H
Pember Mudstone	500.9	498.5	2.4H
Pebble Point Formation	555.9	536.5	19.4H
Paaratte Formation	580.9	581.5	0.6L
Skull Creek Mudstone	636.9	652.2	15.3L
Nullawarre Greensand	661.9	667.6	5.7L
Belfast Mudstone	682.9	687.8	4.0L
Flaxman/Waarre Fm	724.9	805.1	80.2L
Eumeralla Formation	762.9	820.7	57.8L
Killara Coals	1805.9	1771.4	34.5H
Laira Formation	1878.9	1857.0	21.9H
Pretty Hill Formation	1959.9	1924.2	35.7H
TD	2125.0	2125.0	

Table 2: Formation Tops - Actual Versus Prognosed

8. GEOLOGICAL DISCUSSION

8.1 Regional Geology

PEP 159 is located in the central portion of the onshore Otway Basin and contains prospective Early Cretaceous Crayfish Group sediments. The Crayfish Group is overlain by a thick Early Cretaceous Eumeralla Formation followed by a much thinner series of Tertiary Wangerrip Group and Heytesbury Group sediments. The Late Cretaceous Sherbrook Group which is prospective in the Port Campbell Embayment is thin or absent in PEP 159.

The main structural elements in the vicinity of PEP 159 are the Early Cretaceous Windermere Trough, Koroit Trough and Warrong Trough (Figure 1). The Windermere Trough and Koroit Troughs represent typical half graben and are both bounded by the Tyrendarra Fault complex. A north-south oriented transfer zone appears to offset the Tyrendarra Fault from the Tower-Taurus Fault Complex, and forms the dividing line between the Windemere Trough and Koroit Trough (Figure 1). PEP 159 largely overlies the footwall block of the Tyrendarra Fault and the Tower-Taurus Fault Zone.

The permit is further dominated by a series of east-west trending normal faults. The Sherbrook Group and Otway Supergroup sediments progressively thicken towards the south across each successive fault (see illustration in Figure 10). A generalized stratigraphy is summarized in Figure 11. The main exploration targets in PEP 159 are the Pretty Hill Formation, intra Laira Formation sandstones and the Pebble Point Formation. The Heathfield

Sandstone Member of the Lower Eumeralla Formation could also represent a potential reservoir unit.

The best quality source rocks in the area are coals in the lower Eumeralla Formation and lacustrine mudstones found in the Casterton Formation. Maturation modelling indicates that the Casterton Formation in the main depositional centres near Banganna 1 had reached peak generation towards the end of the Early Cretaceous. Structures such as Banganna were most likely charged at this time with additional charging probably occurring during the Late Tertiary. The coals at the base of the Eumeralla Formation are interpreted to be immature for oil and gas in the larger footwall region of the Tyrendarra Fault and early mature in the hanging wall block.

The existing wells have confirmed fair to excellent reservoir properties for the Pretty Hill Formation. Most of the unsuccessful Pretty Hill Formation tests in PEP 159 and adjacent PEP 152 may be related to lack of closure, cross-fault seal failure, inadequate top-seal or fault leakage. However, it is rarely possible to determine the exact failure criterion for individual wells mainly due to insufficient seismic coverage or rather poor seismic quality. Nevertheless, the presence of numerous hydrocarbon shows (Table 1 below) and the fact that Windermere 1 had recovered hydrocarbons from the Heathfield Member of the Eumeralla Formation, indicate the presence of a working hydrocarbon system.

Most recently, Port Fairy 1 in the southern part of PEP 152 had also encountered strong oil and gas shows in the Late Cretaceous Flaxman Formation.

8.2 Previous Exploration Drilling

Pretty Hill 1, the first exploration well in the permit, was drilled in 1962. Since then, a further eight wells have been sunk in PEP 159, but no commercial hydrocarbons have been found despite numerous oil and gas shows (Table 1).

Year	Name	Operator	Well Type	Well Target	Total Depth (MKB)	Result	Flow Rate / Recovery
1962	Pretty Hill 1	Frome	Expl	Pretty Hill	2478	P&A Oil shows	1x DST muddy water
1968	Woolsthorpe 1	Interstate Oil	Expl	Pretty Hill	1971	P&A, fluor in cores	1x DST muddy water
1968	Garvoc 1	Interstate Oil	Expl	Pretty Hill	1533	P&A, fluor in cores	1x DST $C0_2$cut muddy water
1969	Moyne Falls 1	Shell	Expl	Basal Eumeralla	1008	P&A, no show	No tests
1969	Hawkesdale 1	Shell	Expl	Pretty Hill	1774	P&A, fluor in cores	2x DSTs (both failed)
1985	Greenslopes 1	Phoenix	Expl	Pretty Hill	2608	P&A, faint fluor in cuttings	No tests
1987	Ballangeich 1	Phoenix	Expl	Pretty Hill	1250	P&A, no shows	No tests
1991	Killara 1	Phoenix	Expl	Basal Eumeralla & Pretty Hill	2409	P&A, weak shows	2 DSTs recovered muddy water
1997	Taralea 1	Cultus	Expl	Intra-Eumeralla	2800	P&A, no show	No tests

Table 3: PEP 159 - Drilling History

A total of 1997.35 kilometres of 2D seismic data have been acquired in PEP 159 since 1958 including the most recent 2000 Spring Creek Seismic Survey and 2001 Gypsy's Creek Seismic Survey (Table 2).

Year	Survey Name	No. Km
1958	Portland & Pt Campbell	229
1964	Koroit	8
1966	Port Fairy-Nelson	17
1968	Port Fairy Nelson	53
1969	Hawkesdale	225
1970	Portland-Macarthur	37
1971	Nelson-Koroit	32
1973	Coastal Strip	47
1981	C81	21
1982	C82	173
1984	Terrang	171
1984	Greenslopes	54
1985	Toolong	34
1986	Ballangeich	122
1987	Woolsthorpe	56
1988	Tarrone	23
1988	St Helens	11
1989	Shamrock	95
1990	Moyne River	32
1991	Moyne	8
1992	Otway Basin	63
1993	Taralea	50
1993	Kaloola	3
1994	Merrylands	17
1995	Tower Hill	136
1996	Spiers	51
1997	Cartcarrong	8
1998	Mumblin	80
2000	Spring Creek	77
2001	Gypsy's Creek	64.35
TOTAL		**1997.35**

Table 4: PEP159 - Seismic Data

8.3 Contribution to Geological Concepts and Conclusions

Banganna 1 adds to the existing penetrations of Crayfish Group sediments in the Victorian part of the onshore Otway Basin. The exact reason for failure remains speculative and the disappointing well result does not necessarily downgrade similar fault dependent Pretty Hill closures elsewhere in PEP 159. The possibility that Banganna 1 is not a valid structural test has been discussed before (section 7.2) In addition to that Banganna 1 encountered a sand dominated Crayfish Group interval which was directly underlying the Eumeralla Formation. The potential risk of inadequate top seal is also inherent from the seismic data. Strictly speaking Banganna 1 should be viewed as a fault dependent unconformity trap in which a sealing basal Eumeralla Formation was needed to replace the missing Laira Shale top seal. Since the overall presence of structure and adequate top seal may be questioned, little conclusions can be drawn on fault seal. A working cross fault seal was required for the reservoir sands being juxtaposed against Eumeralla Formation or alternatively a non-transmissive fault gouge associated with the Tyrendarra Fault. The situation is further complicated because leakage could have been restricted to the secondary fault or the intersection of the two prospect bounding faults. Therefore fault integrity cannot be excluded as a failure criterion.

The absence of any hydrocarbon shows probably point to the non-existence of a trap in the first place. The presence of a breached trap due to late stage fault reactivation may have been detected from the presence of residual hydrocarbons. In summary it must be concluded that the most reasonable failure reasons for Banganna 1 lies in the primarily absence of a suitable trap which in turn could be related to lack of structure, lack of top seal, lack of fault seal or any combination of these aspects. The forgoing discussion assumes that charge had occurred. However, the missing hydrocarbons shows could also point to the absence of charge.

It must also be pointed out that the interpreted Pretty Hill Formation top at Banganna 1 is rather speculative. The chosen top reflects the original pre-drill seismic interpretation that was merely based on the correlation of a possible “Intra-Laira” sandstone layer from Killara 1 to the Banganna 1 location. As a matter of fact it is also possible that the Laira Formation could be absent in Banganna 1 and that the Pretty Hill Formation directly underlies the unconformity below the Killara Coals. This relationship is possibly seen on 2D-line obe00a-05 (Figure 3) and may also be interpreted on other seismic lines.

Moreover, the lithological and seismic distinction between a “shaly” Laira Formation and an underlying Pretty Hill Formation appears to be less pronounced in PEP 159 compared to the central Penola Trough area in South Australia. As a result the subdivision of the Crayfish Group into several distinct members and a contemplated regional correlation of individual sand packages may be inadequate in this portion of the Otway Basin. It should also be noted that in the vicinity of Pretty Hill 1, Killara 1, Taralea 1 and Banganna 1 a noticeably higher sand- and silt content within the upper Crayfish Group section could increase the top seal risk for any reservoirs below.

Figure 1 Bamganna 1 – Location Map

Figure 2 Structural Overview

Figure 3 Seismic Line obe00a-05 - AVO Anomaly

Figure 4 Seismic Line obe00a-06 – AVO Anomaly

Figure 5 Areal Extent of AVO Anomaly on Gypsy Creek Seismic Survey

Figure 6 Composed Seismic Section from Banganna 1 to Killara-1

Figure7 Strike Line Data Quality in Proximity to Tyrendarra Fault

Figure 8 Closure Size for Volumetric Calculations

TOP PRETTY HILL SST DEPTH STRUCTURE MAP OVER BANGANNA WITH:

P90 (ORANGE), P50 (GREEN) & P10 (RED) CLOSURES

Figure 9 Banganna 1 - Logs and zero-offset synthetic

Figure 10 Schematic Cross-section for PEP 159

Figure 11 Stratigraphic Column for PEP 159

Origin Energy

BANGANNA-01

CORONET BAY, VIC, AUS

PROJECT		WELL DATA		DATUM		DRILLING	
Location: Coordinates:	38° 0' 0.000" S 145° 0' 0.000" E	Total Depth:	2,210.0m	Datum:	AHD	Spud Date:	1-Jan-1900
Datum:	AHD	Drilling Contractor:	Unknown	Datum Elevation:	0.0m	Completion Date:	1-Jan-1900
Water Depth:	0.0m	Rig:	Unknown	Kelly Bushing:	0.0m	Elevation:	0.0 - 0.0m
Operator:	ORIGIN ENERGY PTY LTD	Spud Date:	1-Jan-1900	Ground Elevation:	0.0m	Total Depth:	0.0m
Operator Location:	447 STREET, WA 6000, AUSTRALIA	Completion Date:	1-Jan-1900	Log Datum:	0.0m		

Lithology Key

Lithology	Colour	Lithology	Colour
Mudstone		Coal	
Siltstone		Coal Seam	
Sandstone		Tuff	
Limestone		Tuff Volcanics	
Dolomite		Volcanics	
Marl		Granite	

Wireline Logs

Wireline Log	Colour
Gamma Ray	
Caliper	
Resistivity	
Density	
Neutron	
Sonic	

Remarks

Remark	Colour
Gas Shows	
Oil Shows	
Core Recovery	
Core Photo	
Mud Losses	
Cement Losses	
Casing	
Drilling Break	
Fast Drilling	
Slow Drilling	
Stuck Pipe	
Washout	
Sidetrack	

Chronostratigraphic Units

Epoch	Age
Holocene	Tarwan
Pleistocene	Werrikian, Kalimnan, Gelasian
Pliocene	Piacenzian, Zanclean
Miocene	Messinian, Tortonian, Serravallian, Langhian, Burdigalian, Aquitanian
Oligocene	Chattian, Rupelian
Eocene	Priabonian, Bartonian, Lutetian, Ypresian
Paleocene	Thanetian, Selandian, Danian
Cretaceous	Maastrichtian, Campanian, Santonian, Coniacian, Turonian, Cenomanian, Albian, Aptian, Barremian, Hauterivian, Valanginian, Berriasian
Jurassic	Tithonian, Kimmeridgian, Oxfordian, Callovian, Bathonian, Bajocian, Aalenian, Toarcian, Pliensbachian, Sinemurian, Hettangian
Triassic	Rhaetian, Norian, Carnian, Ladinian, Anisian, Olenekian, Induan
Permian	Lopingian, Guadalupian, Cisuralian
Carboniferous	Pennsylvanian, Mississippian
Devonian	Pridoli, Ludlow, Wenlock, Llandovery
Silurian	Pragian, Lochkovian
Ordovician	Ashgillian, Caradocian, Llandeilian, Llanvirnian, Arenigian, Tremadocian
Cambrian	Tremadocian
Proterozoic	Ediacaran, Cryogenian, Tonian, Stenian, Ectasian, Calymmian
Archean	Neoarchean, Mesoarchean, Paleoarchean, Eoarchean
Hadean	

Chronostratigraphic Units

Epoch	Age
Holocene	Tarwan
Pleistocene	Werrikian, Kalimnan, Gelasian
Pliocene	Piacenzian, Zanclean
Miocene	Messinian, Tortonian, Serravallian, Langhian, Burdigalian, Aquitanian
Oligocene	Chattian, Rupelian
Eocene	Priabonian, Bartonian, Lutetian, Ypresian
Paleocene	Thanetian, Selandian, Danian
Cretaceous	Maastrichtian, Campanian, Santonian, Coniacian, Turonian, Cenomanian, Albian, Aptian, Barremian, Hauterivian, Valanginian, Berriasian
Jurassic	Tithonian, Kimmeridgian, Oxfordian, Callovian, Bathonian, Bajocian, Aalenian, Toarcian, Pliensbachian, Sinemurian, Hettangian
Triassic	Rhaetian, Norian, Carnian, Ladinian, Anisian, Olenekian, Induan
Permian	Lopingian, Guadalupian, Cisuralian
Carboniferous	Pennsylvanian, Mississippian
Devonian	Pridoli, Ludlow, Wenlock, Llandovery
Silurian	Pragian, Lochkovian
Ordovician	Ashgillian, Caradocian, Llandeilian, Llanvirnian, Arenigian, Tremadocian
Cambrian	Tremadocian
Proterozoic	Ediacaran, Cryogenian, Tonian, Stenian, Ectasian, Calymmian
Archean	Neoarchean, Mesoarchean, Paleoarchean, Eoarchean
Hadean	

Lithostratigraphic Units

Group	Formation
Gippsland Group	Latrobe Formation
Sherbrook Group	Lakes Entrance Formation
Sherbrook Group	Gurnard Formation
Sherbrook Group	Mackellar Formation
Sherbrook Group	Paleocene Unit
Sherbrook Group	Upper Cretaceous Unit
Sherbrook Group	Lower Cretaceous Unit
Strzelecki Group	Eumeralla Formation
Strzelecki Group	Koonwarra Formation
Strzelecki Group	Korumburra Formation
Strzelecki Group	Wonthaggi Formation
Strzelecki Group	Flinders Sandstone
Strzelecki Group	Cape Paterson Formation
Strzelecki Group	Cape Liptrap Formation
Strzelecki Group	Cape Patterson Formation
Strzelecki Group	Cape Liptrap Formation
Strzelecki Group	Cape Pa

Origin energy

BANGANNA-01

COMPOSITE WELL LOG 1:200

PERMIT:	PEP 159 VIC	REGION:	PORT FARRY	BASIN	OTWAY
LOCATION (surface): Latitude 38°12' 27.68"S Longitude 142°10' 50.62"E GDA 94 Ref.: 602 373.4E 5 770 462.7N Seismic Location : SP 423 (60m. W) Line : sbe05a-05	TOTAL DEPTH: 1200.0 LOGGER: 2125.0m. Logger (extrapolated): 2127.0m. DATE: 05/02/2003 Spudded: 16/02/2003 Rig Released: STATUS: P & A.			DATUM: Permanent Datum: MSL Logs Datum: R.T. Drilling Datum: R.T. Elevation: R.T. - 63.7m. G.L. - 63.7m.	
Drilling Co.: Century Drilling Limited RT1	Wireline Logs: Reeves / Schlumberger Multilogging			Composite Log compiled/checked: D.A. Short B. Corbett / D. Short Last Modified: October 2003	

Sandstone
Siltstone
Shale
Claystone
Coal
Marl
Conglomerate
Sandy Limestone
Limestone
Tuff / Volcanics
Metamorphics
Granite
Calcareous
Lithic
Microconcretions
Pyrite
Glauconite
Fossils
Chert
Feldspar
Mica
Shale
Chlorite
Gypsum
Fluorescence
Gas Shows
Oil Shows
Oil Stain
Oil Recovery
SWC Recovered
SWC Not Recovered
Paleontological Stage
Casing Shoe
Core Loss
Check Shot
Cement Plug
Drill Stem Test
Perforations
Core
STRATIGRAPHY
Volcanic Conglomerate
1175.0
1192.0
1175.0 – 1192.0 m. SILTSTONE and SHALEY SILTSTONE with minor SANDSTONE and trace COAL.
SILTSTONE, white to light brown, moderate brown, mottled pale to moderate grey, soft to firm, sub-blocky, sub-fissile, sub-platy, carbonaceous specks / laminae, minor very fine sand, sub-rounded, moderate to well sorted, SANDSTONE, white to off-white, very fine, sub-rounded, moderate to well sorted, calcareous, abundant carbonaceous specks / laminae, friable to moderately hard, very fine, sub-rounded, moderate to well sorted, COAL, dark brown, black, sub-vitreous, lustre is firm, subfissile
Fault
Fault
Fault

Origin Energy

BANGANNA-1

COMPOSITE AND PETROPHYSICAL SUMMARY

Company	ORIGIN ENERGY LIMITED
Well Name	BANGANNA-1
Field	Exploration
Country	Australia
Nation	Australia
State	Victoria
Province	PEP159
County or Rig name	Century Rig 11
Field Location	Easting 603373.4 Northing 5770482.7
Field Locn. Line 1	Seismic Line ole09a-06
Field Locn. Line 2	Seismic Station 60m west of SP 423
Latitude	038 12' 27.660" S DMS
Longitude	142 10' 50.620" E DMS
Permanent Datum	Ground Level
Elevation of PD	63.70 M
Elevation of KB	68.90 M
Elevation of DF	68.90 M
Elevation Ground lv	63.70 M
Elevation Log Zero	68.90 M
Above Perm. Datum	5.20 M
Log measured from	RT
Drill measured from	RT
Services	PEx(HALS)-DSI-NGT-SP
Other Services Ln 1	CSAT-GR
Service company	Schlumberger
Number of runs	1
Well class	Exploration
Basin	Otway
Tenement/Concession	PEP159
On-Shore Flag	On-shore
Date	16-FEB-2003
Log date	16-Feb-2003
Date computed	16-02-03
Date plotted	16-02-2003
Time plotted	15:51:12

PETROLOG SOFTWARE Revision 9.10

CROCKER DATA PROCESSING

COMPUTATION PARAMETERS

DEPTH INTERVAL	RW PPM	RW OHMM	TEMP C	GR MIN	GR MAX	R CLAY	RHOB CLAY	PHIN CLAY	t CLAY	RHOH	a	m
1825.0 - 1853.7	35169	.109	54.8	23	105	14	2.63	.262	89	.80	1.00	2.20
1853.7 - 1926.9	34769	.109	55.6	24	105	15	2.63	.262	89	.80	1.00	1.90
1926.9 - 1962.0	34354	.109	56.4	23	105	14	2.63	.262	89	.80	1.00	2.00

LOG DESCRIPTION

SW -CPX	Formation Water Saturation <=1.0 (Complex Litho Model)
PHIE-CPX	Effective Porosity (Complex Litho Model)
PHXO-CPX	Product (PHIE * SXO) (Complex Litho Model)
PHSW-CPX	Product (PHIE * SW) (Complex Litho Model)
MINERAL	Special Mineral Table output flag (Salt,Trona,Anhydrite,Gypsum,Coal)
VCL -CPX	Volume of clay (Complex Litho Model)
VSND-CPX	Volume of Sand (Complex Litho Model)
VLS -CPX	Volume of Limestone (Complex Litho Model)
VDOL-CPX	Volume of Dolomite (Complex Litho Model)
PHIE-CPX	Effective Porosity (Complex Litho Model)
PHXO-CPX	Product (PHIE * SXO) (Complex Litho Model)
PHSW-CPX	Product (PHIE * SW) (Complex Litho Model)
VBW -CPX	Volume of bound water (Complex Litho Model)
EHGR	HiRes Gamma-Ray (F13.4)
SP	SP Shifted (F13.4)
BS	Bit Size (F13.4)
HCAL	HBCC Cal. Caliper (F13.4)
HRLD	HALS High Resolution Deep Resistivity (F13.4)
RXOI	MCFL High Resolution Invaded Zone Resistivity (F13.4)
HRLS	HALS High Resolution Shallow Resistivity (F13.4)
RHOI	HRDD High Resolution Formation Density (F13.4)
HTNP	HiRes Thermal Neutron Porosity (F13.4)
PEFI	HRDD High Resolution Formation Photoelectric Factor (F13.4)
HDRA	HRDD Density Correction (F13.4)
PHIT-CPX	Total porosity from CPX model after hydrocarbon correction (Complex Litho Model)
TGAS	
C1	
C2	
C3	
iC4	
nC4	
ROP	
NET -ROC	
NET -RES	
NET -PAY	
DTCO	Delta-T Compressional (F13.4)