7th International Conference & Exposition on Petroleum Geophysics

"HYDERABAD 2008"

P - 343

Three Stage Extensional Model for the Evolution of Bass Basin of Australia: Evidence of Oblique Rifting from Seismic Interpretation and Fault Trend Analysis.

Pradipta Kumar Das.
Oil & Natural Gas Corporation Limited, Southern Sector, Chennai. pradipta_reena@yahoo.com

Summary

The subdivision of the sedimentary succession into the rift-related depositional sequences (pre-rift, syn-rift and post-rift) has enabled clear identification and understanding of the separate influence of the Tasman rift and the Otway rift in the evolution of the Bass Basin. Tasman rifting had a much more prominent role in shaping the basin history than the earlier Otway rifting both in terms of structural style and stratigraphic development. The structural style in the Bass Basin has been shaped through three major extensional phases that are reflected in distinctly different fault trends. The initial response to extensional forces during Otway rifting was the development of discrete fault segments all across the basin. The present day fault pattern subsequently developed through progressive propagation and linkages of the initial fault segments. The extension direction (E-W) during Tasman rift was oblique to the basement grain (NW-SE) already created during Otway rifting, and this obliquity of Tasman rifting to the earlier trend had a profound influence on the sequential development of the regional fault trend associated with extensional tectonics.

Introduction

The Bass Basin covering an area of 65,000 square kms is geographically located between mainland Australia in the north and Tasmania in the south and lies almost wholly under Bass Strait waters with present day water depth ranging between 30m to 90m (Figure 1). This basin is an interior rift basin and is considered to have been formed during the rifting between the Australian and the Antarctic plates (known as Otway rifting). The basin history has been subsequently modified by Tasman rifting event.

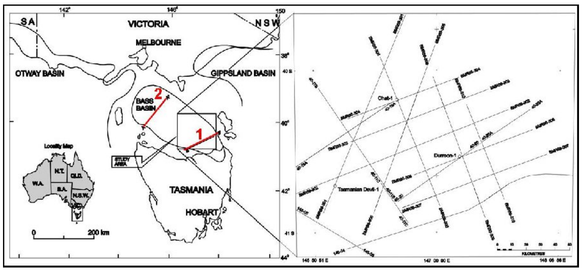

Figure 1 Location map showing the distribution of seismic lines and wells used in the study

The basin has been under active exploration for hydrocarbons since early 1960's and two major oil and gas fields, Yolla and White Ibis, have been discovered so far by different operators in the basin. The estimated gas resource in the Yolla Field is about 450-600 BCF OGIP and the gas accumulation encountered in White Ibis is estimated at 85 BCF OGIP (Lennon *et al*., 1999). Distribution of seismic lines highlighted in the present paper is shown in Figure 1. Figure 2 shows the generalized stratigraphy of the basin.

Previous authors (Baillie and Pickering, 1991; Gunn *et al*., 1997) have interpreted variously the tectonic and structural evolution of the Bass Basin. Baillie and Pickering (1991) suggested two separate basins corresponding to the NW and SE part of the basins but their work suffers from lack of any concrete evidence in support of their conclusions. Smith (1986) suggested that the Durroon Formation, deposited during Tasman rifting, is confined to the SE part of the basin but failed to note that time equivalent unit of Durroon Formation has not been drilled in the NW part of the Basin.

Four major lithostratigraphic units are recognised in the Bass Basin; the early Cretaceous Otway Group, the Late Cretaceous to Late Eocene Eastern View

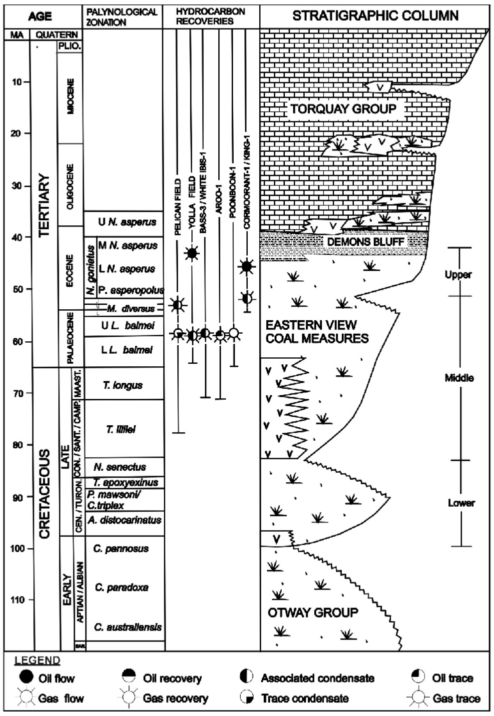

Figure 2 Generalised stratigrpahy of the basin.

Coal Measures (EVCM), the Late Eocene Demon's Bluff Formation and the Oligocene to Recent Torquay Group. EVCM Group is the main hydrocarbon target in the basin having encountered hydrocarbons in Paleocene and Eocene sands (Williamson *et al.*, 1987). Essentially, the rock units have been biostratigraphically sub-divided based on the spore pollen assemblage zones for the non-marine Early Cretaceous to Late Eocene succession and planktonic foraminiferal zonation for the Late Eocene to recent marine section (Morgan, 1991).

The present paper deals with interpretation of about 6500 km of 2D seismic data spread over the basin but with particular focus on the SE part. The exact nature of the influence of the two rifting events, Otway and Tasman rifting, on the tectononstratigraphic evolution of the basin has been investigated to arrive at a clear understanding of how the fault pattern, subsidence history of the basin have evolved and why the NW and SE part of the basin behaved differently to extensional tectonics during formation of the basin.

Methodology

The seismic reflectors have been tied through a synthetic seismogram using the sonic and density wireline logs from the Durroon-1 well and then age-dated by using the available biostratigraphic information from the well (Figure 3). The major sequence boundaries have been picked by identifying the reflection terminations following mainly the onlap and truncation patterns. Based on the model proposed by Prosser (1993), the sedimentary section at Durroon-1 well has been divided into its rift-related (pre- rift, syn-rift and post-rift) depositional sequences (Figures 3 & 4).

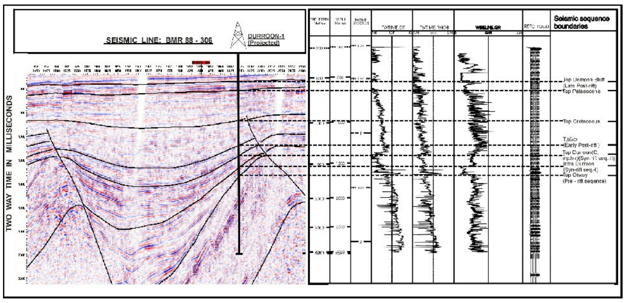

Figure 3 Seismic sequences tied to Durroon-1 well with the help of biostratigraphy and log character.

The major angular unconformity seen in seismic data near Durroon-1 well within the Early Cenomanian succession showing truncation of reflectors below and onlap above has been identified as the **'rift-onset unconformity'** (Top Otway horizon) and is dated about 96 Ma (Figures 3 & 4). This unconformity marks the onset of the Tasman rifting phase which may have been synchronous with the initiation of sea-floor spreading in the Southern Ocean. The Early Cretaceous A. distocarinatus and C.pannosus zones are missing in this well (Morgan, 1991). This indicates flexural / thermal uplift of the footwall block in response to extensional tectonics and substantial erosion at the beginning of the Tasman rifting phase. The pre-rift package in the basin has been correlated with the Otway Group deposited during the Otway rifting episode.

The other sequence boundaries have been identified on the basis of onlap pattern of the reflectors combined with the wireline log character at Durroon-1 (Figures 3 & 4). In all, eight sequence boundaries have been considered for correlation and mapping. They are, from oldest to youngest, Basement, Top Otway (pre-rift), Syn-rift sequence I (Intra Durroon), Syn-rift sequence II (Top Durroon, C triplex zone), T. lilliei (Early post-rift), Top Cretaceous (Early post-rift, Top Paleocene, Top DemonsBluff Formations (late post rift sequences).

The major faults have been interpreted in the seismic sections both from reflection terminations and fault plane reflections and then mapped in plan view. The procedure adopted for fault trend analysis was to identify the cut off points of the faults with respect to each sequence boundary and then project these points to the two dimensional map view and finally fault tips correlated in map view. The two-way time structure contour maps at Basement and Otway Top level have been presented here (Figure 11) to explain the early initiation of extensional fault systems during Otway rifting and later modification of the fault trend during Tasman rifting event.

Tectonic influence on structural style

One regional seismic line (line 1) from the SE part is presented in Figure 5 (for location, see figure 1) showing the structural style which is characterised by large, domino-style, tilted basement fault blocks. Fault throws are in the order of 4 - 5 Km and occur along rotational normal faults. Three major fault blocks, the Bark, Anderson and Boobyalla, have undergone extremely large tectonic subsidence related to extensional normal faulting.

This is in complete contrast to the structural style in the adjacent area to the northwest. The seismic line (line 2) shown in Figure 6 (for location, see figure 1) shows the typical structural style of the NW part of the Basin.

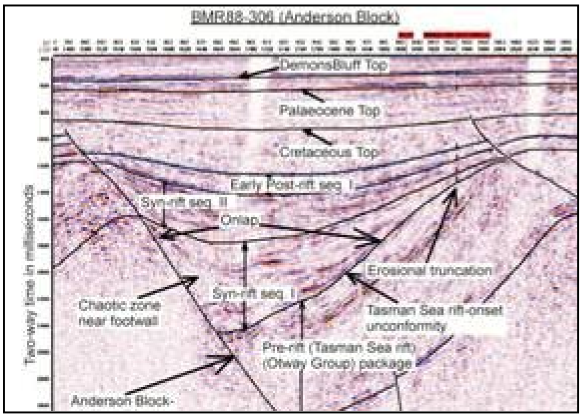

Figure 4 Seismic reflection termination patterns and major rift related sequences interpreted near Durroon -1 well (Anderson Block). Note the thickening of the two syn-rift sequences towards the block-bounding fault and the early post–rift sequence is marked by reflectors draping the footwall and hanging wall crests. The late post rift sequences (Paleocene and DemonsBluff) show regional parallel nature of the reflectors over almost the entire basin.

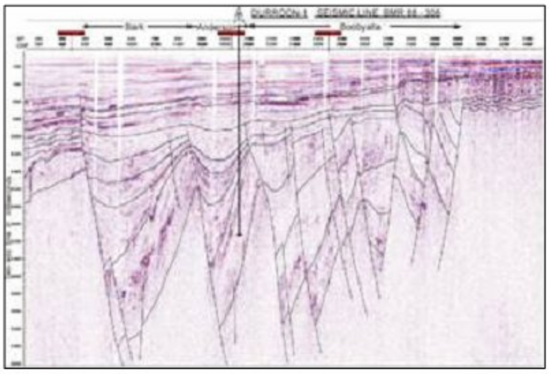

Figure 5 Regional seismic line from the SE part of the basin showing tilted basement fault blocks: Bark, Anderson and Boobyalla blocks (for location, see figure 1: line 1).

Although two opposing major half-graben bounding-faults have accommodated initial extension with a large fault displacement (2-3 km) in the NW part, the predominance of sedimentary loading and syn-sedimentary faulting marks the structural style there with a large number of both planar and listric faults.

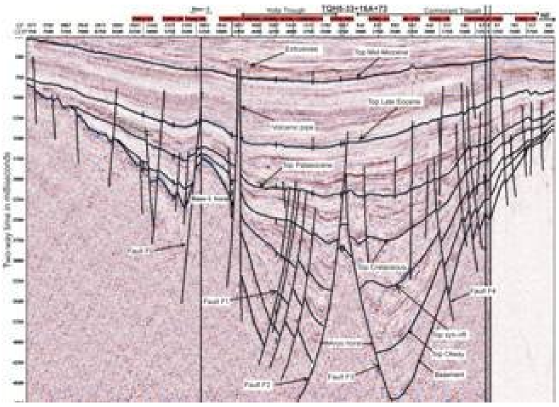

Figure 6 Regional seismic line from the NW part of the basin showing two major horsts (Aroo and Bass-3) and associated troughs (Yolla and Cormorant) (for location, see figure 1: line 2).

The granitic nature of the basement in the SE part as opposed to basement composed of metasediments in the NW part (Gunn *et al*., 1997) is thought to have played an important role in controlling the different way in which the two areas behaved in response to crustal extension. The NW Bass Basin was subjected to an increased rate of post-rift sedimentation compared to the SE part. The maximum TWT thickness of the sediments in the NW part is about 5 seconds with about 4 seconds in the SE part. An estimate of the approximate thickness of sediments based on average velocity from seismic data gives the maximum thickness to be around 9,500m and 7,000m respectively. This variation in the thickness of the sediments deposited in the NW area is the result of rapid accommodation development brought about by sediment loading and crustal flexure during thermal cooling stage.

A preliminary estimate of the amount of extension by measuring the pre-faulted basement length and the post-faulted basement length estimates extension of 1.36 in the SE part compared to 1.22 in the NW part. Also, the fact that the Otway Top horizon is displaced by faulting similar to the basement in the SE part by an order of about 5 km compared to 2-3 km in the Bass area suggests that the effect of Tasman rifting is more pronounced in the SE part compared to the NW part.

Seismic stratigraphy

Prosser (1993) proposed tectonic systems tracts approach to rift basin evaluation giving emphasis to rift related linked depositional systems in a manner similar to sequence stratigraphic concepts developed for passive margin setting by Exxon Group.

The truncation of reflectors below a surface seen near the crestal portion of the hangingwall of the Anderson block (Footwall of the Boobyalla block) and mapped as Otway Top horizon show considerable erosion of the strata below (Figure 4). This horizon represents the top of the Otway Group and this unconformity surface has been correlated with the onset of the Tasman rift. The onset of Tasman rifting is evidenced by the fact that there is a sudden and clear change in the dip of the strata across this surface apart from the overall reflection configuration both below and above this surface of unconformity. The reflection configuration below this horizon is parallel to sub-parallel, moderate to high amplitude and medium to high frequency content whereas the reflector configuration above this surface is high amplitude, parallel to sub-parallel and medium frequency content having a progressive onlapping pattern (Figure 4). The Otway Group of rocks is the pre- rift sequence for the Tasman rifting phase.

The overall wedge shape of the two syn-rift sequences towards the fault surface is clearly seen (Figure 4). The early post-rift sequence shows gross parallel reflectors covering the topography with almost a constant thickness of sediments and drowning the crestal portions of both the footwall and hanging wall blocks but confined to the individual tilted basement blocks. There is however, some displacement observed due to faulting from sediment loading or compaction. The late stage post-rift sequence marks the complete quiescence of the basin from any tectonic movement and the broad parallel reflection configurations of a regionally continuous nature suggests thermal cooling and passive subsidence phase.

The progressive onlapping pattern of the reflection configuration indicates lake highstand whereas there is indication of small downlap surfaces within the syn-rift sequences as well (Figure 4). Though accurate stratigraphy and age dating is difficult to determine without any well control, a qualitative interpretation of the facies is feasible. The eroded footwall scarp material, consisting

probably of coarse clastics, shows an aggradational pattern near to the fault plane, particularly in the Bark (Figure 7) and Anderson (Figure 4) fault blocks. The patchy reflectors with moderate amplitude and low reflector continuity have an overall mounded reflection configuration, indicating a high-energy environment of deposition close to the fault planes. These reflectors appear to be onlapping on successive horizons in the hangingwall blocks. The good reflector continuity of the successively onlapping reflectors in the Bark and Anderson blocks away from the fault planes indicates quiet low energy conditions in the depositional environment. It suggests that very rapid faulting activity created very large fault scarp relief / topography and conditions for deep water. The deep water developed in response to large fault displacement in the two fault blocks seems to have been passively infilled by eroded material from the hangingwall and footwall blocks. Also, sediments brought in by antecedent drainage patterns in the evolving rift (Lambiase, 1990) would tend to deposit deep-water lacustrine facies in the more basinal depocentres with coarser clastics in the proximal areas, particularly in the high areas. The evidence for this is seen in the wireline log character in the Durroon-1 well which is an arenaceous (sandier facies) immediately above the Otway Top horizon (Figure 3). The shaly section succeeding this sandy facies (Durroon Formation of Smith, 1986) in the Durroon-1 well is deposited in a lake highstand which is palynologically of the C.triplex zone. The Durroon Formation has marine dinoflagellates in two horizons within this formation (Morgan, 1991) which suggest that at least marginal marine conditions invaded the area during this period.

There is no well information available in the center of the basin where full stratigraphy is expected to be preserved to link the Otway rifting phase to the Tasman rifting phase. However, as discussed above, different lithofacies that could be expected both laterally and vertically in such lacustrine-dominated sub-basins can be safely predicted. Lacustrine shales and silts of Durroon Formation have excellent hydrocarbon source potential in the syn- rift section of the Tasman rift phase (Morgan, 1991). Closer to the footwalls and the near source areas of the hangingwall tilted fault blocks should provide good coarser clastics in fluvio-lacustrine and / or deltaic environments, suitable for petroleum reservoir rocks. Interdigitation of the good reservoir facies closer to footwall or hangingwall crests with deep lacustrine source facies further down slope would provide rich stratigraphic hydrocarbon plays.

Active rifting was probably very rapid and supposedly in two or possibly three tectonic pulses of extension. This has been interpreted from the overall fault trend in the area. The Otway rifting was already active during the Late Jurassic-Early Cretaceous (evidenced by Jurassic dolerites in the Tasmanian onland margin areas and also in the Victorian coast) Accommodation space was being created by extensional normal faulting. It was during the transitional stage from rifting to drifting of the Otway rift, the Tasman rifting became active. The second stage of major tectonic movement, the Tasman rifting eventually created oceanic crust in the Tasman Sea between 82-60 Ma (Magnetic Anomaly 33 and 24) (Weissel and Hayes, 1977). Some of the existing faults of the previous Otway rifting phase in the area were reactivated with large fault displacement.

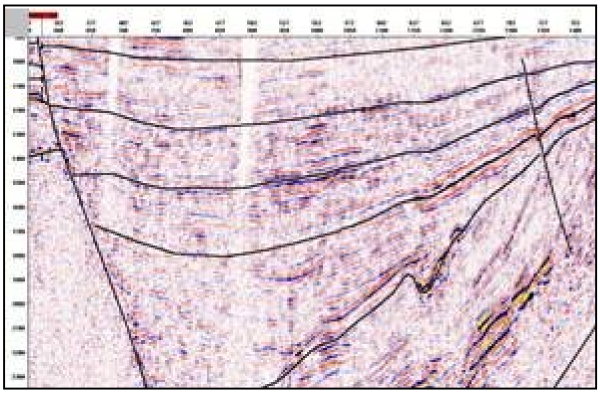

Figure 7 Seismic reflection characteristics of the Bark fault block.

Three stage extensional model for the evolution of the basin

Major basin-bounding fault (western most fault, i.e. the bounding fault of Bark block) that developed early on as seen in the regional line (Figure 5) did not propagate right across the basin during the first stage of movement. The fault segments originally active during the Otway phase of rifting were reactivated during later Tasman rifting event. Analysing the fault trend in the area in conjunction with the seismic stratigraphic analysis, a three-stage extensional history for the tectonic and structural evolution of the basin is envisaged.

Stage-1 (Late Jurassic-Early Cretaceous)

The SE Bass Basin was part of the Otway rift. Continental extension in the eastern Gondwana, a precursor to the separation of the Australian and Antarctica plates, affected a very large area in the SE Australia region. In this first phase, extensional stresses in a NE-SW direction, aligned the normal faults in a NW-SE direction with subsequent infilling of the developing faulted depressions (Figure 5 & 8). The initial response to the extensional stresses was development of large number of faults with small strike extent all across the basin (Figure 8). There are clear indications of a high density of faulting during the Otway phase of rifting. The faults have not affected the complete Otway section in most of the cases being restricted to probably early stages of rifting. This is seen from the fact that all the strike and dip lines show high density faulting in the lowermost part of the Otway section (Figure 5). It indicates that after the initial rifting and associated faulting, the area was into regional subsidence phase where fluvial-dominated sedimentation took place.

Being the end member half-graben unit (Lambiase, 1990) of the Otway rift, the SE area was experiencing the typical third stage / cycle of sedimentation dominated by a fluvio-lacustrine depositional environment. A succession of lithic sandstones, shale and coal, as interpreted from wireline log character constitute the Otway Group. The seismic character within this succession, as mentioned earlier, is moderate to high amplitude, parallel to sub- parallel reflectors with some deltaic progradational and onlap geometry seen. The high amplitude reflections may be from coal seams deposited in flood plain / swampy conditions during the waning phase of Otway rifting.

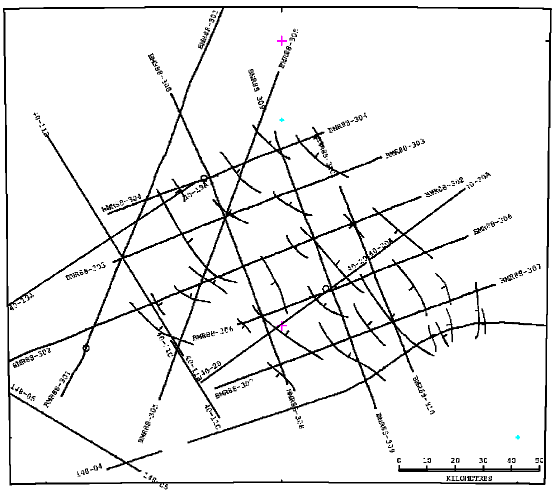

Figure 8 Fault pattern in stage 1 rifting (Late Jurassic – Early Cretaceous) characterised by a large number of faults with small strike extent all across the basin in the NW-SE direction.

Stage-2 (Early Cenomanian)

The Tasman rifting, initiated during the Early Cretaceous (Early to Mid-Cenomanian), and accentuated some of the faults of the earlier system by reactivation with huge throws (up to 4-5 kms), shaped the structural history of the area to its present day pattern. In this second phase of extension, faulting was very rapid with almost all the faults of the first stage being reactivated to varying degrees with propagation along their tips in both directions. But notably here, the predominant trend of the faults was N-S. This was due to the E-W orientation of stresses during this phase of extension (Figure 9). The change in the overall stress direction from NE-SW direction in the Otway rifting phase to E-W in this Tasman rifting phase had a strong influence on the alignment of the fault trends. The strongest evidence of this comes from the strike direction of two major faults; one major fault bounding the Anderson block to its west and the other one is the southern extent of the major bounding fault of the Boobyalla block. Both these major faults trend N-S even at their present day position.

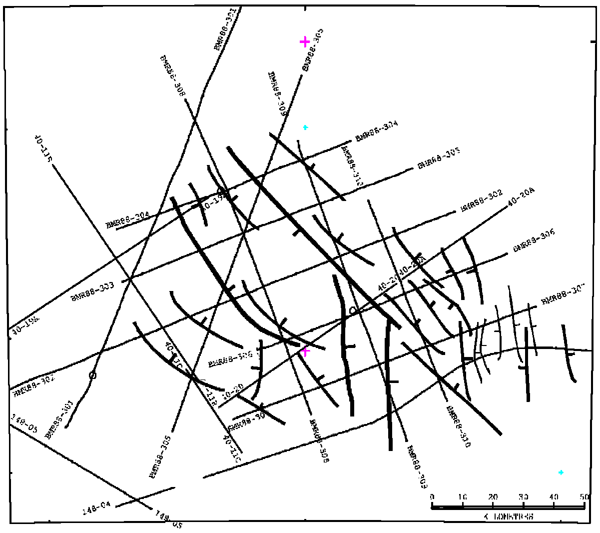

Figure 9 Fault pattern in the stage 2 rifting (Early Cenomanian). Mainly N-S fault trend due to E-W orientation of tensional stresses during Tasman rifting phase.

The fault alignment suggests that the faulting activity has been very intense mostly in the Boobyalla block i.e., towards the south and the southeast. The very high fault intensity in the extreme SE part of the study area is perhaps indicative of the proximity to the future spreading axis of the Tasman rift. During this phase of major extension, the three fault blocks (Bark, Anderson and Boobyalla) became prominent due to massive fault throw (4-5 kms) along the bounding faults of these blocks. There are some indications of erosion of the Otway (Top) horizon in the

Boobyalla block. However, the overall conformable nature of the strata both above and below the Otway top horizon suggest that the uplift of this end of the SE Bass Basin (flexural margin) of the Tasman rift as opposed to the border fault margin has been less prominent. It can therefore be argued perhaps the Otway rifting and Tasman rifting, being contiguous and the area being close to the future Tasman Sea opening margin, the area became more affected by faulting. The reflection character is very patchy with poor continuity, low to medium amplitude in the lower part of the syn-rift section as well as the Otway sequence.

Stage-3 (Early Campanian)

The beginning of oceanic spreading in the Tasman Sea (82 Ma) was another major tectonic event accompanied by extensional forces. The faults already existing from the earlier two stages were reactivated further and the major tilted basement blocks created during stage-2 were subjected to rotational motion along the faults, thereby widening the basin extent considerably (Figure 10). The oblique spreading in the Tasman Sea influenced profoundly the present day NW-SE trend of the major faults. The fault strands propagated along strike further and coalesced rapidly as the spreading in the Tasman Sea continued. It is however, observed that during the later part of Tasman rifting and or during the beginning of spreading in the Tasman Sea, large extensional stresses were passively generated and taken up by the through going fault bounding the Boobyalla block. This is interpreted from the dramatic increase in thickness of the late syn-rift sedimentary packages in the Boobyalla block towards the fault (Figure 5)

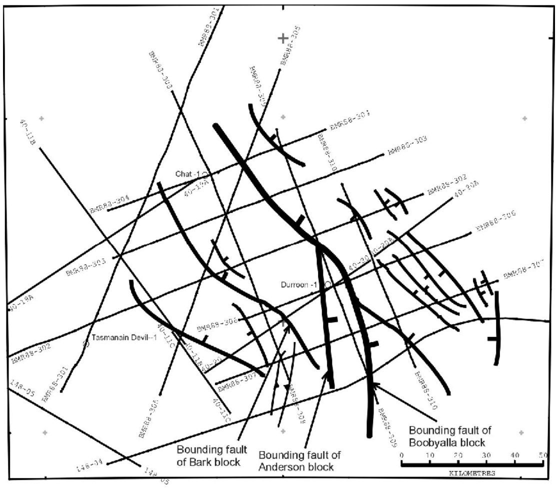

Figure 10 Fault pattern in third stage of extension (Early Campanian). Fault tip propagation and coalescing of faults during the beginning of oceanic spreading in the Tasman Sea brought out the present day trend in the NW-SE direction.

Of the three major block-bounding faults (Bark, Anderson, Boobyalla blocks), the north-south trending fault of the Anderson block did not propagate too far and was blocked by the criss- crossing Boobyalla block-bounding fault and the effect is also seen apparently by more rotation of the pre-rift package of this Anderson block (see Figure 5). The three major faults in the present day structural pattern (Figure 10) seem to have developed to their present day extent in stages (compare with Figures 8 and 9) by fault tip propagation and coalescing of fault segments. The block bounding fault of the widest block, the Boobyalla block (see figure 10), appears to have taken most of the displacement since the Early Campanian. The extension is attributed to far field stresses generated by the beginning of spreading in the Tasman Sea.

The basement encountered at Bass-3 well in the NW central part of the basin consists of metasediments which support the view that the nature of the basement in the western and northwestern part of the Bass Basin is made up of metamorphosed sediments as against the granitic basement to the east and southeast. Hence, mineralogically, the nature of the basement is different in the NW area compared to the SE area. This difference in the type of basement rocks might have influenced the way the upper crust behaved in response to the extensional stresses. The upper crust behaved in a more brittle manner in the SE part where it is ruptured by few large- displacement faults with tilted basement blocks. In the NW part, however, the upper crust was ruptured by large number of small throw faults except the two major half-graben bounding faults.

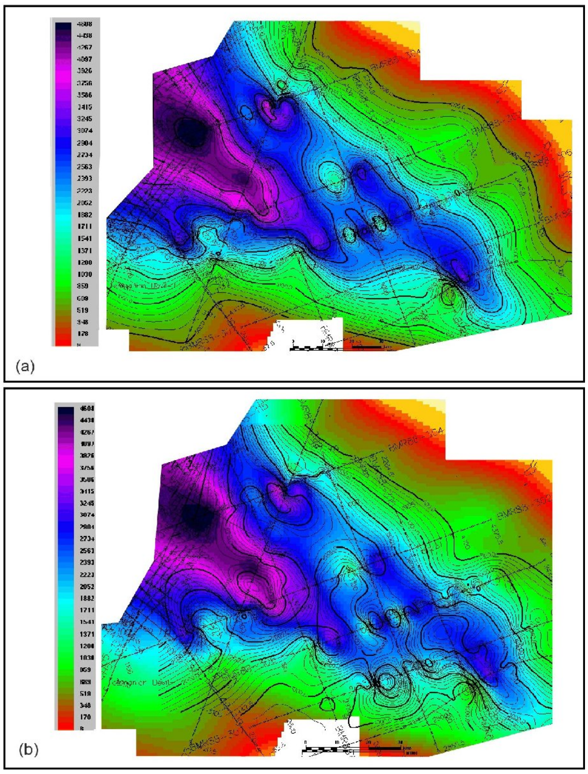

Figure 11 Two-way time structure maps at basement level (a) and Otway Top level (b).

Comparison to analogue sand box modeling results

Scaled analog sandbox models have proved to be powerful tools for simulating the development of extensional structures in rift systems (McClay *et al*., 2002). Through a series of experiments, they have shown simulation of oblique rift systems by scaled sandbox models using dry, cohesionless, fine-grained quartz sand. Extensional deformation in the models was controlled by the orientation and geometry of a zone of stretching at the base of the model. Rift basins produced by oblique rifting are defined by segmented border fault systems parallel to the rift axes and by intrarift fault systems that are sub perpendicular to the extension direction. Segmentation of the rift margin increases with increase in obliquity of the rift axis, resulting in a consequent increase in displacement on intrarift fault systems. The Otway rifting event had created the NW-SE oriented rift zone and with the E-W extension during Tasman rifting stage, the orientation of the rift zone to the extensional stress direction in the second stage became oblique.

Figure 12 shows analogue sandbox modeling results of two stages (20 % and 50 %) of extension in case of an oblique rift (two angles of obliquity, 60^0 and 45^0) (McClay *et al*., 2002). The analogue modeling results of an oblique rift as shown in the Figure 12 (c) can be closely compared with the present day structural pattern in the SE Bass Basin as depicted in (Figure 10). The rift border fault is segmented and the fault orientation is oblique to the rift zone. The rift interior faults are also not very long, suggesting obliquity of the rift zone to the extensional direction. The fact that distinct depocentres developed during such rifting separated by accommodation zones is also brought out by the time structure maps at basement and Otway top level (Figures 11a and 11b).

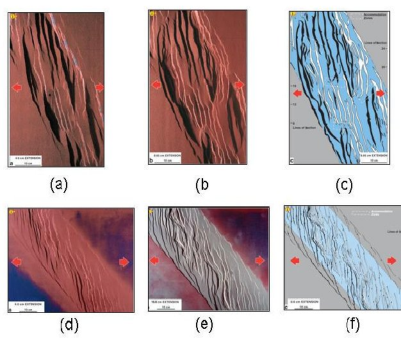

Figure 12 Analog sand box modeling results for an oblique rift; (a) 60^0 obliquity, 20 % extension, (b) 60^0 obliquity, 50 % extension. (c) Line diagram interpretation of (b); (d) 45^0 obliquity, 20 % extension (e) 45^0 obliquity, 50 % extension ;(f) Line diagram interpretation of (e) (After McClay et. al., 2002)

Conclusions

The present study, while clarifying some of the gaps in the understanding of the evolutionary history of the Bass Basin, establishes that the Tasman rift event had a much greater role in shaping the basin history from Late Cretaceous period. Although the extensional stresses of Tasman rift had greater impact on the SE part in terms of massive displacement along normal extensional faults, leading to greater amount of fault related extension, the seismic data in the NW area suggest that the impact of Tasman rift is expressed quite differently. Chronostratigraphically, an equivalent unit to that of the Durroon Formation could be correlated in the NW part also based on seismic reflection characteristics but remains subjective in the absence of actual drilling information in this area. The three phase extensional model for the progressive evolution of the structural style and stratigraphic framework of the basin corresponding to Late Jurassic-Early Cretaceous, Early Cenomanian and Early Campanian major tectonic events explains the present day fault pattern and disposition of depocentres.

Acknowledgements

The author expresses his heartfelt gratitude to Shri G.Sarvesam, GM (GP) and HGS, ONGC Ltd., Southern Sector, Chennai for his constant inspiration and encouragement without which this paper would not have been possible. The author thanks the Basin Manager (KG-PG Basin) and Director (Exploration) of ONGC Ltd. for permission to publish the paper. This paper is based on a part of the PhD work done by the author at the then National Centre for Petroleum Geology and Geophysics, University of Adelaide, Australia under the supervision of Dr. Nicholas Miller Lemon.

References

Baillie, P. W. and Pickering, R., 1991. Tectonic evolution of the Durroon Basin, Tasmania. Exploration Geophysics 22, 13 -18. Gunn, P. J., Mackey, T. E., Yeats, A. N., Richardson, R. G., Seymour, D. B., McClenaghan, M. P., Calver, C. R. and Roach,

M.J., 1997. The Basement elements of Tasmania, in R. A. Facer, ed., Exploration Geophysics, v. 28, p. 225-231.
Lambiase, J. J., 1990. A Model for Tectonic Control of Lacustrine Stratigraphic Sequences in continental Rift Basins. In: Katz, B.J. (ed) Lacustrine Basin Exploration, Case Studies and Modern Analogs: AAPG (American Association of Petroleum Geologists) Memoir, 50, 265-276.

Lennon, R. G., Suttill, R. J., Guthrie, D. A., and Waldron, A. R., 1999. The renewed search for oil and gas in the Bass Basin: Results of Yolla-2 and White Ibis-1. APPEA (Australian Petroleum Production and Exploration Association) Journal, 39, 248-261.

McClay, K.R, T. Dooley, P. Whitehouse, and M. Mills, 2002. 4-D evolution of rift systems: Insights from scaled physical models, AAPG Bulletin, v. 86, no. 6 (June 2002), pp. 935–959.

Morgan, R., 1991. New palynology of the Durroon mudstone, Durroon-1 well. Tasmania Dept. of Mines, Unpublished report.

Prosser, S., 1993. Rift-related linked depositional systems and their seismic expression. In: Williams G.D. and Dobb A. (ed), Tectonics And Seismic Sequence Stratigraphy, Geological Society Special Publication, 71, 35-66.

Smith, G.C., 1986. Bass Basin geology and petroleum exploration. In: Glenie, R.C. (ed) Second South-eastern Australia Oil Exploration Symposium, Melbourne, 257-284.

Weissel, J.K. & Hayes, D.H., 1977.Evolution of the Tasman Sea reappraised. Earth and Planetary Science Letters, 36, 77-84.

Williamson, P.E., Pigram, C.J., Colwell, J.B, Scherl, A.S., Lockwood, K.L..and Branson, J.C., 1987, Review Of Stratigraphy, Structure, And Hydrocarbon Potential Of Bass Basin, Australia. AAPG (American Association of Petroleum Geologists) Bulletin 71, 253-280.