Cue Energy Resources Limited

CUEBASS08

T/37P and T/38P Bass Strait

Marine Seismic Survey

interpretation report

APRIL 2009

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Leech, D.P., Kernick , C and Iwaniw, A. 2008. The structural and sedimentary histories and hydrocarbon potential of the Pelican and Dondu Troughs, Bass Basin. Eastern Australian Basin Symposium.

1. Introduction

Cue Energy Resources Limited, on behalf Galveston Mining and Exoil Ltd., undertook the CUEBASS08 two-dimensional (2D) marine seismic survey offshore in Commonwealth waters in the Bass Basin in March/ April 2008. The survey was acquired in T/37P and T/38P centred approximately 100 km and 120 km respectively from the nearest point of Victoria on the mainland; and 100 km from the north coast of Tasmania (see figure 1).

The current permit interest holders for both permits are as follows:

Permit	Company	Operator	Equity
T/37P	Galveston Mining Ltd	Cue Energy	50%
	Exoil Ltd		50%
T/38P	Galveston Mining Ltd	Cue Energy	50%
	Exoil Ltd		50%
	(Note Beach Petroleum have an 80% equity stake in a specific area around the Spikey Beach-1 location		

Table 1. Permit holders

Galveston Mining is a 100% subsidiary of Cue Energy Resources and Cue Energy Resources is the operator for these blocks.

The aim of the CueBass08 seismic survey was to acquire new data over a previously under-explored area in the south-western part of T/37P (figure 2). 3000 line kilometres (in a 1km x 1km grid) of 2D seismic were acquired in T/37P. The survey met the primary year-three permit commitments.

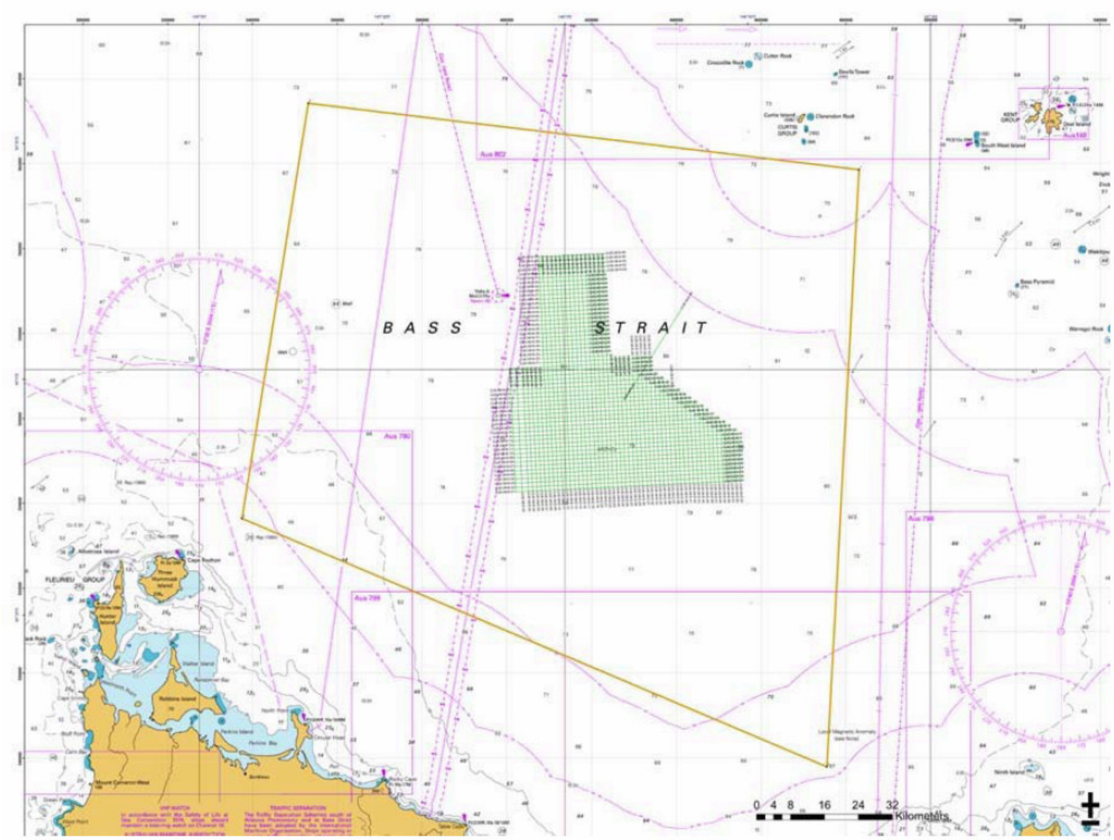


Figure 1. Location Map for the CueBass08 Marine seismic survey

A total of 660 line kilometres of new 2D seismic data were acquired in T/38P, contiguous with the acquisition of data in T/37P. These data were above commitment in this block. The aim of these data were to better constrain a North-trending structural high, known as the Poonboon-Nangkero High (Leech et al., 2008) on which a number of leads had been previously been mapped.

The CueBass08 failed to identify any new structural features which would warrant follow-up exploration in T/37P or T/38P at this time. The most interesting structure, the NW Nangkero Lead, was identified on pre-existing datasets and remains structurally robust at multiple levels following the new seismic data. The new data has helped control the complex faulting patterns around this lead.

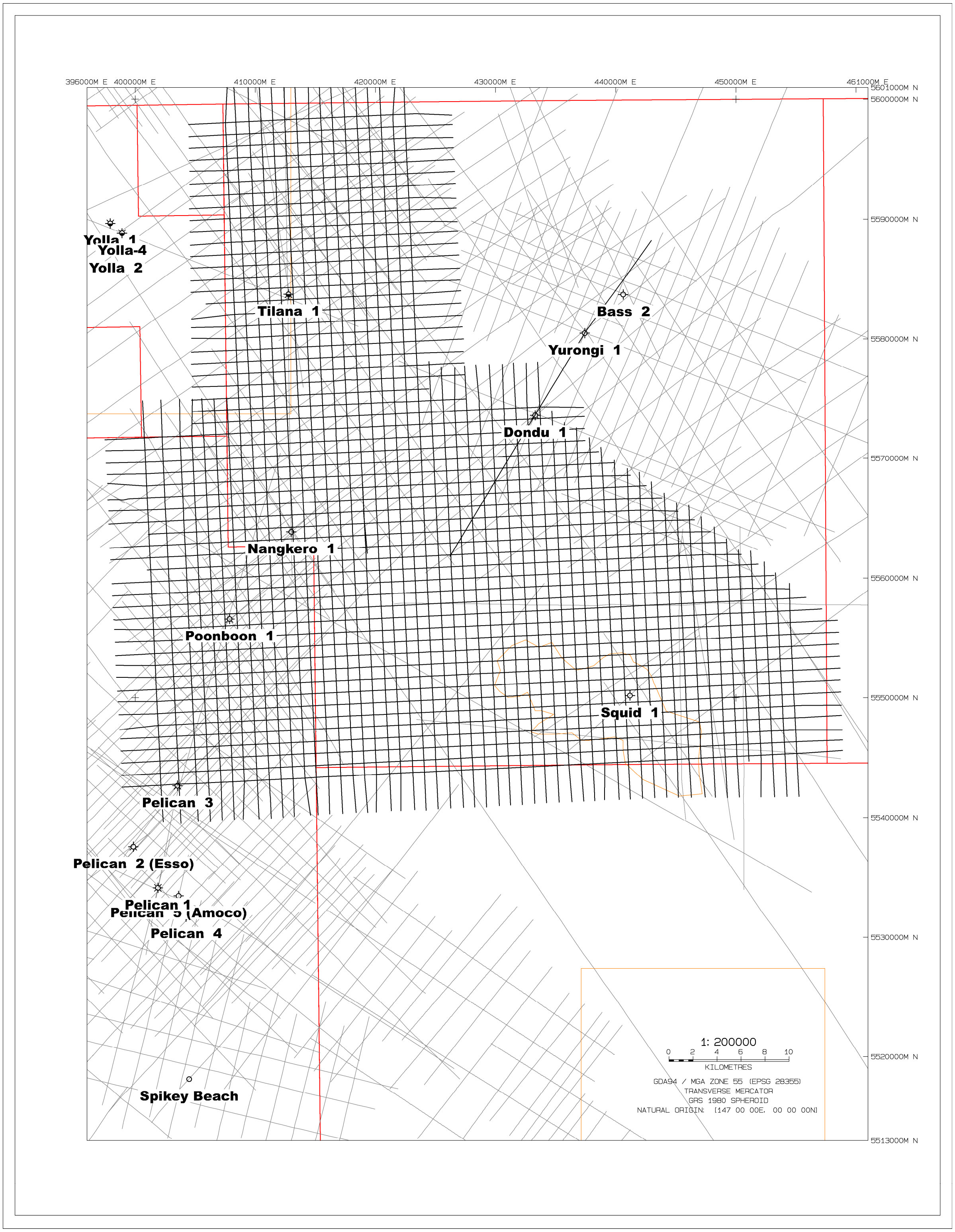


Figure 2. Layout for the CueBass08 seismic survey

2. CueBass08 Processing Summary

The CueBass08 seismic dataset were processed by Dayboro Geophysical. A detailed report was provided to the JV and submitted to the designated authority as per the Data Management Plan.

In summary, Dayboro used a processing flow which included SRME, Tau-P deconvolution and pre-stack time migration (Dayboro, 2008). The PSTM gathers with the final PSTM velocities applied were output to SEGY format. The PSTM gathers were mute to within three angle ranges; and near, mid and far stacks were supplied to Cue. These were used to derive some basic 2D AVO attributes within the key reservoir sections.

The observer's logs note that "first break is negative". This refers to the direct arrival, as such the water-bottom reflection is a positive peak. Nothing in the processing flow has altered the polarity of the data and so the polarity is classified as SEG Normal.

The final seismic lines were given the prefix CUE08_ and Cue adopted this nomenclature during the interpretation.

Qualitatively the seismic data is as good if not better than pre-existing datasets in the Bass Basin. In general, Bass Basin seismic suffers from energy dispersion and adsorption from within coals and volcanic sequences and peg-leg multiples can reduce data quality. Dayboro Geophysical did a good job in maintaining signal and the CueBass08 data quality was good within the upper key reservoir section. The processing sequence has maintained high amplitude frequency and clarity with little noise. The seismic quality deteriorates with depth. At Palaeocene level and below, there is a lot high frequency interference which warrants frequency filters during interpretation. This was mitigated by applying frequency filters during interpretation

3. Interpretation

3.1 Methodology

The CueBass08 seismic survey (SEGY) was loaded into SMT Kingdom V8.2 software. Horizon and fault mapping was undertaken using the SMT Kingdom 2D/3DPak module. Interpreted events were imported into Petrosys and time and depth grids were generated using the Petrosys gridding algorithms. Final maps were created in Petrosys.

Synthetic seismograms were generated for offset well data and were used to QC the seismic data. Generally there was a good to excellent tie at the top Eastern View Coal Measure interval. Pre-existing datasets were then tied to the CueBAss08 seismic survey. Cue had purchased a reprocessed dataset from Fugro but these were neither phase-matched nor amplitude balanced. Although Kingdom has an auto-tie module, the nature of the events in the Bass Basin made the auto-tie correlation very poor. Instead each survey was manually tied (shifted and balanced) back to a reference line (0221-N1-PSTM). The confidence of the tied deteriorates away from the CueBass08 survey.

3.2 Mapped Events

Seven seismic horizons were interpreted and mapped regionally across the new dataset (see table 1). In addition, local intrusive/ extrusive tops and bottoms were mapped at different levels across the dataset. Finally, a local sandstone “pod”, situated around the Squid-1 well location, was mapped. A summary stratigraphic table for the Bass Basin is shown in figure 3.

The mapped events were controlled by reference tops at numerous wells including Tilana-1, Bass-2, Dondu-1, Yurongi-1, Poonboon-1, Nangkero-1 and Pelcian-3. The well tops were QC’ed with the latest stratigraphy provided by Geoscience Australia (Blevin et al., 2003; Partridge 2002).

REGIONAL			
Name	***AGE***	***Seismic Character***	***Abbreviation***
Sea floor	Present day	Weak peak	000-SF
Base Limestone	Oligocene	Strong to moderate Trough	020-LMST
Top Demons Bluff	Upper Eocene	Weak Peak	035-DB
Near top Eastern View Coal Measures	Middle Eocene	Strong Peak	040-NTEV
Base Upper Eastern View Coal Measures	Lower Eocene	Spatially variable	
Top L. balmei	Palaeocene	Spatially variable	054-Lbal
Top Furneaux MS	Top Cretaceous	Spatially variable	
LOCAL			
Oligocene sst pod		Local angular UC	030-Sst top
Intrusive/extrusive	Miocene and older	Variable	Multiple according to level

Table 2. Summary mapped events table

The top seafloor pick was poorly imaged on the seismic data. This was unexpected by the operator, and the processor stated that their work flow was to optimise the reservoir section acoustic impedance not the water bottom reflection. It was proposed by Dayboro that one of the issues is that because of the shallow water depth (<75m), there is heavy interaction between the direct arrival and the water-bottom reflection. Both these events travel at near or close to the speed of sound in water which is also the velocity of the multiple energy that the processor tried to attenuate. In addition, geotechnical well core data has shown that at least the top 50m of the sediments at the sea floor consists of interbedded soft calcareous muds and clays. It is possible that this leads to gradational change in velocity at the precise seawater interface. A top seafloor event was not mapped, instead the first major break was mapped and then tied and bulk shifted to known well tops. The top seafloor map was QC'ed with the sonar bathymetry dataset.

The base limestone pick is a strong to weak trough. This represents a decreasing velocity boundary between calcareous marl and limestones into claystone. This event was often picked using SMT's "hunt" autopicker – this event was picked for velocity modelling.

The top Demons Bluff Formation represents the top regional seal and was picked in order to better constrain seal thickness and breach. This event is characterised by a weak peak.

The near Top EVCM marker was identified as a strong peak on the seismic data and represents an increasing velocity boundary between the shales of the overlying Demons Bluff Formation and the uppermost sandstone section of the top EVCM (Boonah Sandstone: see Figure 3).

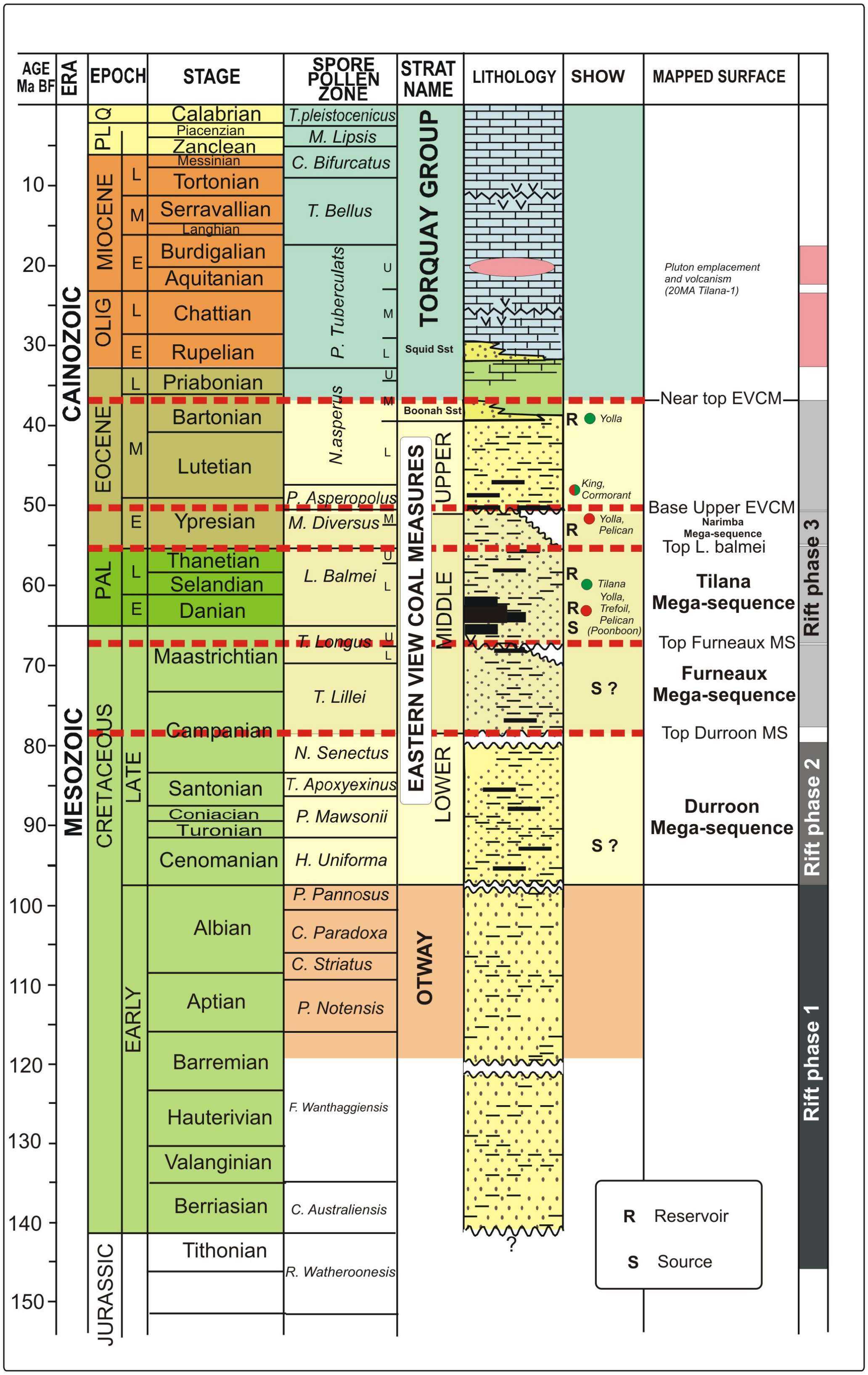


Figure 3. Bass Basin Stratigraphy (from Leech et al., 2008)

Interpretation beneath the Top EVCM becomes more difficult due to the increase in structuring and lack of distinct seismic event character. In most instances, faulting was first interpreted and then events were mapped in by "ghosting" known thickness sections, usually proximal to well control points. The conventional geophysical practice of picking either a peaks or troughs for an event did not hold through for all events in all fault blocks. The base Upper EVCM (top M. diversus zone) and Palaeocene (top L. balmei) were firstly picked close to wells and then regional loops were made between the wells. These regional "loop lines" were then used to control the tops for the rest of the survey.

As mentioned above, the seismic character and resolution deteriorated with depth and band pass filters were used to remove high frequency noise in sub-Palaeocene levels. Figure 4 shows a very useful filter which was used to remove noise in the deeper levels: this filter was successful in picking deep lineaments, basement and the Furneaux Megasequence. An example of the resultant SEGY is shown in figure 5.

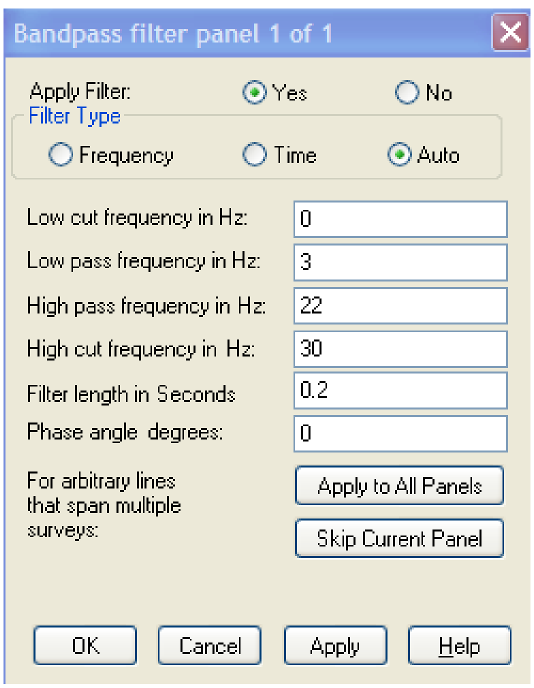
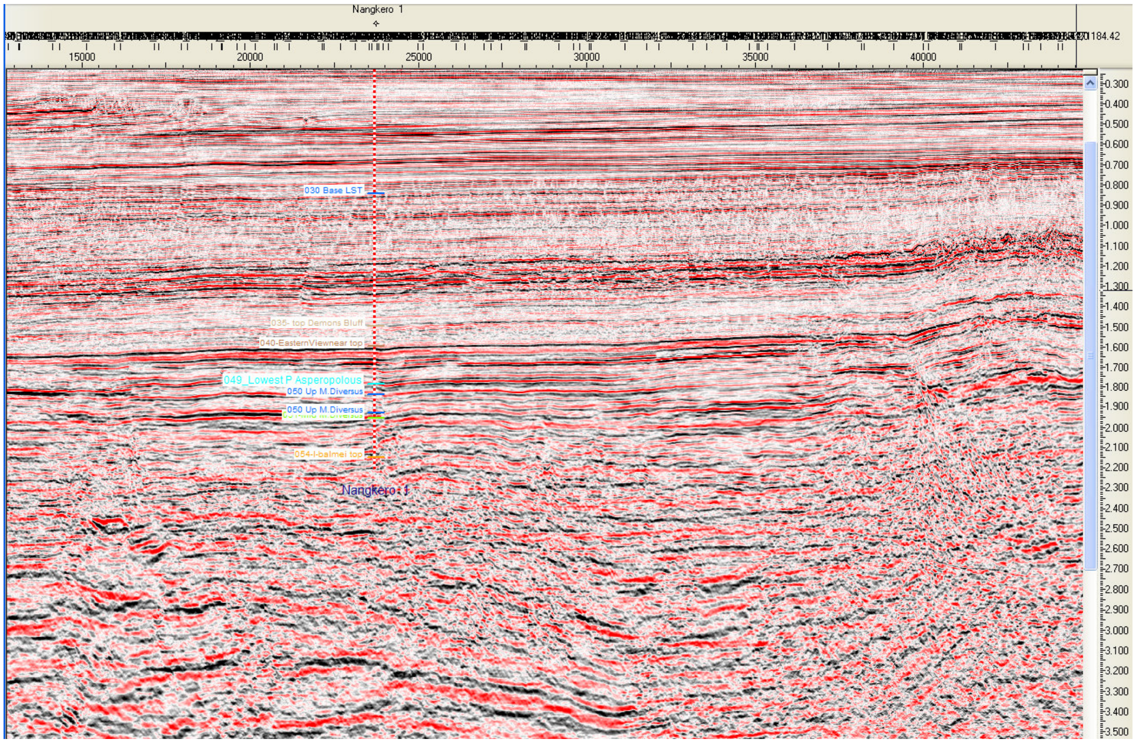


Figure 4. Band pass filter used in deeper levels.



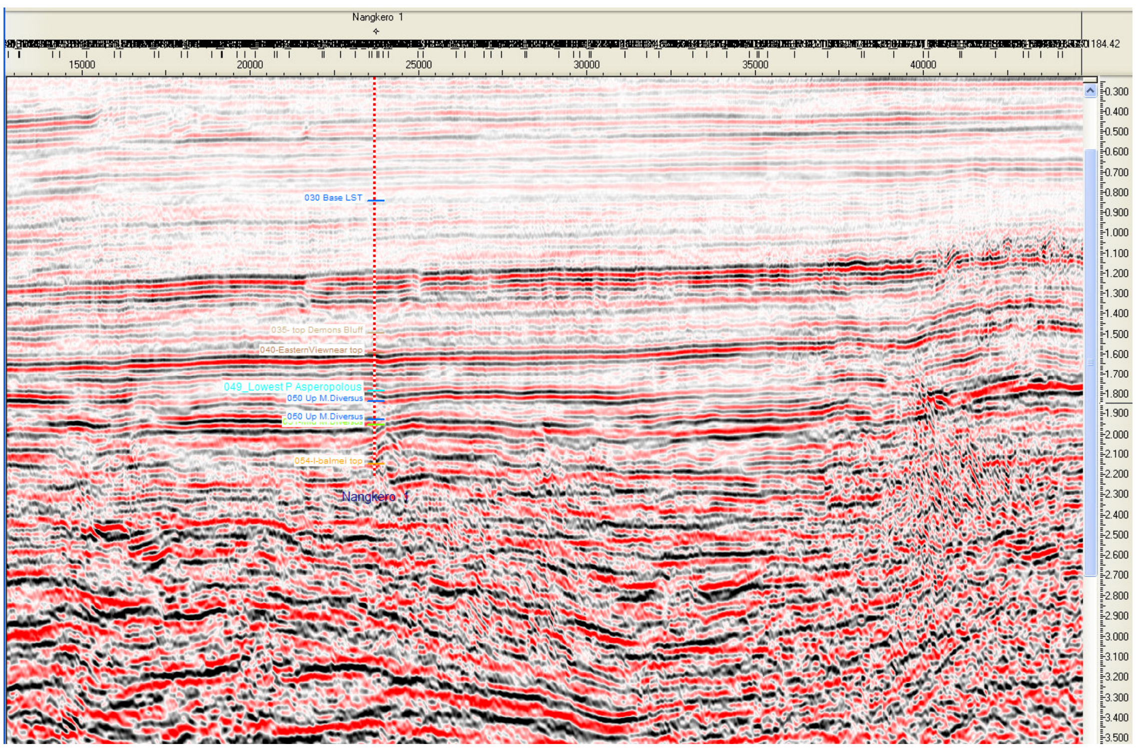


Figure 5. Seismic Line CUE08_E12 showing original SEGY from Dayboro (top) and SEGY with band pass filter as indicated in figure 4 (bottom).

3.3 Depth conversion

Well derived interval velocity analysis and stacking velocity analysis were used for depth conversion.

Interval and average velocities were calculated from well tops and check shot information. Significant lateral interval velocity variations were noted across the basin and the well-derived interval and average velocities were gridded and

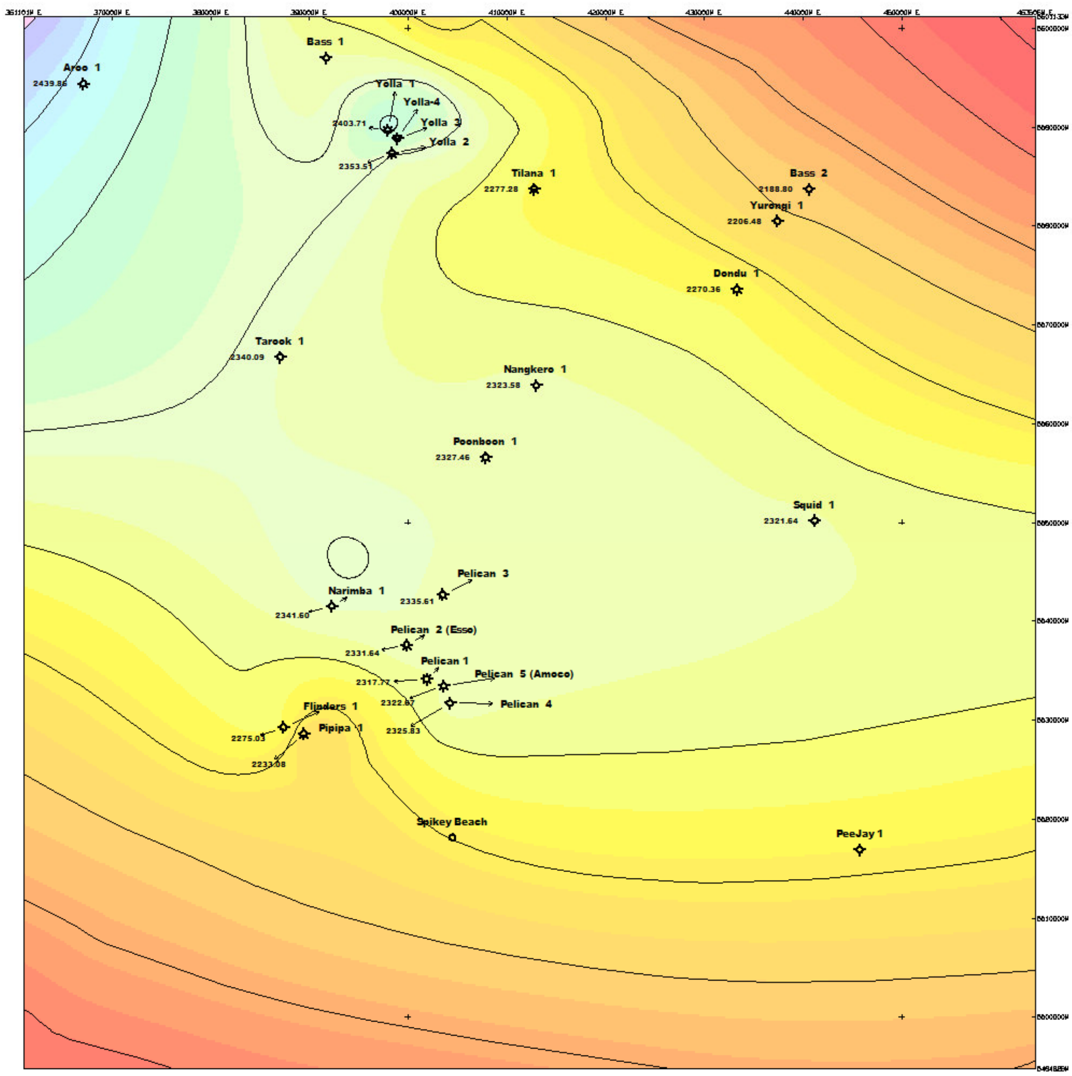


Figure 6a. Average velocity (Vav) velocity grid from surface to top EVCM.

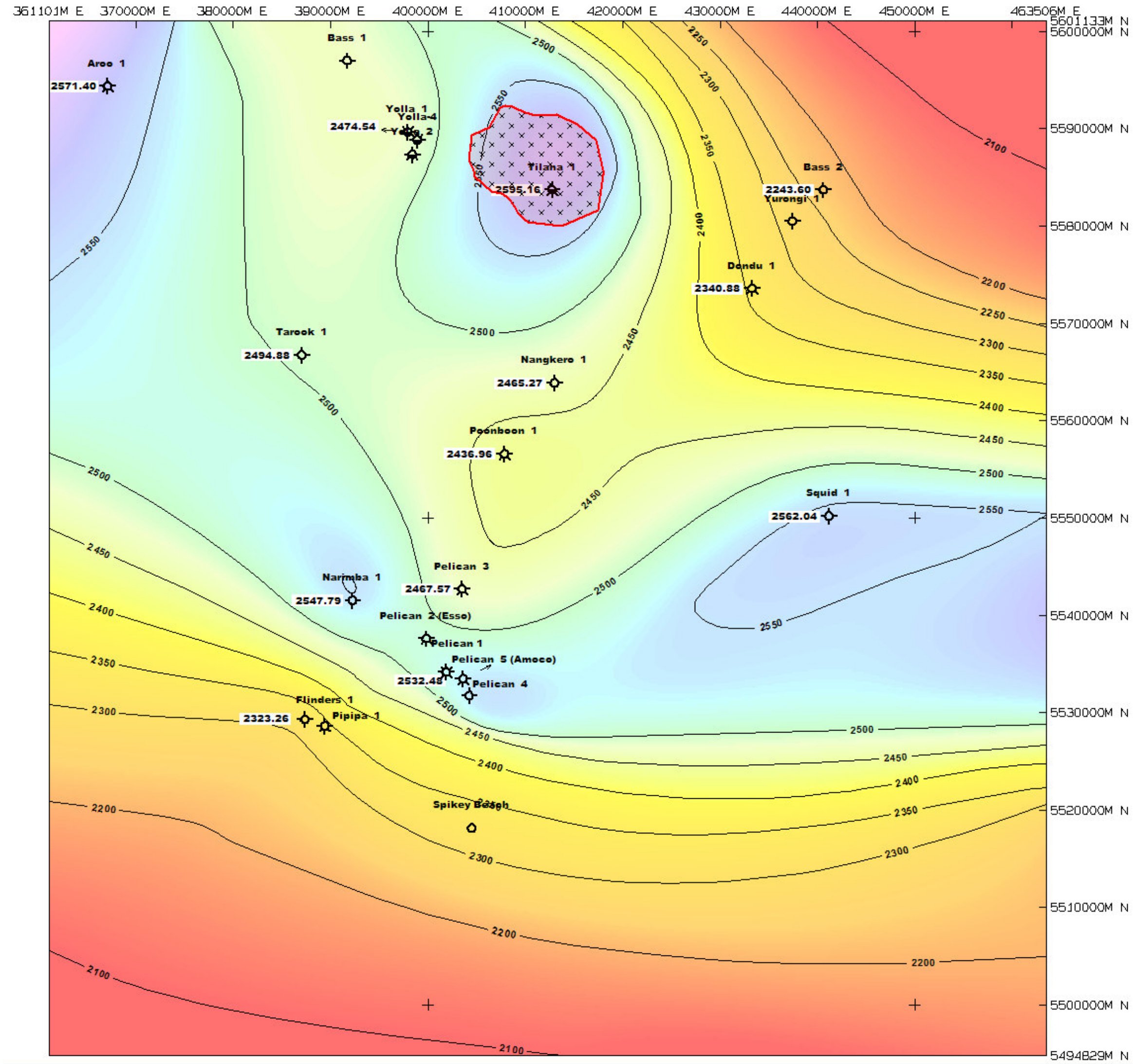


Figure 6b. Average velocity (Vav) velocity grid from surface to base Upper EVCM (M. diversus)

modified to account for the regional geology (see figure 6a and 6b). Local velocity aberrations associated with the igneous rocks and the Squid sandstone pod were removed with detailed velocity substitution within isochrons (figure 6b). Interval stacking velocity data were also used to generate depth maps within the CueBass08 survey area. Stacking velocity data was provided in the "Western format" by Dayboro and these data were imported into the Petrosys seismic data file. The raw stacking velocity picks were averaged for each zone top and then gridded. It was observed that

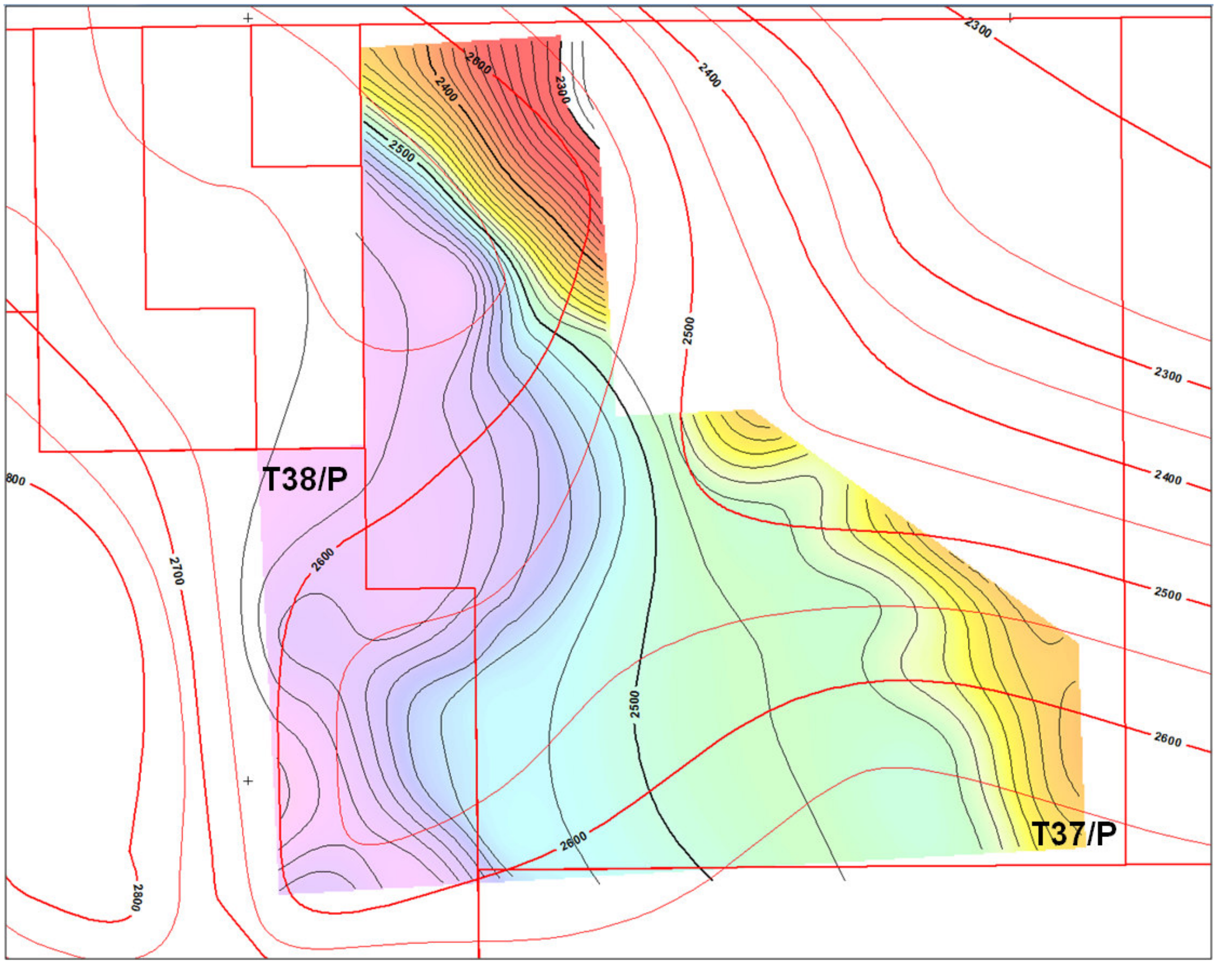


Figure 9. Smoothed stacking velocity map showing zone surface to top Palaeocene (L. balmei). Overlain on this is the Average velocity (Vav) velocity grid from surface to Palaeocene derived from the well velocity model.

there was significant lateral and vertical velocity variation, and therefore a strong smooth filter was used to remove local velocity pick irregularities. The subsequent average velocity maps are considered reliable, especially away from well control points.

4. Results

4.1 Sea Floor

(Enclosure 1)

The top sea floor map shows that the central part of the Bass Strait is generally flat, becoming shallower to the south east. The deepest part of the basin is located around Bass 2 where the water depths are greater than 84m.

4.2 Top EVCM (Eastern View Coal Measures)

(Enclosure 2 and 3)

Post-rift sag and subsidence conditions occurred from the late Early Eocene to Middle Eocene (see Figure 3). Although faulting is observed cross-cutting the top EVCM and Demons Bluff Formations it is not as extensive as seen in the deeper horizons (compare to enclosures 4 to 7). The top Upper EVCM Boonah Sandstone is the most continuous sandstone body in the Bass Basin, and as such it is an attractive exploration target in T/37P and T/38P (Leech et al., 2008). Blevin (2003) proposed that the Boonah Sandstone was deposited during a regressive event before the Demons Bluff maximum-flood-surface event. The thickness of this sandstone varies across the basin, but generally is in the in the order of 15-25m. Where intersected the reservoir properties are consistently good to excellent. The sandstone hosts an oil-leg at Yolla, and Brooks et al (2006) indicate average porosity and permeability of 32.5% and 118mD, respectively. At Poonboon-1 the Boonah Sandstone has average porosity of 30% with associated permeability of 100mD (Lang et al, 2003). Oil shows were recorded from the Cormorant structure from inter-*N. Asperus* sandstones which underlie the Boonah Sandstone.

The central part of the Bass Basin is a symmetrical NNE-trending basin at the top EVCM level (refer to enclosures 2 and 3). The principal structures are either NNE-trending basin parallel faults or later N-trending faults. Intrusive and extrusive rocks are often associated with the latter faults. Most structures

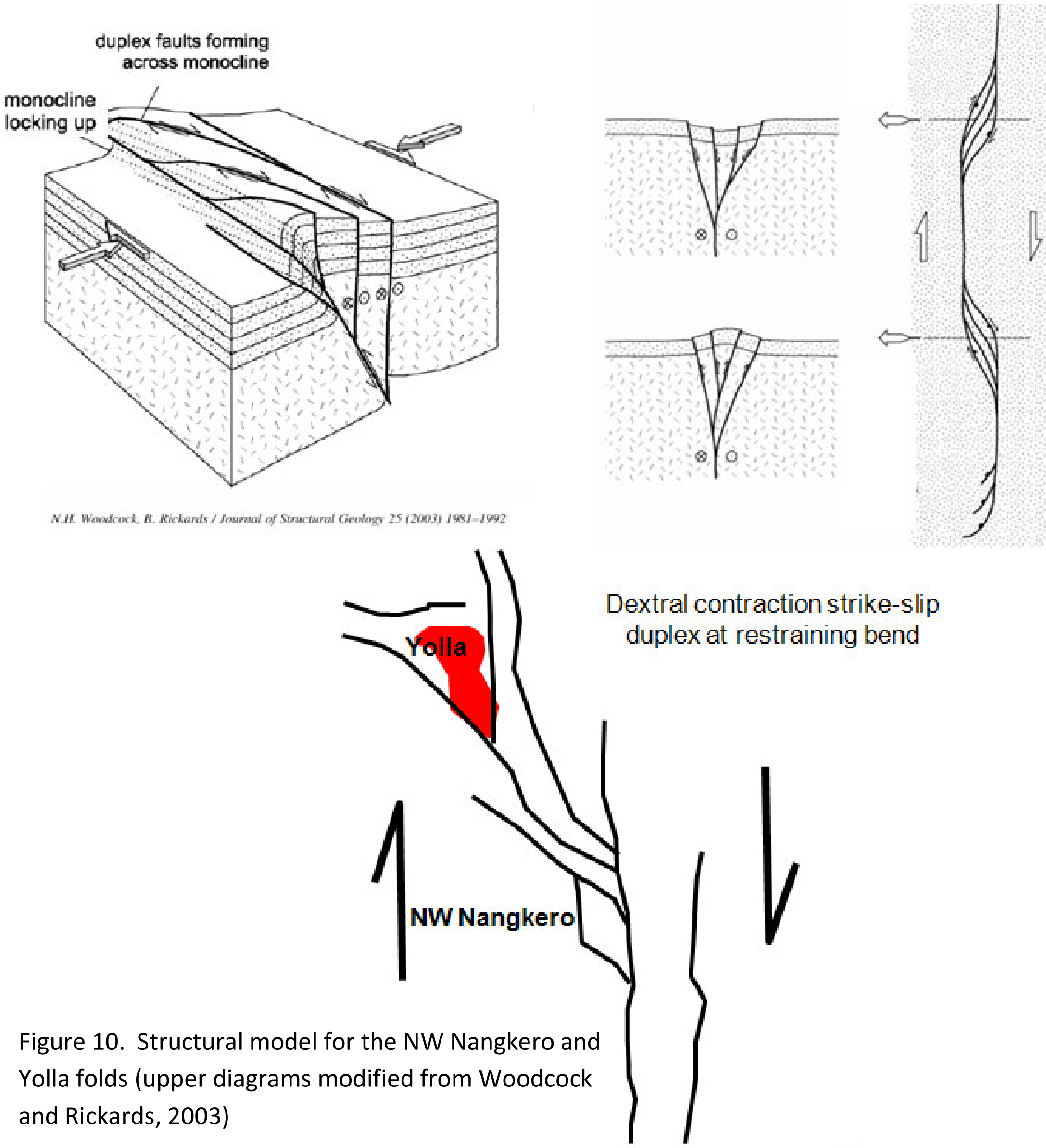


Figure 10. Structural model for the NW Nangkero and Yolla folds (upper diagrams modified from Woodcock and Rickards, 2003)

at the top EVCM level have been tested; however the Spikey Beach and the NW Nangkero prospects are interesting and robust leads at this level.

The NW Nangkero is located along a south-trending splay of the Yolla fault system. The prospect has a maximum closure of 10km^2 and a most likely closure of less than 5km^2. It is likely that there is an intrusive sill within the Top EVCM sediments. It is probable that the NW Nangkero and Yolla structures are temporally related. The NW Nangkero structure is a fault-related-fold. The map-view fault pattern shown in figure 10 is particularly diagnostic of an en-echelon, imbricate fault-system. It is proposed that the Yolla-NW Nangkero folds developed a positive flower- structure (see figure 10) and the fault-system geometry supports dextral transpressional fold propagation (Woodcock and Rickards, 2003). Seismic evidence indicates that the last movements along this fault occurred during Miocene-Oligocene times which are possibly related to the Chattian Unconformity event.

4.3 Base Upper EVCM (top M. diversus)

(Enclosure 4 and 5)

The reservoir properties of Early Eocene sandstones are good to very good. For this reason, the Base Upper EVCM (top *M. diversus*: see figure 3) was mapped as a potential reservoir horizon. The *M. diversus* sandstones are a primary gas bearing reservoir at the Yolla Field. The Intra-EVCM 2755 sand flowed at a rate of 32.3MMCFD and 561bcpd upon test at Yolla-4 (Brooks et al., 2006). The uneconomic Pelican Gas Field is also reservoired in Early Eocene strata, but here, reservoir connectivity is poor owing to a combination of rapid facies variation with extensive structural compartmentalization. Gas-bearing Early Eocene sandstones were tested three times at Pelican Field; Pelican-5 DST-6 flowed 5.5MMCFD and 441bcpd for a period of 5 hours before in the ingress of water (Mitchell, 2007). DST analysis combined with RFT data is consistent with low permeability reservoir and gas accumulation of limited extent (Mitchell, 2007).

It is shown in enclosures 3 and 4 (Base Upper EVCM TWT and depth maps) that the top *M.diversus* section is considerably more structured when compared to the top EVCM (see enclosure 2 and 3). The principal structural elements at this level consist of the Pelican Trough, the Dondu Trough, the Yolla Trough and a N-trending Poonboon-Nangkero High. The Poonboon-Nangkero High forms a prominent ridge separating the Yolla from the Dondu Trough. An initial aim of the CueBass08 survey was to test if deep lineaments propagated from the basement to Palaeocene and/or Eocene levels along the eastern part of the Poonboon-Nangkero High. Unfortunately the amount of structuring is minor and few robust structural-trapping mechanisms are mapped out from the Dondu Trough. It is proposed that the Poonboon-1 well is a good test of this high feature, and although there is updip potential to the south of Poonboon-1, this is volumetrically small.

The NW-Nangkero lead forms a small 4-way closure at the Base Upper EVCM level, with a spill point to the south east. Other features to note at this level are a small lead to the south east of Tilana-1. This feature is in an optimal charge migration pathway from either the Yolla or Dondu Trough areas.

4.4 Top Palaeocene (top L. balmei)

(Enclosure 6 and 7)

The thickest accumulation of Paleocene sediments were deposited in the Yolla Trough (Leech et al., 2008). At the Yolla Field, sands have moderate to good reservoir properties, with average measured porosity and permeability of 17.3% and 337mD measured from Yolla-4 core. Flow rates of 32MMCFD were recorded on test in the primary gas bearing zone (Brooks et al., 2006). Brooks et al. (2006) postulate a fluvial-model with a west to northwest flow direction. Importantly from a T/37P and T/38P perspective, the reservoir characteristics of the Paleocene-aged sediments remain good across the composite Yolla-Dondu mega-trough as evidenced at Poonboon-1 (Buffin, 1994), which is located on the N-trending ridge which now separates the Yolla and Dondu Troughs. Although no wells have intersected Paleocene rocks in the central part of the mega-trough (i.e. SE and SW of Poonboon-1), high amplitude seismic events near the base of the Paleocene may indicate thick sandstone or coal beds. This assertion is supported by the presence and concentration of interbedded sands and coals in Poonboon-1 which can be mapped southwards.

The basin is considerably more structured at Paleocene level and there is a bimodal distribution of NNE and N-trending faults. Similar to the upper levels the main structural elements are concentrated along the Poonboon-Nangkero High area and along the NE basin margin. Unfortunately the new data from the CueBass08 survey failed to identify any new significant structures.

There are limited structural traps identified in the central part of the Dondu Trough (south eastern T/37P). Four features are observed basin-ward of the Dondu-1 well, but all of these are small and have areal extents of less than $4km^2$. Although these features are well positioned for charge out of the Dondu tough their small size makes them unjustifiable commercial tests at this time. Two large structures are recorded on the southern boundary of

T/37P. These features have limited structural relief and have high technical risk associated with them.

The revised mapping shows that there is up-dip potential at Paleocene level to the south of Poonboon-1. This “attic” has limited structural relief.

5. References

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6. APPENDIX 1.