PEP 159, OTWAY BASIN, VIC

Banganna-1

WELL PROPOSAL

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SUMMARY

Banganna-1 is proposed as a gas exploration well (TD approximately 2050 mSS) in the south-western corner of PEP 159. It is located 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. The Banganna prospect is a large, fault-dependent dip closure at the base Laira/top Pretty Hill level.

The reservoir target comprises a possible gas bearing sand at the base of the Laira Formation in addition to potential reservoir sandstones in the underlying Pretty Hill Formation. The main technical justification of the drilling proposal is the presence of a significant AVO-anomaly identified on the 2000 Spring Creek Seismic Survey. Based on the present seismic interpretation, the AVO-anomaly over Banganna is correlated with a reservoir at the base of the Laira Formation.

The existing well logs suggest that the Pretty Hill Formation below the AVO-anomaly represents a thick sand dominated interval and may comprise several reservoir/seal pairs. The seismic appearance and observed amplitudes at Banganna are similar to the gas bearing Pretty Hill in the Penola Trough. The possible extension of the gas column into the Pretty Hill Formation is also suggested by the fact that AVO-anomalies on 3D-seismic data from the Penola Trough are mainly seen at the top of a gas column rather than imaging the entire gas-bearing interval.

The trapping mechanism requires an intra-formational shale layer in the Laira Formation to act as top-seal and a sealing Eumeralla Formation in the hanging wall block of the Tyrendarra Fault to act as cross-fault seal. Charge is believed to have sourced from mature Casterton Formation beneath Banganna and from the east in the Warrong Trough.

The main risk associated with the prospect is cross-fault seal leakage and possible lack of top seal.

The overall chance for finding hydrocarbons is estimated at approximately 17%.

Mean recoverable reserves for the Banganna prospect are estimated at 24.7 PJ for the gas case (+ 371.0 MSTB of condensate).

Economic analysis indicates the Banganna project has a positive EMV of 0.34 M @ 10.5% DF ATAX.

Banganna-1, if successful, will upgrade the hydrocarbon potential of the Crayfish Group sandstones in PEP 159 and adjacent PEP 152, and may encourage further exploration work focussing on similar structures.

1.0 GENERAL INFORMATION

WELL NAME:	Banganna-1
PERMIT:	PEP 159
BASIN:	Onshore Otway Basin
TYPE OF WELL:	Gas Exploration
PARTICIPATION INTERESTS:	Origin Energy Resources Ltd (Operator) 50.00% Essential Petroleum Resources Ltd 50.00%
LOCATION:	seismic line obe00a-06 at shot point 423 Latitude: 38° 12' 27.66'' S Longitude: 142° 10' 50.62'' E 603373.4E 5770482.7N Datum: GDA 94
ELEVATION:	Ground Level: 63.7 m AMSL (approximate) Rotary Table: 68.9 m AMSL (approximate)
PROPOSED T.D:	2050 mSS
PRIMARY OBJECTIVES:	Intra-Laira Sandstone / Pretty Hill Formation
MEAN RECOVERABLE RESERVES:	24.7 PJ (gas case)
WELL COST ESTIMATE:	C&S: $1549k P&A: $1133k

2.0 TECHNICAL JUSTIFICATION

2.1 Permit Summary

PEP 159 comprises 2,280 square kilometres of onshore area in the Victorian part of the Otway Basin. The permit is in the third year of the current 5-year term, which commenced on 12/11/2000. The current term expires on 11/03/2006. The proposed well, Banganna-1, will meet the formally extended year 2 well commitment.

The current participants in the PEP 159 permit are:

Origin Energy Resources Ltd	50.00% (Operator)
Essential Petroleum Resources Ltd	50.00%

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 (see Table 1).

Table 1 Wells drilled in PEP 159

Year	Name	Operator	Well Type	Well Target	Total Depth (MKB)	Result	Flow Rate/ Recovery
1962	Pretty Hill 1	Frome	Expl	Pretty Hill Fm	2478	P&A Oil shows	1DST Muddy water
1968	Woolsthorpe 1	Interstate Oil	Expl	Pretty Hill Fm	1971	P&A, fluor in cores	1DST Muddy water
1968	Garvoc 1	Interstate Oil	Expl	Pretty Hill Fm	1533	P&A, fluor in cores	1DST CO_2cut Muddy water
1969	Moyne Falls 1	Shell	Expl	Basal Eumeralla	1008	P&A, no show	No tests
1969	Hawkesdale 1	Shell	Expl	Pretty Hill Fm	1774	P&A, fluor in cores	2 failed DSTs
1985	Greenslopes 1	Phoenix	Expl	Pretty Hill Fm	2608	P&A, faint fluor in cuttings	No tests
1987	Ballangeich 1	Phoenix	Expl	Pretty Hill Fm	1250	P&A, no show	No tests
1991	Killara 1	Phoenix	Expl	Basal Eumeralla & Pretty Hill Fm	2409	P&A, weak shows	2DSTsrec'd Muddy water
1997	Taralea 1	Cultus	Expl	Intra Eumeralla	2800	P&A, no show	No tests

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

Table 2 Seismic Surveys acquired in PEP 159

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**

2.2 Regional Geology

Situated in the Victorian part of the onshore Otway Basin, PEP 159 contains prospective Early Cretaceous Crayfish Group sediments overlain by a thick Eumeralla Formation and thin Tertiary Wangerrip and Heytesbury Group cover (see Figure 1). The Late Cretaceous Sherbrook Group is thin or absent in PEP 159.

The main structural elements in the vicinity of PEP 159 are the Windemere, Koroit and Morenda Troughs. The Windemere and Koroit Troughs are half grabens bounded to the north 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 and Koroit Troughs. PEP 159 largely overlies the footwall block of the Tyrendarra Fault and the Tower-Taurus Fault Zone.

The permit is dominated by a series of east-west trending normal faults, with the Sherbrook Group and Otway Supergroup sediments progressively thickening to the south across each successive fault (see Figure 3).

The main exploration targets in PEP 159 are the Pretty Hill Sandstone, Laira Formation and Pebble Point Formation. The Heathfield Sandstone Member of the Lower Eumeralla Formation may also represent a potential reservoir unit.

The best quality source rocks in the area are coals and shales within the Casterton Formation. Maturation modelling indicates that the Casterton Formation beneath Banganna, and to the east in the Warrong Trough, reached peak generation towards the end of the Early Cretaceous. Therefore the Banganna structure is likely to have been charged at the end of the Early Cretaceous with minor additional charging possibly occurring in the Late Tertiary. The coals at the base of the Eumeralla Formation could also be a potential source, but this would require face-loading across the Tyrendarra Fault, as they are presently immature for oil and gas to the north on the footwall block, but are early mature on the hanging wall side.

The existing wells penetrating the Pretty Hill Formation have confirmed fair to excellent reservoir properties for these sandstone intervals. Explanations for the failure of the existing Pretty Hill tests in the PEPs 152 and 159 include lack of closure, cross-fault seal failure, missing top-seal, and fault leakage. In some cases, it is not possible to determine the failure criterion due to sparse seismic coverage, the quality of the seismic data, and the overall uncertainty associated with the interpretation of individual prospects. However, the presence of numerous hydrocarbon shows (see Table 1) and the fact that Windemere-1 recovered hydrocarbons from the Heathfield Member of the Eumeralla Formation, indicate the presence of a working hydrocarbon system.

More recently, Port Fairy-1 in the southern part of PEP 152 encountered strong oil and gas shows in the Late Cretaceous Flaxmans Formation. The well is currently interpreted as a non- to sub-commercial gas condensate discovery.

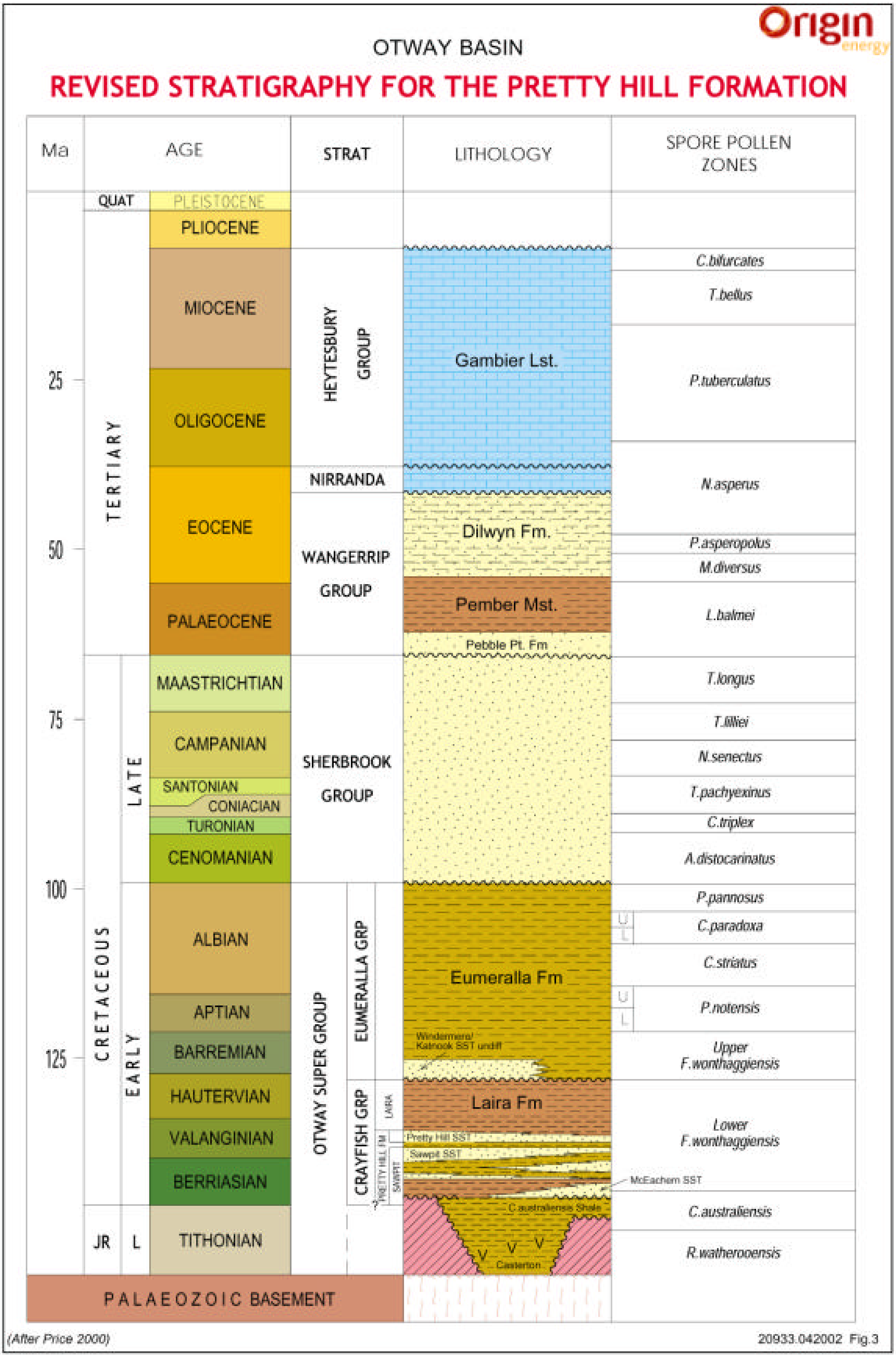
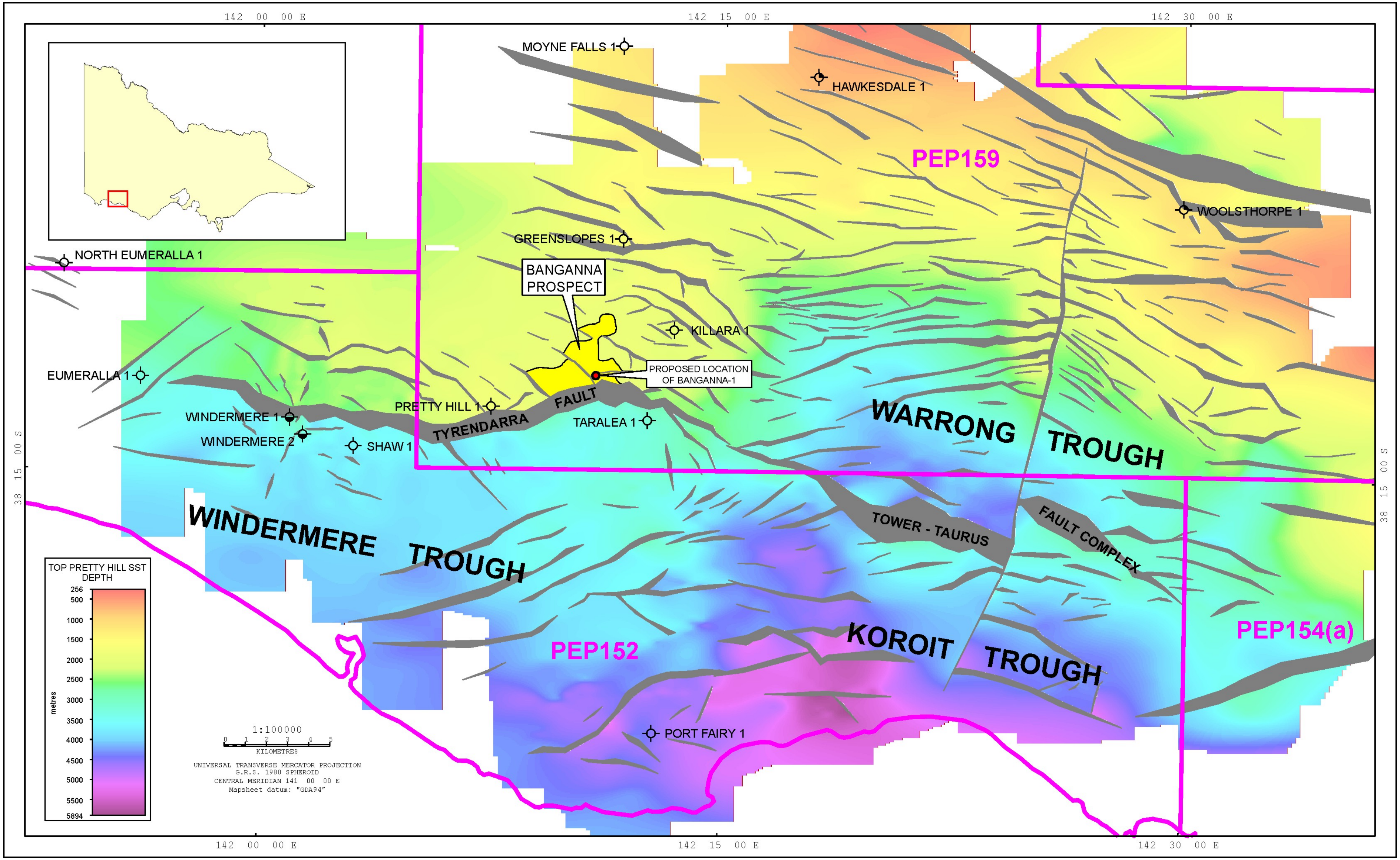


Figure 1 Generalized Stratigraphic Column for PEP 159

Figure 2 Structural Overview of PEP 159



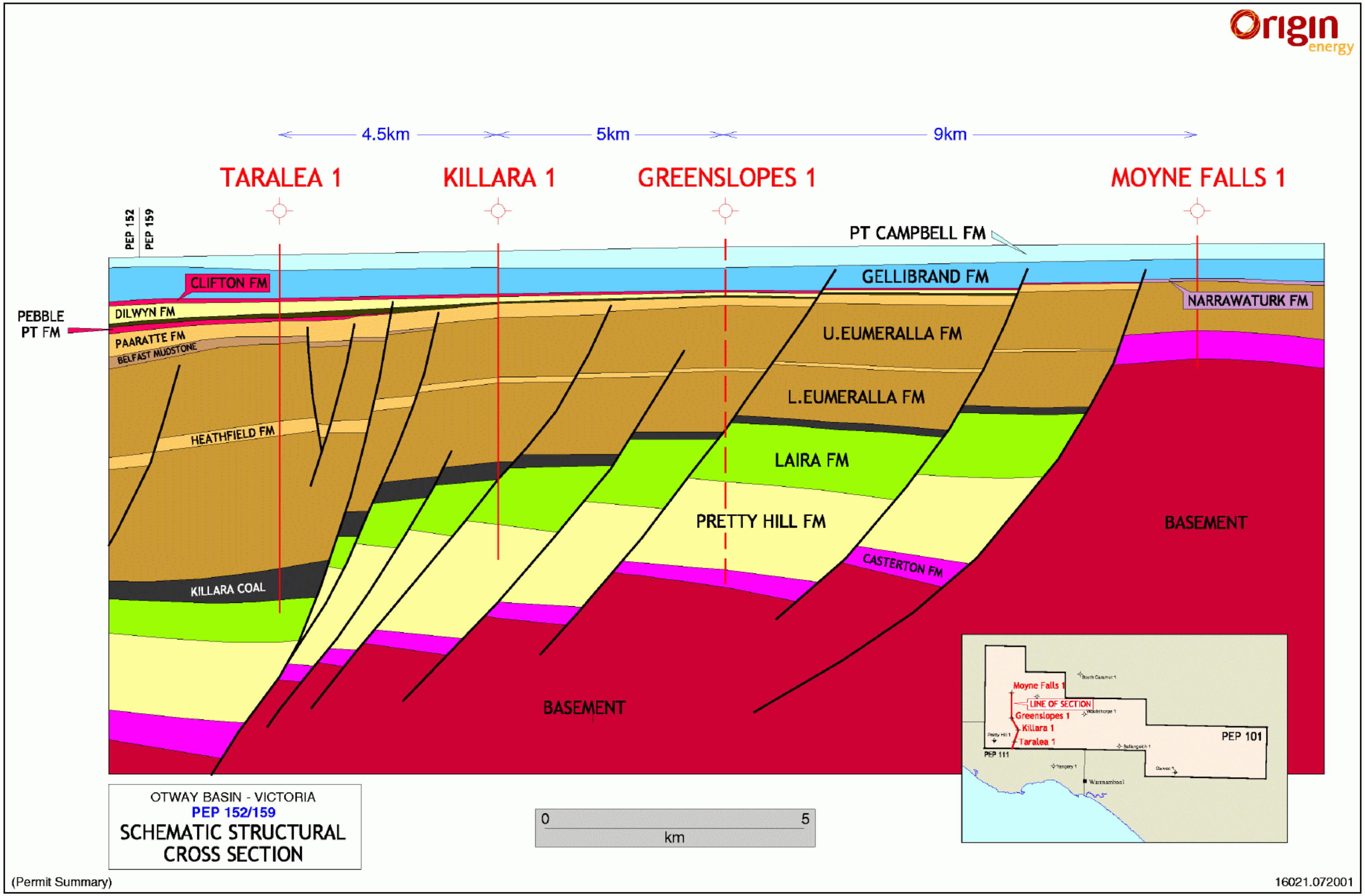


Figure 3 Schematic Cross-section for PEP 159

2.3 Prospect Description

The Banganna prospect was originally identified as a fault related Pretty Hill Sandstone play located in the footwall block of the Tyrendarra Fault. Following the acquisition of the Spring Creek Seismic Survey in 2001 (see location map in Figure 4), and the subsequent remapping of the prospect, the presence of an AVO-anomaly became apparent below the Crayfish Unconformity.

The AVO-anomaly straddles the interpreted top Pretty Hill seismic event on lines obe00a-04 and 05, and occurs immediatly above the base of the interpreted Laira Formation on line obe00a-06. Figure 5 shows a composed seismic section that ties in the Banganna Prospect and the existing Killara-1 well. The AVO-anomaly visible on line obe00a-06 is most likely related to a sandstone layer at the base of the Laira Formation as encountered in Killara-1 which had a weak oil show.

The locations of the AVO-anomalies are shown superposed on the top Pretty Hill depth map in Figure 6. Figures 7 and 8 illustrate the seismic mapping of the Pretty Hill Formation on dip line obe00a-06 and strike line obe00a-07.

The Banganna Prospect can be subdivided into two compartments by the NW-SE striking fault labelled A in Figure 6. The dividing fault shows only minor throw (10- 50 m) and may not seal at Pretty Hill level. As the AVO-anomalies on lines obe00a-05 and 06 are restricted to the eastern fault compartment, the same fault may be sealing for a thin intra-Laira reservoir.

The larger closure at Pretty Hill level is dependent on the main EW-striking Tyrendarra Fault in the south and a second NW/SE-striking fault in the west (Fault B in Figure 6). Towards the north and east the prospect is controlled by dip closure.

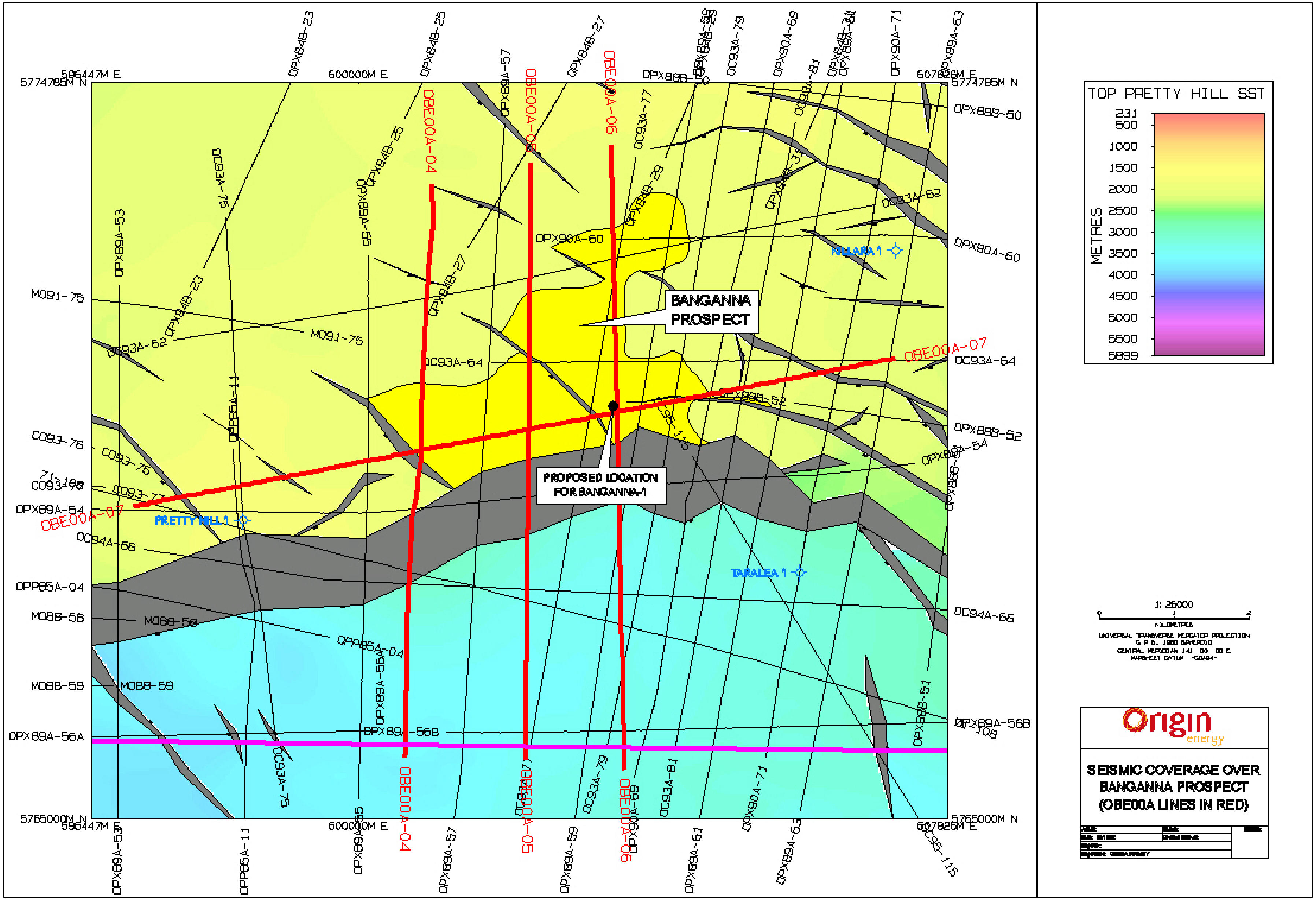
The trap requires an intra-formational shale layer in the Laira Formation above the reservoir sands to act as the top-seal, and the Eumeralla Formation in the hanging wall block of the Tyrendarra Fault to act as the cross-fault seal.

The seismic appearance and observed amplitudes in the Pretty Hill Formation at Banganna are similar to the gas bearing Pretty Hill Sandstone in the Penola Trough where the AVO anomalies only occur at the top of the gas column of known pools. Since the base of the gas columns in the Penola Trough are not being imaged, it is therefore highly likely that the gas column at Banganna extends down below the AVO into the Pretty Hill Sandstone.

Based on the existing log data in PEP 159, the Pretty Hill Formation at Banganna is either a thick sand-dominated interval or comprises several reservoir/seal pairs. Porosity estimates are based on the porosity/depth cross-plot shown in Figure 9. The graph contains data from PEL 32 in the Penola Trough and from wells in and adjacent to PEP 159. The wide range of porosity values at each depth interval reflects the variability of individual sandstone beds (rapid lateral and vertical facies changes) and possible secondary dissolution effects. Min-, max- and mean porosity values appear to decrease with burial depth, and an average porosity of 15 % is predicted for the target interval at Banganna.

No core data are available from the intra-Laira sands, however, log analysis from the sandy Laira at Killara-1 indicate an average porosity of 15 %, which supports the expected value derived from the porosity/depth cross-plot.

Figure 4 Location Map



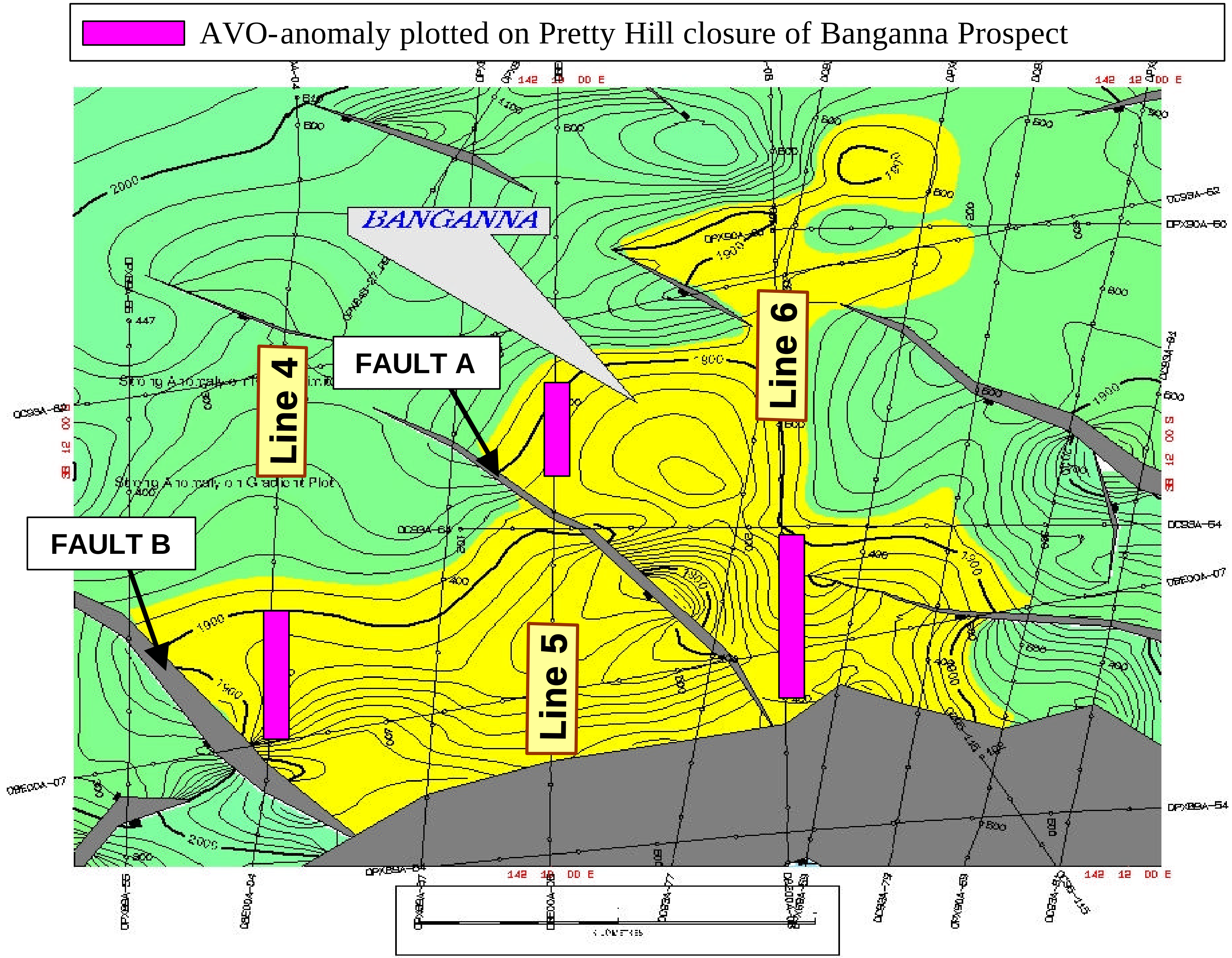


Figure 5 Top Pretty Hill Formation Depth Structure Map

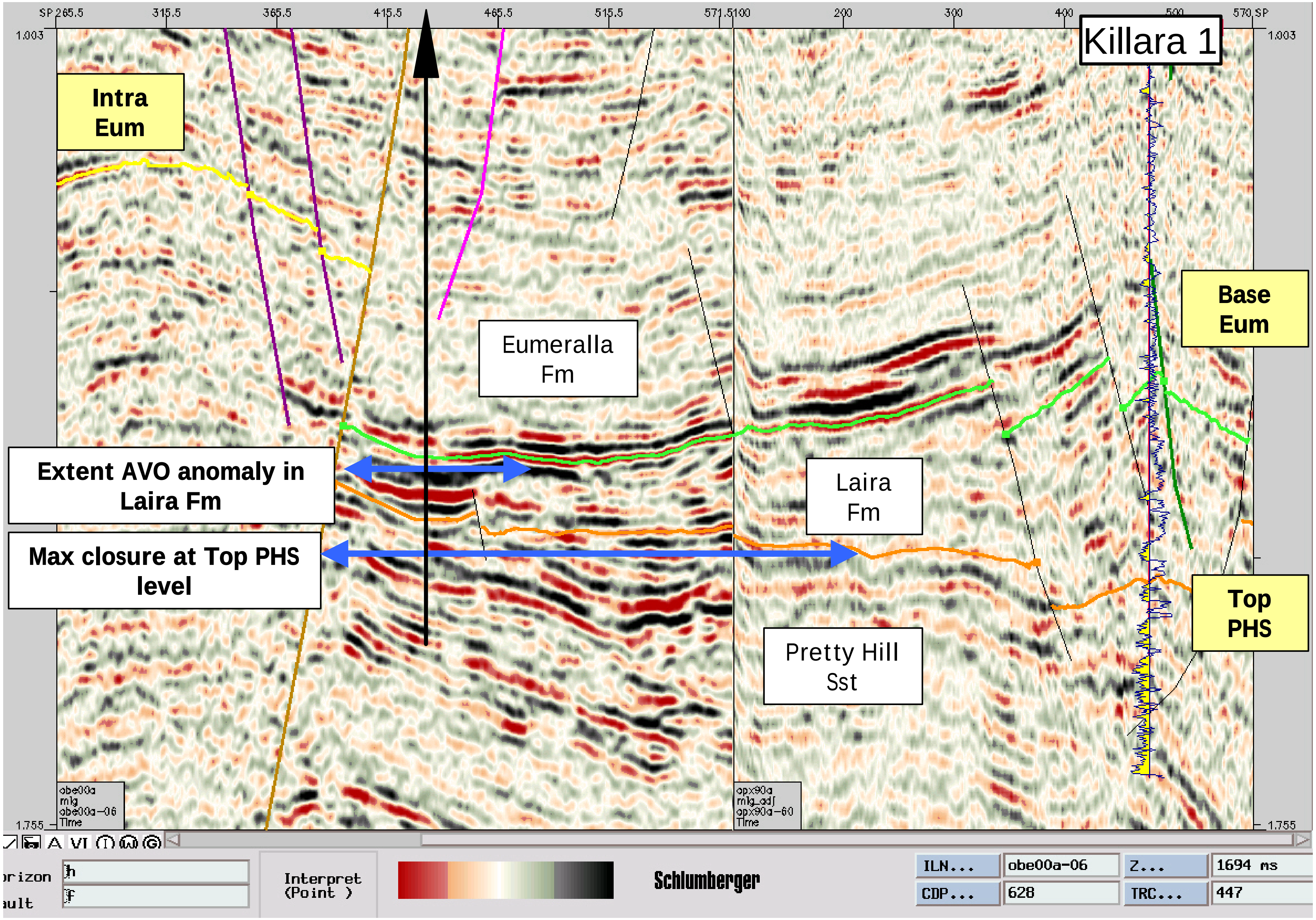


Figure 6 Composed Seismic Section from Banganna to Killara-1

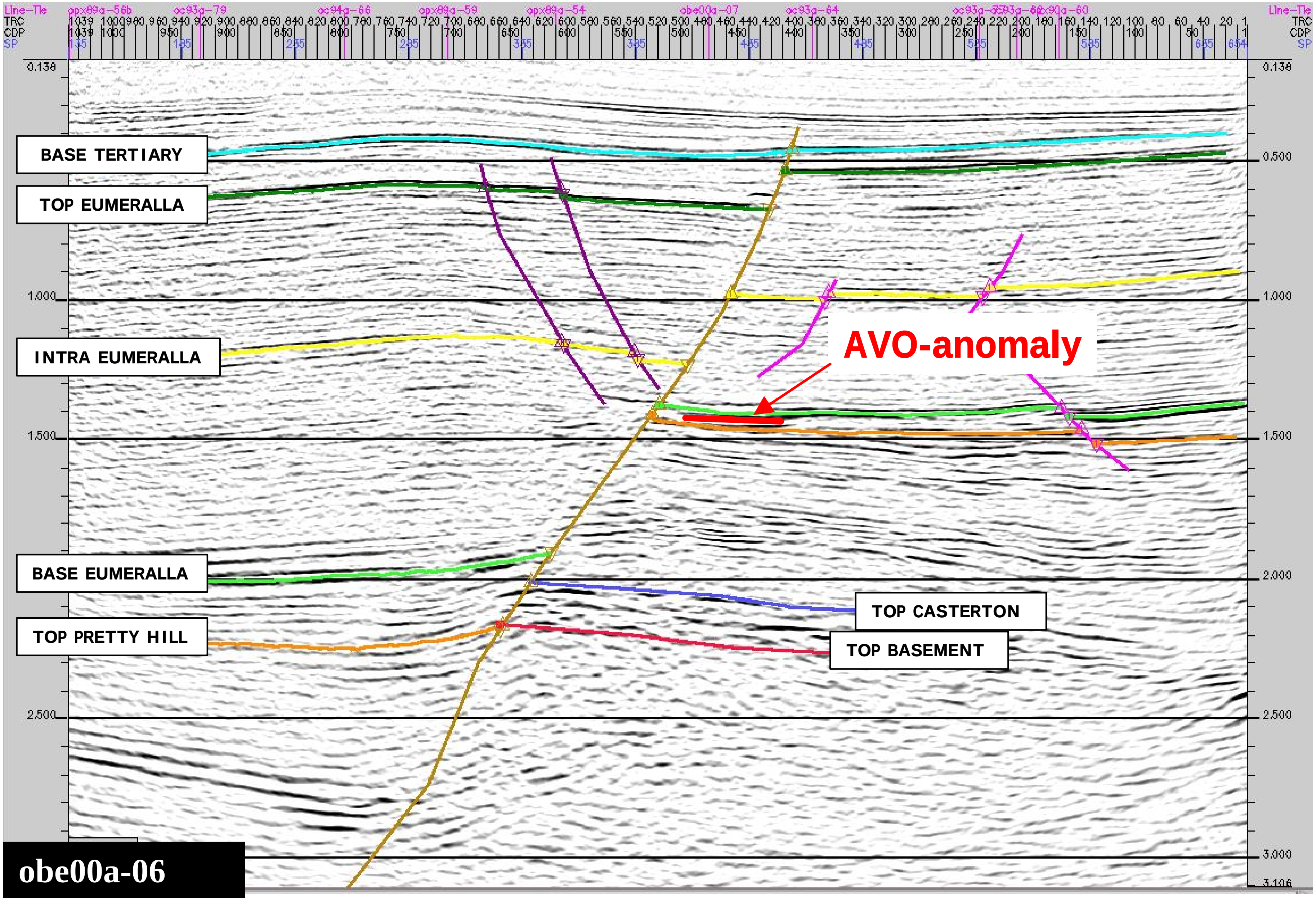
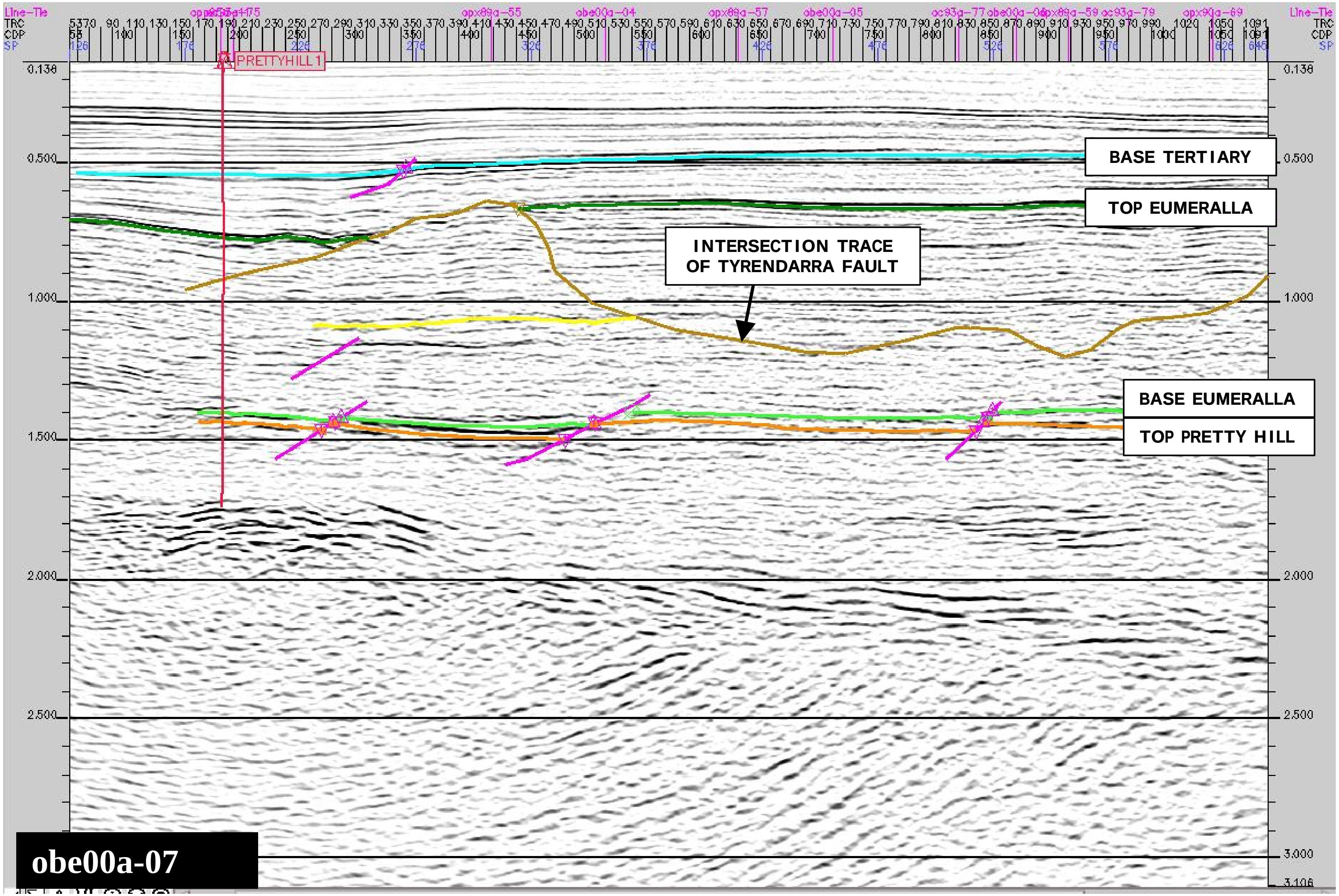


Figure 7 Seismic Line oeb00a-06 – Seismic Interpretation

Figure 8 Seismic Line oeb00a-07 – Seismic Interpretation



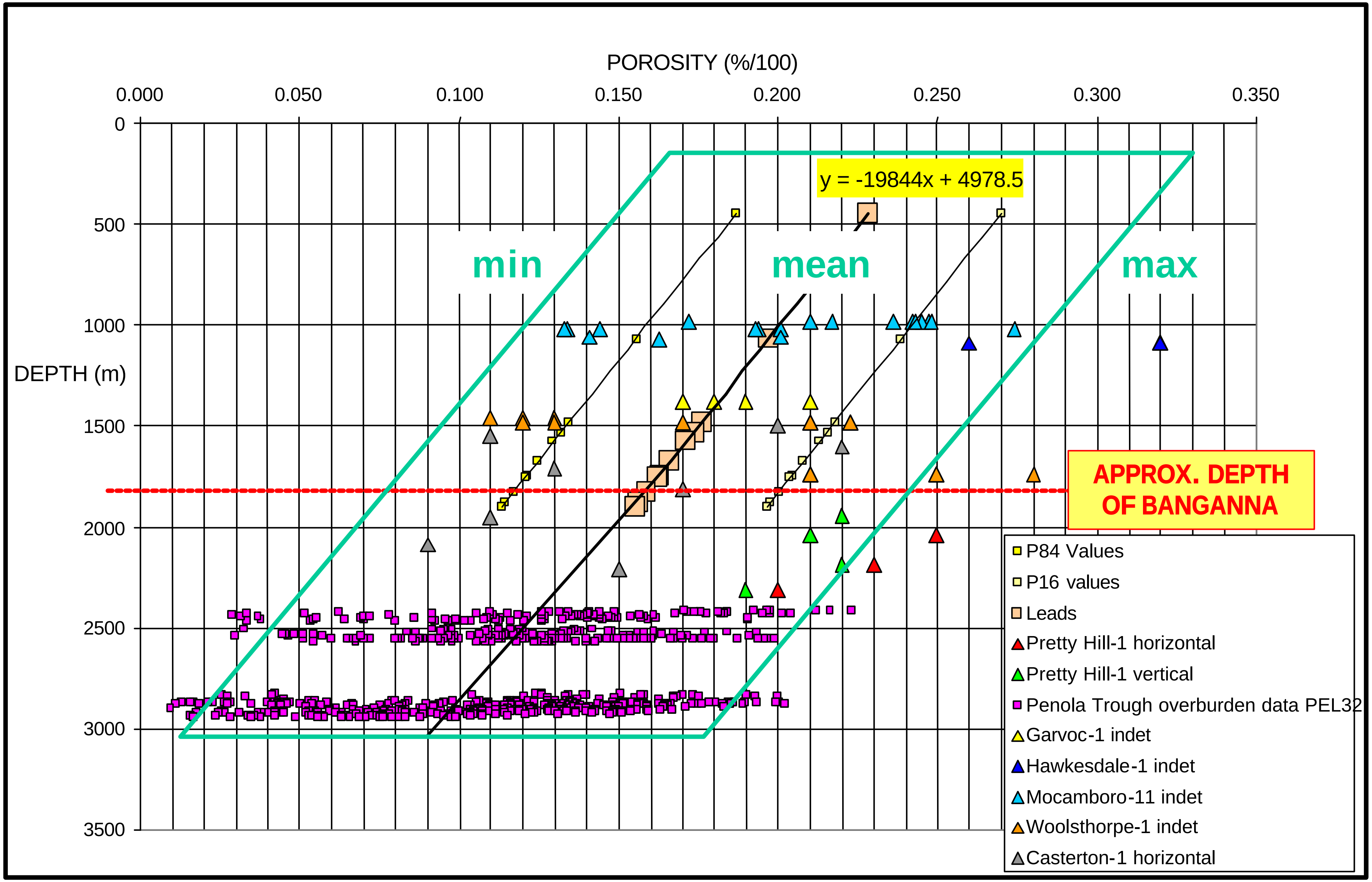


Figure 9 Porosity / Depth cross-plot for Pretty Hill sandstone

2.4 Well Location and Stratigraphic Prognosis

The proposed location for Banganna-1 is situated 45 m west of shotpoint 423 on seismic line obe00a-06. It is not possible to locate the well directly on seismic line obe00a-06 due to surface basalt conditions.

Coordinates for well Banganna-1:	Latitude:	38 ° 12' 27.66'' S
	Longitude:	142 ° 10' 50.62'' E
	Easting:	603373.4E
	Northing:	5770482.7N
	Datum:	GDA 94

As indicated in Table 3, the well will penetrate the Tyrendarra Fault. The actual thickness of the fault zone is unknown and some uncertainty exists in the exact positioning of the fault trace on the 2D seismic line. While it is difficult to prognose the exact depth range in which the well trace will penetrate and/or run sub-parallel to the fault zone, an estimate of 998-1140 (within the Eumeralla Formation) has been made.

Table 3 Prognosis of Formation Tops

Group	Formation	TWT (ms)	Depth (mSS)	Depth (mKB)	Thickness
Pliocene	Surface Basalt		-63.7	5.2	40
Heytesbury	Port Campbell Limestone		-23.7	45.2	104.7
	Gellibrand Marl	83	81	149.9	231
	Clifton Formation	332	312	380.9	31
Wangerip	Dilwyn Fm	362	343	411.9	89
	Pember Mudstone	446	432	500.9	55
	Pebble Point Fm	495	487	555.9	25
Sherbrook	Paaratte Formation	517	512	580.9	56
	Skull Creek Mudstone	565	568	636.9	25
	Nullawarre Sandstone	587	593	661.9	21
	Belfast Mst	604	614	682.9	42
	Flaxmans / Waarre Fm	639	656	724.9	38
Otway	Eumeralla Fm	670	694	762.9	447
	Larger fault zone expected	900 to 1000	998 to 1141	1066.9	unknown
	Eumeralla Fm	1000	1141	1209.9	596
	Killara Coals	1375	1737	1805.9	73
	Laira Formation	1417	1810	1878.9	38
	Top AVO anomaly	1439	1848	1916.9	43
	Pretty Hill Formation	1463	1891	1959.9	159
	TD	1550	2050	2118.9	

2.5 Reserves Calculations

Reserve estimates have been calculated for eastern fault compartment at Banganna, and not the western compartment, because the AVO anomalies are strongest on lines obe00a-5 and –6 in the eastern fault compartment, and it is uncertain if the two fault compartments are in communication. Reserves have been calculated for both the Laira Formation reservoir and the Pretty Hill Formation. Both estimates use the top Pretty Hill depth contours for which the P10, P50, and P90 cases of closure size are shown in Figure 10.

A single 15 m thick sand model was used for the Laira Formation including a wide range of average porosity values (11 to 17 %). The presumed high net/gross Pretty Hill Formation was quantified by using a gross volume distribution curve derived from the P10 to P90 closure polygons. The porosity distribution applied to the Laira Formation was also used for the Pretty Hill Formation.

For the Laira reservoir, the probabilistic reserves calculations give un-risked OGIP estimates of 1.0, 3.0, 7.2 and 3.7 [BCF] for the P90, P50, P10 and mean cases respectively. The equivalent values for the Pretty Hill are 11.5 (P90, 24.7 (P50), 47.8 (P10) and 27.6 (mean).

A more detailed summary of all the parameters used for the reserves calculation is contained in Appendix 1.

2.6 Risking

Banganna-1 has been assigned a chance of success of 17 %. The detailed input parameters for the risk calculations are summarized in Appendix 2. The main risks are briefly discussed below.

Table 4 Chance of Success for Banganna-1

BANGANNA PROSPECT	
Chance of success	**%**
Closure	73
Reservoir	86
Charge	81
Source	90
Seal	36
Overall COS	**17**

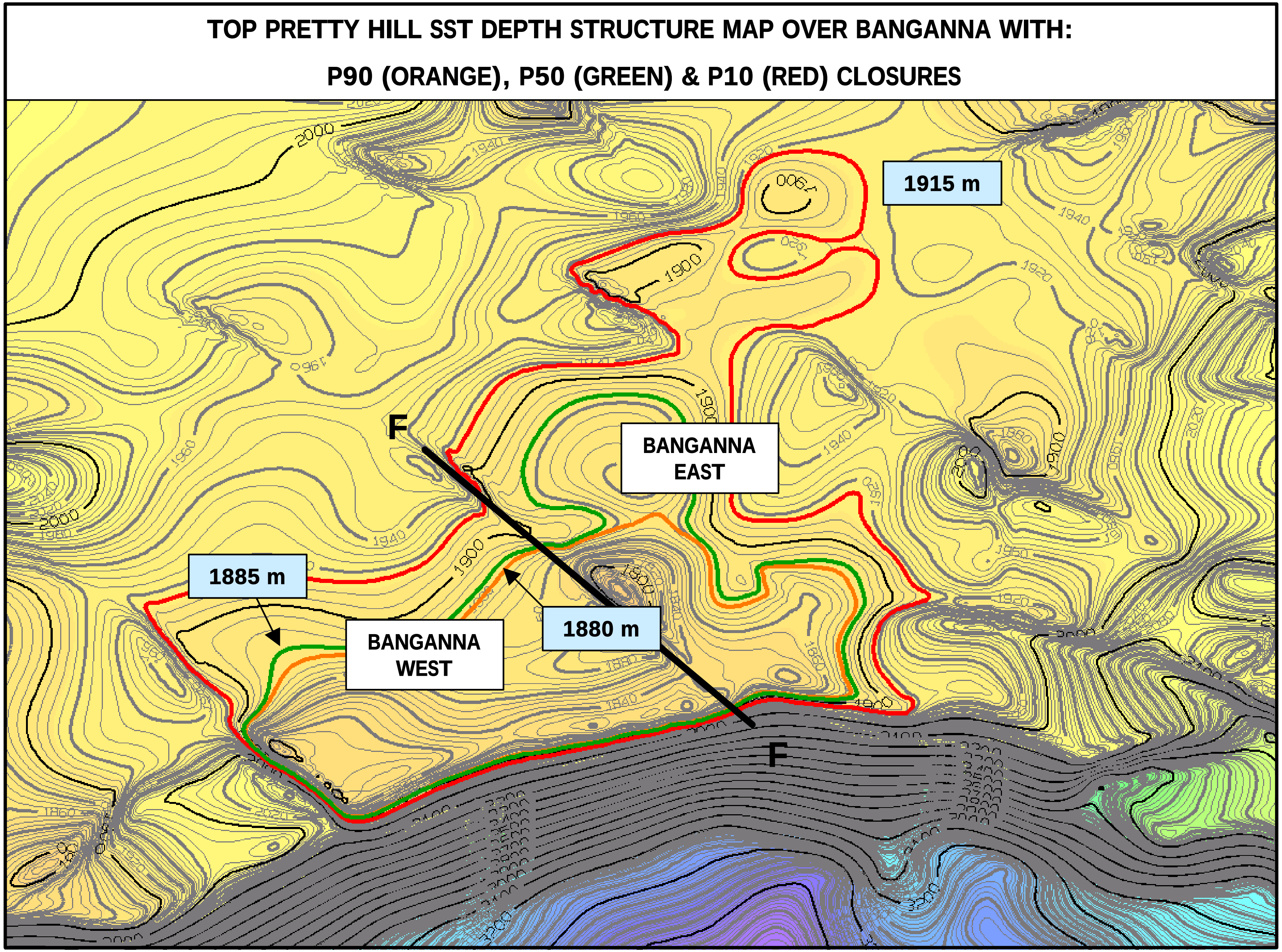


Figure 10 Closure Size for Volumetric Calculations

Closure (Pcl)

The chance of adequate closure at the proposed Banganna location is estimated to be 73%. The structural mapping is based on nine dip- and three strike lines with an average line spacing ranging from 500 to 1500 meters. Minor risks are seen in the fact that the 2D lines are of different vintages and some of the lines are of rather poor quality. There are also some uncertainties in closure height and areal extent due to the difficulties in picking formation tops.

Source (Psc)

The source potential of the Casterton Formation has been discussed in Section 2.2. The chance of adequate source and maturity is estimated at 90 %.

Charge (Pch)

Charge is considered to represent a minor risk (81 % chance of success) since the Pretty Hill Formation is very sandy and should have acted as a good lateral and vertical conduit for hydrocarbon migration from the Casterton Formation.

Reservoir (Prs)

The chance for the presence of reservoir in the Laira / Pretty Hill section is considered to be very high (86%). The proposed well is located only 5.3 km from the “type locality” of the Pretty Hill Formation penetrated by Pretty Hill-1, and the formation has been intersected in numerous wells to the north and east.

Seal (Psl)

Seal adequacy represents the highest individual risk with an estimated chance of success of 36 %. Cross-fault leakage comprises a significant part of this risk due to the possibility of breaching of the hydrocarbon trap in response to Late Tertiary reactivation of the Tyrendarra Fault. Missing top seal is also a possibility due to the high sand content of the basal Laira Formation in PEP 159.

On most seismic dip lines the seismic interval between the interpreted Base Eumeralla and Top Pretty Hill thins towards the crest of the Banganna structure, and the presence of a sealing shale unit above the reservoir sands remains questionable. It is possible that a sealing basal Eumeralla lithology is required somewhere along the length of the closure, but the AVO anomalies on lines obe00a-5 and –6 lie well outside the Base Eumeralla closure, which suggests a shale within the Laira Formation is acting as the top-seal for the AVO anomaly.

3.0 ECONOMIC ANALYSIS

The success case for Banganna-1 is estimated to be 31.8 BCF OGIP from a combined Laira and Pretty Hill reservoir. The mean un-risked gas case generates a NPV of $ 7.7M ATAX @ 10.5% discount factor and an EMV (16.5% chance of success) of $ 0.34M ATAX @ 10.5% discount factor.

The key project economic assumptions for the economic analysis are summarized in Table 5 below.

Table 5 Economic Assumptions

Production			
	Total OGIP	31.8	BCF
	Total Gas Reserves	24.7	PJ
	Total Condensate	371.0	MSTB
	No. of Producers	3	WELLS
	Total Depth	2050	mKB
	Distance to Pipeline	3.0	KM
	Prod. Start Date	7-Jul-04	
Development Cost		**$ MM**	
	Exploration well P&A	1.133	
	Exploration well C&S	1.549	Cost/well
	Development well	1.500	Cost/well
	Completion	0.500	Cost/well
	Tie-ins	0.300	Cost/well
	Flowline	0.600	
	Surface Facility	10.50	
	Compressor	4.000	
	Abandonment cost	0.125	Cost/well
Development Schedule		**TIME**	
	Exploration well	4Q2002	
	2 Development wells	4Q 2003	
	Surface Facility	1Q 2004	
	Flowline	1Q 2004	
	Compressor	3Q 2007	

A summary of the NPV and EMV at a variety of discount rates is given in Tables 6 and 7 respectively. Cash flow calculation are summarised in Table 8.

Table 6 Net Present Value for un-risked Gas Case

Net Present Value (Un-risked)				
Discount RATE	**Before Tax**	**Before Tax**	**Before Tax**	**After Tax**
(%)	**Oper. Income**	**Cap. Investment**	**Cash Flow**	**Cash Flow**
	$MM	***$MM***	***$MM***	***$MM***
Undisc.	55.9	23.6	32.3	22.5
8.1	37.2	20.2	16.8	10.1
10.5	33.3	19.4	13.7	7.7
11.6	31.7	19.1	12.4	6.7
12.5	30.5	18.8	11.5	6.0
15.0	27.4	18.1	9.1	4.2
20.0	22.4	16.8	5.3	1.3
			Before Tax	***After Tax***
	ROR	%	31.8	23.1
	Payout Period	(mo's)	51.6	66.7
	Undisc PIR	$ k/$ k	1.4	0.97
	10.5 Pcnt. PIR	$ k/$ k	0.71	0.4
	11.6 Pcnt. PIR	$ k/$ k	0.66	0.36
	NPV/Vol@10.5	$ k/MMSCF	0.56	0.31
	NPV/Vol@11.6	$ k/MMSCF	0.51	0.27

Table 7 EMV Results

COS=16.5%	**Before Tax**	**After Tax**
	EMV	**EMV**
Discount RATE (%)	***$ MM***	***$ MM***
Undisc.	4.38	2.76
8.1	1.83	0.74
10.5	1.32	0.34
11.6	1.12	0.18
12.5	0.96	0.06
15.0	0.57	-0.24
20.0	-0.04	-0.70

Table 8 Cashflow Calculation - Gas Case

Date	Total Gas Production	Condn/ Oil Volume	Gas Price	Total Gas Rev	Condn/O ilPrice	Net Condn Revenue	Total Revenue	Total Opcosts	Total Royalty	Total Oper Inc	Total Capital	Total BT Cash	Total Taxes	Total AT Cash
	TJ	*MSTB*	*$/Gj*	*$k*	*$/bbl*	*$k*	*$k*	*$k*	*$k*	*$k*	*$k*	*$k*	*$k*	*$k*
2003(06)	0	0.0	2.275	0	42.2	0	0	0	0	0	2059	-2059	0	-2059
2004(06)	0	0.0	2.324	0	38.4	0	0	0	0	0	16596	-16596	0	-16596
2005(06)	3650	54.8	2.274	8663	37.2	1876	10593	1516	778	8246	0	7809	0	7809
2006(06)	3650	54.8	2.424	8847	37.2	1872	10719	1586	792	8341	0	8333	2544	5789
2007(06)	3650	54.8	2.476	9035	37.2	1868	10903	1626	762	8515	4477	4031	2753	1278
2008(06)	3650	54.9	2.528	9252	37.2	1869	11121	1955	751	8416	0	8408	1797	6611
2009(06)	3650	54.8	2.582	9423	37.2	1860	11283	2002	762	8518	0	8510	1470	7040
2010(06)	2847	42.7	2.637	7506	37.2	1447	8953	1940	535	6478	0	6574	1191	5384
2011(06)	1971	29.6	2.693	5307	37.2	999	6306	1862	279	4165	0	4275	535	3740
2012(06)	1629	24.4	2.750	4479	37.2	824	5302	1859	179	3265	0	3307	-61	3368
2013(06)	0	0.0	0.000	0	0.0	0	0	0	0	0	492	-273	-385	113
2014(06)	0	0.0	0.000	0	0.0	0	0	0	0	0	0	0	0	0
Total	24707	370.6		62511	0.0	12616	751276	14346	4837	55944	23623	32321	9844	22477

APPENDIX 1

RESERVE CALCULATIONS
FOR
BANGANNA-1

Prospect/Field Recoverable Gas

Country:	**AUSTRALIA**	Name:	**BANGANNA**
State:	**SA**	Segment:	**LAIRA FM**
Block:	**PEP 159 VIC OTWAY**	Classification:	**Unspecified**

Input Data

Variable	Unit	Shape	Min	P90	P50	P10	Max	Mode
Area	km2	Triang	0.0135	1.02	2.37	4.20	5.68	1.80
Thickness	m	Single	15.0	15.0	15.0	15.0	15.0	15.0
Shape factor	%	Triang	86.8	90.0	94.0	97.0	99.3	95.0
Deg. of fill	%	Single	100	100	100	100	100	100
Net-to-gross	%	Lognor	5.34	11.5	20.3	35.9	77.1	16.7
Porosity	%	Triang	9.00	11.7	15.0	17.3	19.0	16.2
Sw	%	80% dependent on porosity;			limits 30.0 - 60.0; -ve sense			
FVF (1/Bg)	vol/vol	Triang	146	150	156	162	166	156
Gas rec fac	%	Single	100	100	100	100	100	100

Risk Factors

Play Chance:	**100%**		Prospect Specific Chance:	**100%**	
Reservoir	100%	confident	Trap	100%	confident
Source	100%	confident	Reservoir effectiveness	100%	confident
Seal	100%	confident	Seal effectiveness	100%	confident
			Source Rock effectiveness	100%	confident

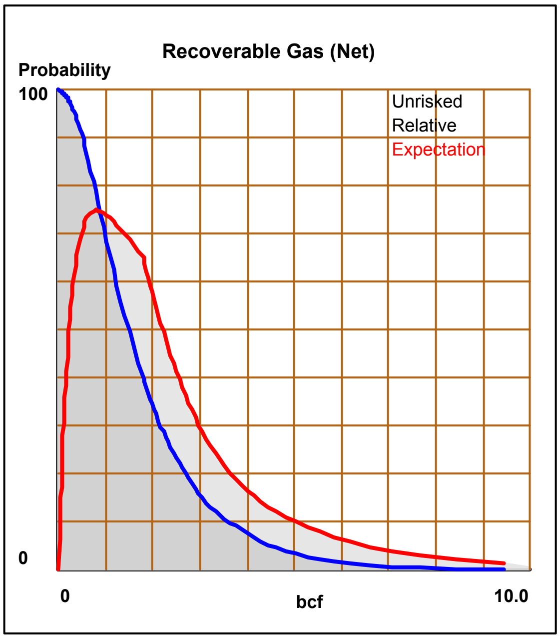
Chance of Success: **100%**

Reserves Summary

Unrisked	**Gas-in-Place**	**Recoverable Gas**	
bcf	Whole Trap	Whole Trap	Net
P90:	**1.03**	**1.03**	**0.516**
P50:	**2.98**	**2.98**	**1.49**
P10:	**7.23**	**7.23**	**3.61**
Mean (Mz):	**3.67**	**3.67**	**1.84**
Probability of mean:			38.9%
Risked Mz:		**3.67**	**1.84**

Overall chance of success: **100%**

Production Working Interest: **50.00**
Exploration Working Interest: **50.00**
Production Working Interest is used to calculate net volumes



min unrisked: 0.871E-03 max unrisked: 14.1

Comments:

UPDATED BANGANNA STRUCTURE WITH GIPSYS CREEK SEISMIC INTEGRATED
P90 closure = 1880 m, P50 = 1885 m, P10 = 1915 m

REP file:	I:\andrew constantine\onshore otway\pep152+159\rep sheets\bangan	Author:	Tye, Stuart
version:	4.43d	Date:	20/12/02

4.43d

Prospect/Field Recoverable Gas

Country:	**AUSTRALIA**	Name:	**BANGANNA EAST**
State:	**SA**	Segment:	**PHSS**
Block:	**PEP 159 VIC OTWAY**	Classification:	**Unspecified**

Input Data

Variable	Unit	Shape	Min	P90	P50	P10	Max	Mode
GRV	mmcm	Triang	14.5	36.3	71.8	127	172	44.6
Deg. of fill	%	Single	100	100	100	100	100	100
Net-to-gross	%	Triang	54.2	65.0	78.3	90.0	99.3	80.0
Porosity	%	Triang	9.00	11.7	15.0	17.3	19.0	16.2
Sw	%	80% dependent on porosity;			limits 35.0 - 55.0; -ve sense			
FVF (1/Bg)	vol/vol	Triang	146	150	156	162	166	156
Gas rec fac	%	Single	100	100	100	100	100	100

Risk Factors

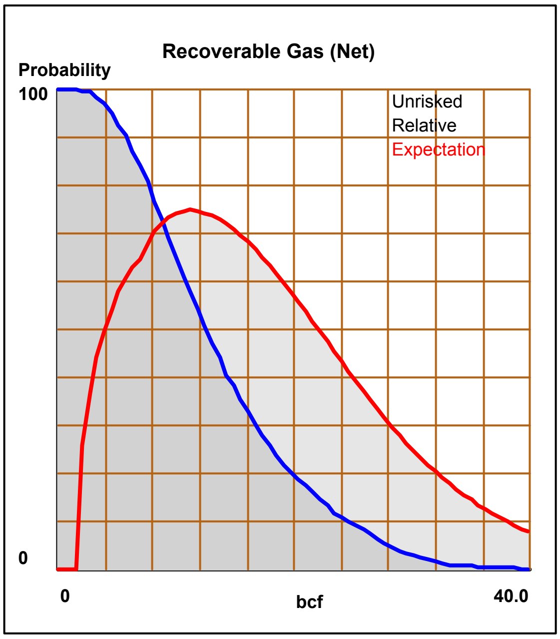
Play Chance:	**100%**		Prospect Specific Chance:	**100%**	
Reservoir	100%	confident	Trap	100%	confident
Source	100%	confident	Reservoir effectiveness	100%	confident
Seal	100%	confident	Seal effectiveness	100%	confident
			Source Rock effectiveness	100%	confident

Chance of Success: **100%**

Reserves Summary

Unrisked	**Gas-in-Place**	**Recoverable Gas**	
bcf	Whole Trap	Whole Trap	Net
P90:	**11.6**	**11.6**	**5.82**
P50:	**25.1**	**25.1**	**12.6**
P10:	**49.6**	**49.6**	**24.8**
Mean (Mz):	**28.4**	**28.4**	**14.2**
Probability of mean:			40.9%
Risked Mz:		**28.4**	**14.2**

Overall chance of success: **100%**



min unrisked: 0.824 max unrisked: 61.2

Production Working Interest: **50.00**
Exploration Working Interest: **50.00**
Production Working Interest is used to calculate net volumes

Comments:

UPDATED BANGANNA STRUCTURE WITH GIPSYS CREEK SEISMIC INTEGRATED
P90 closure = 1880 m, P50 = 1885 m, P10 = 1915 m

REP file:	I:\andrew constantine\onshore otway\pep152+159\rep sheets\bangan	Author:	Tye, Stuart
version:	4.43d	Date:	20/12/02

4.43d

APPENDIX 2

RISK CALCULATIONS FOR BANGANNA-1

Origin Energy

Risk Calculation Overview

Version date : 9 March 1999

Prospect : **Banganna GAS**
Play : PHSS and Laira Fault closure

Permit : PEP159
Basin : Otway

Author : JB,RS,RT,DL,GA,AC
Reviewed : 4/09/2002

**** *Basic Framework for Risking* ****

COMPONENT	KEY ASPECTS
Closure	Structural closure and areal distribution of gross reservoir are within the range of the trap area distribution.
Reservoir	Gross reservoir thickness, vertical net to gross ratio, porosity, hydrocarbon saturation, recovery factor & initial flow rates are within the ranges identified.
Charge	The volume of hydrocarbons that have entered and remain in the trap are within the range of the resource distribution.
Source	Suitable source volume, maturity and macerals exist to expel a volume within the range of the resource distribution.
Seal	Competent seal exists to contain a volume of hydrocarbons within the range of the resource distribution.

**** *Risk Classification* ****

RANGE	DESCRIPTION
0 - 20 %	Possible but very doubtful; Only a slight chance; Very unlikely indeed; Very improbable.
20 - 40 %	Could be true but more probably not; Unlikely; Chances are fairly poor; Two or three times more likely to be untrue than true.
40 - 60 %	Chances are about even, or slightly better than even or slightly less than even.
60 - 75 %	Likely; Probably true; About twice as likely to be true as untrue; Chances are good.
75 - 90 %	Highly probable; Strongly believe; Highly likely.
90 - 100 %	Virtually certain; Convinced.

**** *CHANCE OF ADEQUACY (%)* ****

COMPONENT	0 - 20	20 - 40	40 - 60	60 - 75	75 - 90	90 - 100	SUMMARY COMMENTS
Closure				73			
Reservoir					86		
Charge					81		
Source						90	
Seal		36					

**** *OVERALL GEOLOGICAL PROBABILITY (%)* **** **17**

n:/excel/proforma/Risk Calculation, workcopy (REP).xls

20-Dec-2002

Origin Energy

Closure Adequacy (P_{cl})

Prospect : **Banganna GAS**

Play : PHSS and Laira Fault closure

******* LEVEL OF KNOWLEDGE / DATA AVAILABILITY (0=know nothing, 3=high)*******

PARAMETER / DATA	AVAILABLE	CONFIDENCE	COMMENTS / REALITY CHECKS
a. Well control (number & proximity of wells)		3	Pretty Hill-1 (2.8 km to WSW) and Killara-1 (3.3 km to ENE) key wells
b. Seismic control (quality, grid spacing, DHIs)		2	9 dip lines and 3 strike lines; 500 - 1000 m spacing between dip lines; AVO response on three dip lines with gathers
c. Velocity control (depth conversion methods applied eg. paradigm application)		3	Good velocity control (see Peter Boult's maturation study - PEP 101 & 111)

******* CHANCE OF ADEQUACY (%) *******

ISSUE	0 - 20	20 - 40	40 - 60	60 - 75	75 - 90	90 - 100	COMMENTS / REALITY CHECKS
• Control (eg. seismic grid size) is such that structural complexity/simplicity is as mapped, particularly the extent of faulting and the control on the spillpoint					90		Closures based on Top PHS depth map but AVO appears to be in overlying LFm. Assume intra-Laira surfaces parallel Top PHS. If yes, then control good. If not (ie. lower slope and diff slope direction) then closure will be smaller and have diff shape.
• Depth conversion of time mapping is sufficiently controlled by velocity model. ie. consider well control, interval velocity variation, isopach variation, isochron variation						100	Good velocity control in this area
• Interpretation quality is sufficient to adequately define reservoir structure. Consider confidence of horizon picking, sufficient horizons picked, etc.					90		Base EFm and Top PHS picks approaching Tyrendarra Fault ??? due to coals near base of EFm and convergence of Top PHS towards crest of structure
• Seismic data is of sufficient quality to ensure trap is adequately defined (eg fault imaging). Consider noise, misties, statics, phase, migration velocity, etc					90		Reasonable quality
OVERALL CHANCE				73			

Origin Energy

Reservoir Adequacy (P_{rs})

Prospect : **Banganna GAS**

Play : PHSS and Laira Fault closure

**** *LEVEL OF KNOWLEDGE / DATA AVAILABILITY (0=know nothing, 3=high)* ****

PARAMETER / DATA	AVAILABLE	CONFIDENCE	COMMENTS / REALITY CHECKS
a. Well control (lithology, cores, ∅, k, DST, etc.)		**2**	Laira Fm (Killara-1); Pretty Hill Sst (Killara-1, Pretty Hill-1, Penola Trough)
b. Seismic control (amplitude, AVO, forward modelling, DHI, etc.) calibrated against well control		**3**	AVO response on lines 4, 5 & 6
c. Burial profile and diagenetic history available		**1**	No core / petrographic data on reservoir quality of Laira. Log analysis suggests av PHIE 15% and av VCL 28%
d. Reservoir characterisation available (facies architecture, porosity model, etc.)		**0**	No data available

**** *CHANCE OF ADEQUACY (%)* ****

ISSUE	0 - 20	20 - 40	40 - 60	60 - 75	75 - 90	90 - 100	COMMENTS / REALITY CHECKS
• Sequence developed (no consideration of reservoir facies). Consider sequence missing due to non-deposition, &/or erosion.						**100**	Sequence mappable on seismic
• Reservoir facies developed. Consider facies change, thickness, net to gross, areal distribution, etc.						**100**	No data available. Expected to be present.
• Modelled reservoir quality is present. Consider depositional influences (eg clay choking), diagenesis (eg. Cementation, secondary ∅, etc), preservation by early hydrocarbon fill, effects of compaction by deeper burial, development of fractures, etc.						**95**	Nore core plug or petrographic data available for sandy Laira but reservoir quality is not considered major risk. Log analysis of laira in Killara-1 indicates av porosity = 15.1% and VCL = 28.3%
• Effective reservoir volume not substantially reduced by waste zone below top seal.						**90**	No data available
OVERALL CHANCE					**86**		Warning- More than one risk per question

Origin Energy

Hydrocarbon Charge/Preservation Adequacy (P_{ch})

Prospect : **Banganna GAS**

Play : PHSS and Laira Fault closure

******* LEVEL OF KNOWLEDGE / DATA AVAILABILITY (0=know nothing, 3=high)*******

PARAMETER / DATA	AVAILABLE	CONFIDENCE	COMMENTS / REALITY CHECKS
a. Migration pathways interpreted (seismic and well data, datum well defined and mappable, regional interval & structure maps available, seismic resolution at critical events)		**2**	Migration pathways not modelled but not expected to be a problem
b. Understanding of the tectonic history		**3**	Good understanding of tectonic history
c. Time/burial depth/maturation history profiles available to establish appropriate isochron maps		**2**	see Peter Boult's maturation study - PEP 101 & 111
d. Geotechnical data available to substantiate hydrocarbon alteration in reservoir		**0**	No data available
e. DHIs identified		**2**	AVO responses on lines 4, 5 & 6

******* CHANCE OF ADEQUACY (%) *******

ISSUE	0 - 20	20 - 40	40 - 60	60 - 75	75 - 90	90 - 100	COMMENTS / REALITY CHECKS
• Hydrocarbons were expelled or remigrated post-trap formation. Consider late charge remobilised from palaeo-traps, structural enhancement post-migration						**100**	Trap existed before peak generation
• Suitable lateral and vertical conduits (lithology and faults) exist between source and trap						**95**	PHS very sandy therefore expect good lateral & vertical migration paths
• Migration pathways (drainage cell size) at the time of hydrocarbon migration were focused toward the trap. Consider complexity of structuring, tortuosity of path, and distance of migration (migration efficiency)						**95**	Kitchen area most likely located to north and east of Banganna in Killara-Warrong Troughs. Winderemre Trough also potential kitchen if trap capable of receiving charge via face loading
• Hydrocarbons have been preserved in the reservoir. Consider flushing, water washing, biodegradation, cracking, etc or DHIs						**90**	No data available but not expected to be a problem.
OVERALL CHANCE					**81**		

Origin Energy

Source Adequacy (P_{sc})

Prospect : **Banganna GAS**

Play : PHSS and Laira Fault closure

**** LEVEL OF KNOWLEDGE / DATA AVAILABILITY (0=know nothing, 3=high)****

PARAMETER / DATA	AVAILABLE	CONFIDENCE	COMMENTS / REALITY CHECKS
a. Well control (source intervals intersected, source quality & maturation data available, etc.)		3	CFm intersected in Pretty Hill-1, Greenslopes-1, Woolsthorpe-1, Hawkesdale-1; EFm visible on seismic beneath Banganna and Killara-1
b. Seismic control (regional interval & structure maps available, seismic resolution at critical events))		3	Top basement, Top PHSS and base EFm mapped regionally
c. Maturation modelling available (burial history, heat flow, kinetics)		3	Peter Boult's maturation study - PEP 101 & 111
d. Maps available to establish source volume		1	Top CFm not mapped. No isopach maps available.

**** CHANCE OF ADEQUACY (%) ****

ISSUE	0 - 20	20 - 40	40 - 60	60 - 75	75 - 90	90 - 100	COMMENTS / REALITY CHECKS
• Organic matter is of suitable type (consider HI, maceral composition and hydrocarbon type targeted) and richness (Consider TOC, S_1 + S_2, etc.)						100	CFm source of oil & gas in Penola Trough
• Adequate volume of source rocks present. Consider thickness and drainage area						90	Highly likely but not calculated
• Source rocks have reached a sufficient maturation level for the hydrocarbon type being targeted. Consider biogenic versus thermogenic generation, expulsion efficiency						100	see Peter Boult's maturation study - PEP 101 & 111
OVERALL CHANCE						90	

Origin Energy

Seal Adequacy (P_{sl})

Prospect : **Banganna GAS**

Play : PHSS and Laira Fault closure

******* LEVEL OF KNOWLEDGE / DATA AVAILABILITY (0=know nothing, 3=high)*******

PARAMETER / DATA	AVAILABLE	CONFIDENCE	COMMENTS / REALITY CHECKS
a. Well control or analogue fields		2	Pretty Hill-1, Killara-1
b. Seismic control for mapping faults (orientation, displacements, highside/lowside lithologies)		2	Good control
c. Fault plane profiling available		0	no data available
d. Fault seal analysis available		1	no data available
e. Capillary pressure analysis of seals available		2	Peter Boult's studies on the Laira & Eumeralla in Penola Trough
f. DHIs identified		2	AVO anomalies on lines 4, 5 & 6

******* CHANCE OF ADEQUACY (%) *******

ISSUE	0 - 20	20 - 40	40 - 60	60 - 75	75 - 90	90 - 100	COMMENTS / REALITY CHECKS
• Top seal has sufficient thickness, continuity and quality. Consider DHIs, pore entry pressures,etc.				65			Eumeralla considered to have limited top-seal potential in Penola Trough. Laira Fm has better seal potential and could be thick enough to support small gas column in sandy Laira
• Lateral seal, where trap is reliant on such seal, is sufficiently impermeable to maintain trap integrity. Consider fault gouge seal, stress regime, thickness of seal across fault, lateral variation of fault throw and closure against fault on juxtaposed side				70			Eumeralla Fm considered to have limited sealing capacity but AVO response on lines 4, 5 & 6 suggest presence of gas
• Bottom seal, where trap is reliant on such seal, is sufficiently impermeable to maintain trap integrity. Consider pore entry pressures, weathering, etc						100	Not Applicable
• Faults &/or fractures in the seal(s) have not been the conduit for leakage since hydrocarbon charge					80		No hydrocarbons in Pretty Hill-1 (valid structural test). Probably leaked up Tyrendarra Fault.
OVERALL CHANCE		36					

APPENDIX 3

LITHOLOGICAL DESCRIPTIONS
FOR
BANGANNA-1

HEYTESBURY GROUP

Port Campbell Limestone

Creamy white to very light grey (rarely light yellow), weakly cemented calcisiltite and fine to medium-grained calcarenite, which gradationally overlies the Gellibrand Marl. The formation is moderately well bedded and rich in fossil fragments including bryozoans, molluscs, echinoids and brachiopods. Bioturbated marly and clayey limestone beds up to 9 m thick (typically < 1 m) are common near the base of the formation. The marls are typically medium to light grey in colour, very calcareous and soft, with trace bryozoa, shell fragments, foraminifera, sponge spicules and echinoid spines.

Gellibrand Marl

Grey, calcareous silty clay to clayey silt with minor interbeds of fine to coarse-grained calcarenite. Glauconite is locally abundant. The formation is commonly burrowed and ranges from massive to well bedded in appearance, with bedding often highlighted by irregularly shaped calcareous concretions. The marly facies is typically rich in bryozoans and molluscs, and to a lesser extent, echinoids, brachiopods, corals, crabs and shark teeth.

Clifton Formation

Medium to coarse-grained calcarenite with minor interbeds of marl and mudstone. The calcarenite is composed largely of bryozoan fragments and abraded shells, with quartz making up less than 10% of the unit. It is typically moderately well bedded, with alternating poorly and strongly cemented beds common. Bryozoans, echinoids and molluscs are common.

NIRRANDA GROUP

(most likely absent)

WANGERRIP GROUP

Dilwyn Formation

The Dilwyn Formation is a predominantly sandstone unit with minor siltstone and claystone interbeds. Sandstones are clear to white, light brown, very fine to very coarse, subangular to rounded, poor to moderately sorted, with minor pyrite, trace mica and carbonaceous material, occasional grey quartzite grains, brown dispersive clay matrix. Porosity is fair to excellent. Siltstones are light to moderate brown, soft sandy in part, with trace carbonaceous material and partly argillaceous. Claystones are moderate to dark grey-brown to brown, soft, dispersive, sandy and silty in part, with abundant carbonaceous/coal fragments. Minor coals are dark brown to black, pyritic and lignitic.

Pember Mudstone

Claystone, light to medium brown, medium grey in part, very soft, amorphous, silty and sandy in part and can include a variety of bioclasts, carbonaceous material, glauconite, mica, pyrite, ferruginous clasts and rock fragments. Commonly burrowed. Unit is less sandy than the overlying Dilwyn Formation.

Pebble Point Formation

The Pebble Point Formation consists of medium to very coarse subangular to subrounded quartz sandstones with a sideritic and limonitic matrix. The unit becomes more silty and shaley with increased depth. Closed framework coarse to medium grained sandstones and gridstones with calcareous and ferruginous cement are common component of the sander portion of the formation.

SHERBROOK GROUP

Paaratte Formation

The Paaratte Formation consists of predominantly sandstones, off-white to light grey, medium to very coarse-grained, occasionally pebbly, subrounded to subangular quartz, interbedded with white to light brown, very fine to medium grained sandstone with glauconite and minor feldspar, in an argillaceous to calcareous matrix, in part strongly dolomitic and or sideritic, tight and highly resistive. Minor siltstone interbeds are light to medium grey, argillaceous, carbonaceous, micaceous dolomitic and calcareous, and in parts grade to silty mudstone and silty dolomite.

Skull Creek Mudstone

The Skull Creek Mudstone, if present and distinguishable, consists of dark grey to black, carbonaceous mudstone with minor interbedded fine-grained sandstones and interlaminated siltstones.

Nullawarre Sandstone

Sandstone, white to light grey to green, very fine to medium, subrounded to subangular quartz, minor to abundant glauconite, trace to abundant white argillaceous matrix poor to moderate visible porosity, oolitic, limonitic cement, very hard in part.

Belfast Mudstone

The Belfast Mudstone is pale grey to black, pyritic, fossiliferous, glauconitic, carbonaceous and micaceous mudstone possibly with fine-grained sandstone and siltstone interbeds.

Flaxmanns/Waare Formation

The basal Scherbrook Group units may contain sandstones, siltstones, claystones, and traces of coal. The siltstones are light grey, grey brown quartzose, argillaceous, feldspathic, lithic and partly carbonaceous. The claystones are dark grey to brown carbonaceous, silty and slightly glauconitic. Sandstones, if present are white to light grey and fine to very fine- grained.

OTWAY GROUP

Eumeralla Formation

The Eumeralla Formation consists dominantly of siltstone, mudstone and sandstone. The mudstones are generally medium grey, medium brown grey, light to medium greenish grey with rare light blue and green-grey; soft to firm, occasionally hard and splintery and partly dispersive. They can be micaceous, carbonaceous and silty with minor sandstone and coal interlaminations. Siltstones are grey and grey green, argillaceous, micaceous, feldspathic, and slightly carbonaceous.

The sandstones present in the unit are white to light grey, grey-green or grey-brown, very fine to medium grained with subrounded quartz, abundant white to brown feldspar, micaceous, lithic, chloritic, with trace orange feldspar in an argillaceous and slightly calcareous matrix, moderately strong silica cement.

Basal Eumeralla Formation (Killara Coals)

The basal Eumeralla may contain coals interbedded with siltstones, claystones and sandstones. Siltstones are light grey to green grey, carbonaceous/calcareous. Claystones are dark grey to dark brown, occasionally grade into siltstones and laminated sandstones. Sandstones are white to light grey, dark grey to green and very fine to medium grained. The coals are generally black, vitreous in lustre, but may in places grade into carbonaceous siltstone.

Laira Formation

The Laira Formation may comprise of interbedded silt- and claystones or may otherwise contain sandstones. At Banganna, the Laira Formation is believed to contain a potential sandstone interval that is associated with the AVO-Anomaly.

Pretty Hill Formation

Predominantly sandstone and minor amounts of siltstone and claystone. The target sandstones have been described in Killara-1 as white to light grey variable grain sizes.

“Sandstone, clear to translucent, pink white to very light grey, fine to very coarse grained, appears to be of two dominant grain size populations, one medium to very coarse grained and dominantly medium, the other very fine to fine grained and dominantly very fine grained, strong silica cement in finer grained aggregates, inferred good visual porosity, interbedded with minor dark grey to green-grey carbonaceous siltstone or dark grey, minor purple, black mudstone”.