Competent Persons Report

Assets of Great South Land Minerals Limited, Tasmania

Prepared for

Empire Energy Corporation International (Leawood, Kansas, USA) and its wholly owned subsidiary Great South Land Minerals Limited of Hobart.

Date: 23rd October 2008

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1. EXECUTIVE SUMMARY

Great South Land Minerals Limited requested that RPS Energy (RPS) provide a Competent Persons Report on the Special Exploration License SEL 13/98, Tasmania. Great South Land Minerals Limited (GSLM) holds 100% interest in the Special Exploration License SEL 13/98 which covers a portion of the Tasmania Basin. The permit area is approximately 15,410 square kilometres and covers approximately 25% of the island of Tasmania. The permit will expire on 1 October, 2009. No petroleum wells have been drilled in the permit area to date.

Seismic coverage is approximately 1300 kilometres of 2D (TB01-2001; 775 km, TB02-2006; 175 km and TB02b-2007 345km). To date, only stratigraphic tests and mineral holes have been drilled in the Tasmania Basin. Drilling between 1997 and 2001 was conducted by GSLM using diamond coring mineral exploration rigs to establish stratigraphy.

Following the integration of the 2007 gravity and seismic data in to the existing database, GSLM have identified more than 15 potential drill sites targeting prospects and leads of various sizes. To date, the interpretation of all the acquired seismic data has identified several fault block traps and anticlines with shallow targets in the Gondwana Petroleum System, and deeper targets have been identified in the Larapintine Petroleum System. In the Central Highlands, these are mainly Devonian anticlinal structures, which contain Ordovician targets. Twelve of the located targets have been evaluated within this report. A drilling program of the primary targets is planned by GSLM. The first exploration well to test the Bellevue prospect was spudded on 17th Sept 2008, with the completion of a pilot hole through the basalt. The remaining well will be completed by the Hunt rig #3 expected on site in October 2008. Also permission has been given to drill the Thunderbolt prospect during 2008.

To date, there have been no oil or gas fields discovered in the Tasmania Basin although several oil seeps have been reported. Oil seeps can be valuable in signifying the occurrence of mature source rocks in frontier exploration. In order for a seep to be authentic and considered part of a petroleum system, it must be correlated to a source rock. Currently, the seeps reported in the Tasmania Basin have had limited correlations made to petroleum systems, however, there is a seep in a recently used quarry at Lonnavale, to the southwest of Hobart, that has been correlated with the Permian Tasmanite Oil Shale. The seep indicates that an active and significant petroleum system may exist in the Tasmania Basin. Two potential petroleum systems could be present in the Tasmania Basin. These are the Pre-Carboniferous System (Larapintine) and the Permian System (Gondwana).

The first petroleum system is referred to in this document as the Pre-Carboniferous System and is based on an Ordovician source. Structures formed in the Tabberabberan Orogeny have the potential to form large traps. Seismic coverage is not yet dense enough to fully define such traps. The Ordovician Limestone and Silurian Siliciclastic Formations are suggested reservoirs. The reservoir quality of these formations is not known.

The second possible petroleum system is the Permian System, the source of which is expected to be the Early Permian Woody Island Formation and its member the Tasmanite Oil Shale. The potential reservoir for the system is a relatively well understood fluvial formation called the Liffey/Faulkner Group. This formation has modest permeability in most locations (<10 mD). It is hoped that the intra-formational seals in the Liffey Group can either provide seal for structural traps or set up stratigraphic traps. The play has good source rock presence as evidenced by the Tasmanite Oil Shale, which has been typed to the Lonnavale seep. The maturity level and therefore the timing of expulsion is not well understood. The identification of potential source rocks is an encouraging aspect of this play.

The Prospective Resources for the seven primary prospects and leads within the SEL 13/98 block are summarised in Table 2. "Risk Factor" for Prospective Resources means the chance or probability of discovering hydrocarbons in a sufficient quantity for them to be tested to the surface.

Asset	Operator	% Interest	Status	Licence Expiry Date	Licence Area Km^2	Comments
Tasmania SEL 13/98	GSLM	100%	Exploration	1st October 2009	15,410	Exploration interpretation and drilling

Table 1 - Tasmania Assets of Great South Land Minerals

Prospect / Lead	Gross Prospective Resources Oil (mmbbls)				Risk Factor	Operator
	Low Estimate	Best Estimate	High Estimate	Mean Estimate	COS %	
Bellevue Upper Unit	38	151	484	220	2.0	GSLM
Bellevue Lower Unit	24	95	307	139	2.0	GSLM
Bracknell Dome	3	18	90	37	1.2	GSLM
Butlers Rise	2	14	63	25	0.77	GSLM
Interlaken	2	10	40	17	0.47	GSLM
Cressy	3	12	48	21	1.2	GSLM
Hummocky Hills	5	30	138	58	1.2	GSLM
Thunderbolt	12	53	198	88	0.72	GSLM
Macquarie River	3.52	13.1	42.4	19.7	0.58	GSLM
Nile River	3.52	13.1	42.4	19.7	0.81	GSLM
Quamby	0.405	1.52	4.95	2.28	0.63	GSLM
Steppes	1.96	7.39	24	11.1	1.3	GSLM
Stockwell	2	7.4	23.6	11	0.75	GSLM

Table 2 - Prospective Resources

Source: RPS Energy
Chance of Success (COS): Chance or probability of discovering hydrocarbons in sufficient quantity for them to be tested to the surface

2. PERMIT DESCRIPTION

The Tasmania Basin is a frontier basin which covers around 25% of the island of Tasmania, a state of the Commonwealth of Australia. GSLM holds 100% interest in the Special Exploration License SEL 13/98 which covers the potential prospective portion of the basin. The permit expires on 1 October, 2009. The permit area is 15,410 square kilometres and covers most of the basin as illustrated in Figure 1.

Figure 1 - Permit location and major boreholes

Onshore petroleum permits in Australia are administered by the relevant state government. In general, Australian petroleum permits of any jurisdiction are governed by an agreed work programme system with terms of five "permit" years. The anniversary of the permit year is usually the formal award date. The Tasmanian State Government has chosen to define the agreed work programme for Special Exploration Licence SEL 13/98 in terms of mandatory expenditure targets. The proposed and mandatory expenditure per year is shown in Table 3 and the respective activities in Table 4.

Permit Year Ending	Expenditure Proposed by GSLM	Cumulative Expenditure Proposed by GSLM	Mandatory Expenditure (80%)* (AUD)
1/10/2005	$5,341,000	$5,341,000	$4,272,800
1/10/2006	$3,020,000	$8,361,000	$2,416,000
1/10/2007	$4,799,000	$13,160,000	$3,839,200
1/10/2008	$6,530,000	$19,630,000	$5,224,000
1/10/2009	$1,810,000	$21,500,000	$1,448,000

*The mandatory spend is 80% of the value of the programme proposed by the operator

Table 3 - SEL 13/98 expenditure-based programme agreed with regulator

Year Ending	Activity	Status
1/10/2005	2D seismic survey TB02, seismic interpretation, and drilling	TB02 suspended (175 km acquired and processed)
1/10/2006	152 km 2D seismic	Completed
1/10/2007	270.5 km 2D seismic. Interpretation and integration of seismic. Extensive gravity survey.	Completed
1/10/2008	1 Well	Bellevue#1 Spudded, Top hole drilled and cased to 274 metres
1/10/2009	7 wells 400km 2D Seismic	Planned

Table 4 - SEL 13/98 planned activities

3. REGIONAL OVERVIEW, TASMANIA BASIN

3.1 Exploration Drilling History

No petroleum wells have been drilled in the permit area. To date, only stratigraphic tests and mineral holes have been drilled in the Tasmania Basin. Between 1997 and 2002, GSLM drilled five stratigraphic tests, all with hard rock diamond core rigs. None of these wells were drilled on a defined structure. The results of these wells are summarised in Table 5.

Borehole	Operator	Type	Spud Year	Total Depth (mKB)	Purpose	Hydrocarbon Indications (gas % corrected for air, nitrogen and CO_2 contamination)[2]	Formation at TD	Age
Shittim-1	GSLM	Diamond core	1997	1751	Stratigraphic Test	Methane max. 31%, ethane max. 2.12% traces C3-C6. Helium up to 4.8%.	Phyllite and quartzite	Proterozoic
Jericho-1[1]	GSLM	Diamond core	1997	640	Stratigraphic Test	Methane max. 10%, ethane max 1.26% traces C3-C6. Helium detected.	Bundella Fm	Permian
Lonnavale-1	GSLM	Diamond core	1997	557	Stratigraphic Test	Methane max. 1.8% ethane max. 0.35 % traces C3-C6.	Ferntree Fm	Permian
Pelham-1	GSLM	Diamond core	1997	503	Stratigraphic Test	Methane max. 1%	Bundella Fm	Permian
Hunterston-1[3]	GSLM	Diamond core	2002	1324	Stratigraphic Test	Methane and ethane and traces C3-C6.	Dolomitic siltstone	Proterozoic

Table 5 - GSLM stratigraphic boreholes

1 Isotopic analysis of the methane at Jericho-1 showed it to be thermogenic in origin.

2 All gas measurements are air, nitrogen and CO_2 corrected. The estimation of CO_2 content may result in error. Samples were collected in various ways and sent to a laboratory for gas chromatograph analysis. The amounts above are subject to error and should be treated as qualitative.

3 All the wells were drilled with a mineral rig with BOP attached, all were mud logged.

3.2 Seismic and Gravity Data

GSLM acquired 659 kilometres of seismic reflection data in 2001 across the Central Highlands and in the Northern Midland and Southern Midland areas of Tasmania. In 2006, GSLM recorded 152 kilometres of 2D seismic data across the Central Highlands and in 2007 a further 345 kilometres of 2D seismic data was acquired across the Central Highlands and was interpreted and integrated into the seismic database.

GSLM also acquired a ground gravity survey in the Tasmanian Central Highlands. This data was incorporated with the state gravity database to produce the Bouger Anomaly and Residual Bouger Anomaly maps over the permit.

The current seismic basemap overlying the residual Bouger Anomaly map is shown in Figure 2, and the Seismic basemap with the borehole locations is shown in Figure 3.

The quality of the seismic data set is highly variable and coherent events across sections are rare. The line spacing and geometry is also problematic for defining individual structures and prospect mapping. The spatial geometry of the surveys is currently dictated by being mainly restricted to main roads. This is due to seismic acquisition logistics.

Generally the Permian to present day section on most seismic lines are of reasonable quality. The Pre-carboniferous sections tend to be particularly difficult to interpret due complex structural styles and poor imaging on most lines.

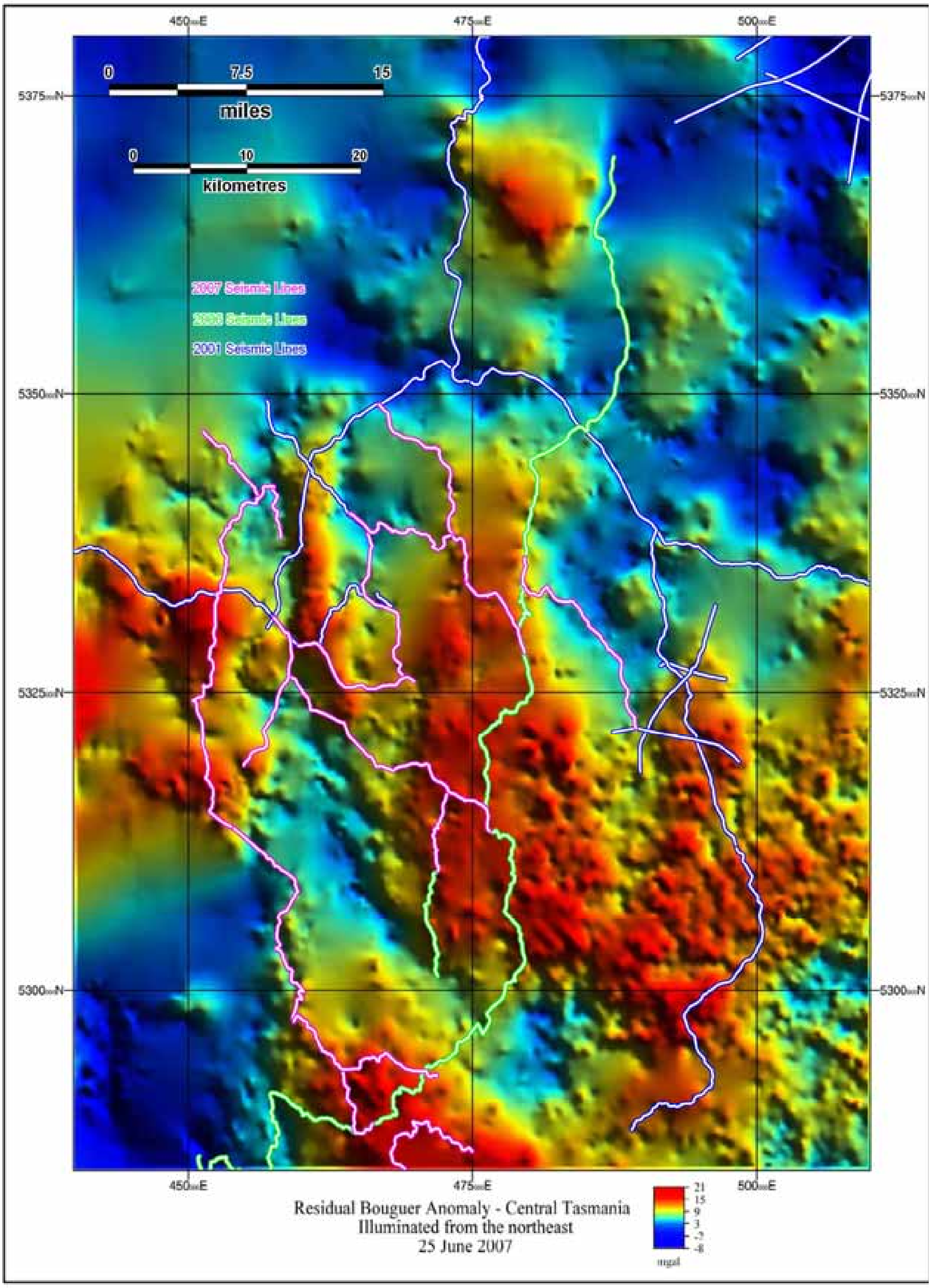

Figure 2 - Seismic Coverage Block SEL 13/98

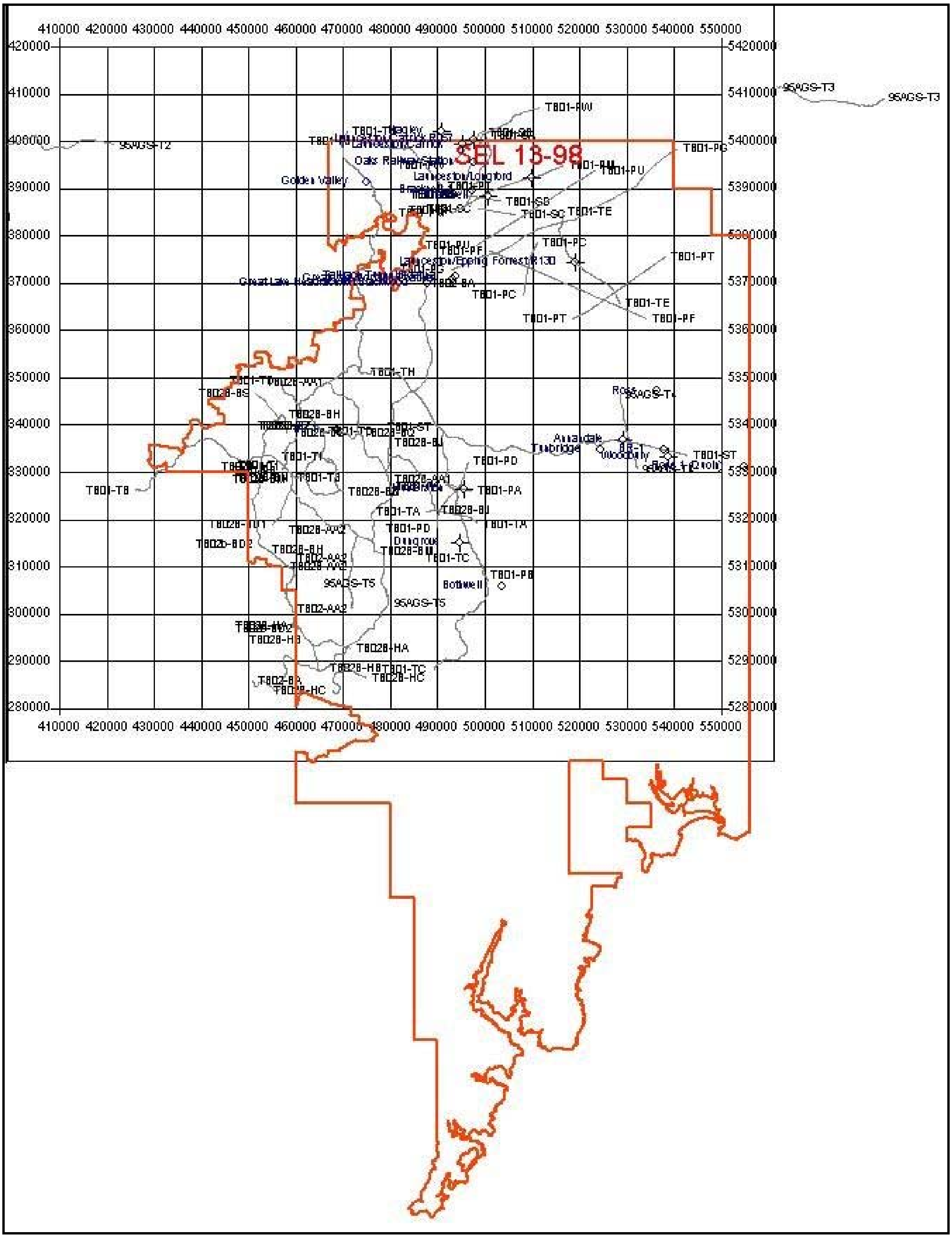

Figure 3 – SEL 13/98 Permit Map showing Seismic Lines and Wells

3.3 Structural Setting

The island of Tasmania is situated off the southeast coast of the Australian continent. The Tasmania Basin is an erosional remnant of a foreland basin (Collinson *et al,* 1987) that covers most of central and eastern Tasmania. A regional seismic line through the central part of the Tasmania Basin is shown in Figure 5.

The oldest basement consists of Proterozoic rocks which are exposed on the western half of Tasmania. Later basement rocks of Cambrian to Early Devonian age are known as the Wurawina Supergroup. All of these rocks were deformed by the mid Devonian tectonic event called the Tabberabberan Orogeny, which was a major Australian event.

Following a long hiatus, a succession of predominantly flat lying sedimentary rocks of Carboniferous to Late Triassic age were deposited (Bacon *et al*, 2000). In the Jurassic, dolerite intruded this succession as thick sheets, resulting in bodies with thicknesses of up to 600 metres. The total known maximum thickness of the Carboniferous to Late Triassic succession (excluding the dolerite) is 1.7 kilometres (Bacon *et al*, 2000). This is assumed that this estimate is based on the integration of drilling and outcrop data. The present boundaries of the basin are erosional and the original basin extent was probably much greater (Bacon *et al*, 2000).

Today there is no strongly defined depocentre in the epicratonic sediment layer, which makes up the basin. The basin was uplifted at the end of the Cretaceous, probably associated with the Australian-Antarctic plate margin break-up. Erosion of approximately two kilometres of sediment is interpreted to have occurred. No further sediment was deposited until the Cenozoic. Cenozoic deposits are only a few hundred metres thick.

The Tasmania Basin can be divided into three major structural elements (Figure 6). The Longford Sub-basin (onshore extension of the Bass Basin) effectively divides the rest of the basin into a large western half called the Central Lakes-Huon Block, and an eastern half called the Douglas River Block (block names modified after Wakefield, 2000). All of these areas are underlain by folded Palaeozoic rocks of Cambrian to Devonian age.

Over much of the basin, the Earlier Palaeozoic is covered by generally flat-lying Jurassic Dolerite and Permian to Triassic sediments. The Longford Sub-basin is evident at the surface in a region called the “Lowlands”. It formed due to extension in the Latest Cretaceous to Early Cenozoic (Stacey and Berry, 2004) but contains only a few hundred metres of Cenozoic sediments. A densely faulted zone, which may be a wrench zone, lies between the Longford Sub-basin and the Highlands (Blackburn, 2004). The Tiers Fault is an obvious cliff at the present day and it delineates the western edge of this zone (Figure 6).

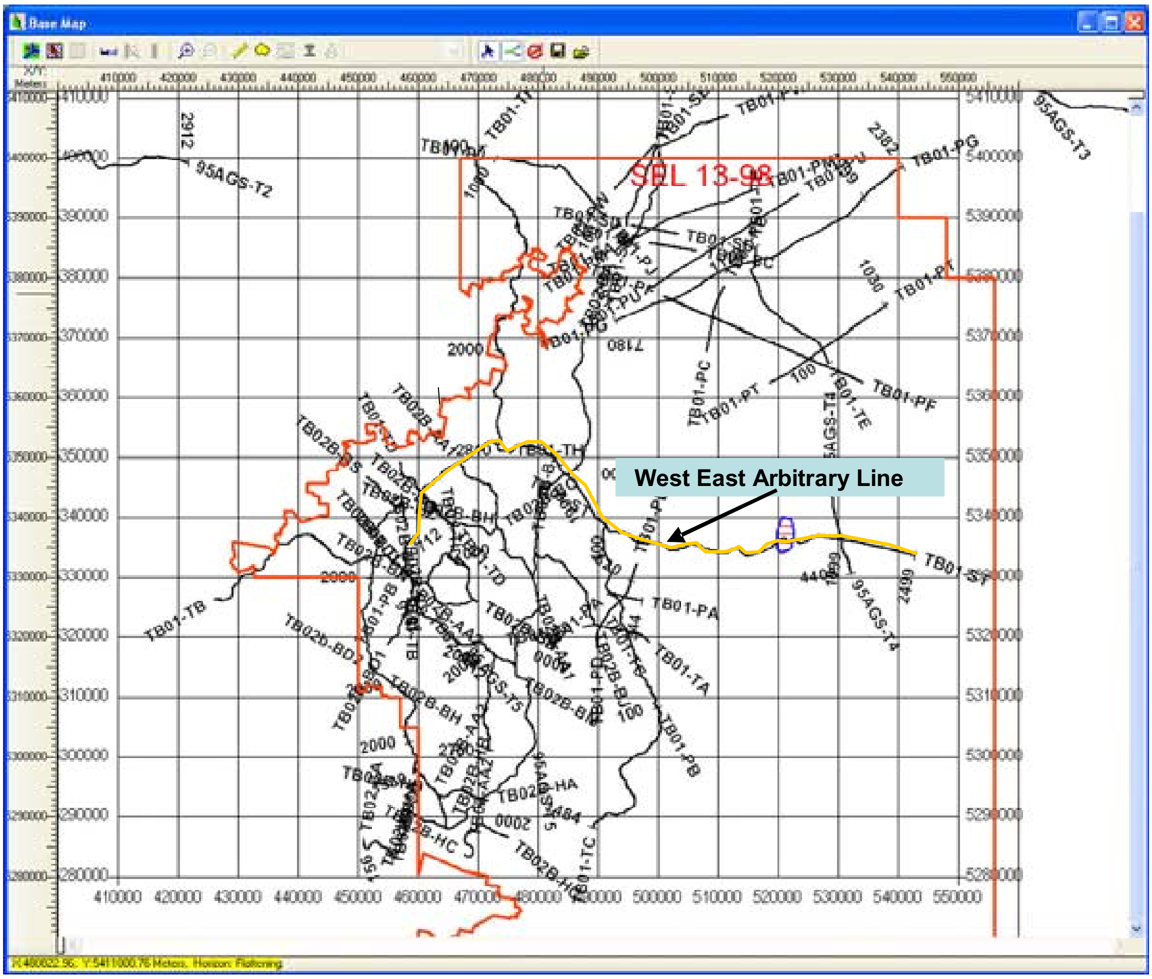

Figure 4 - West - East arbitrary line location map

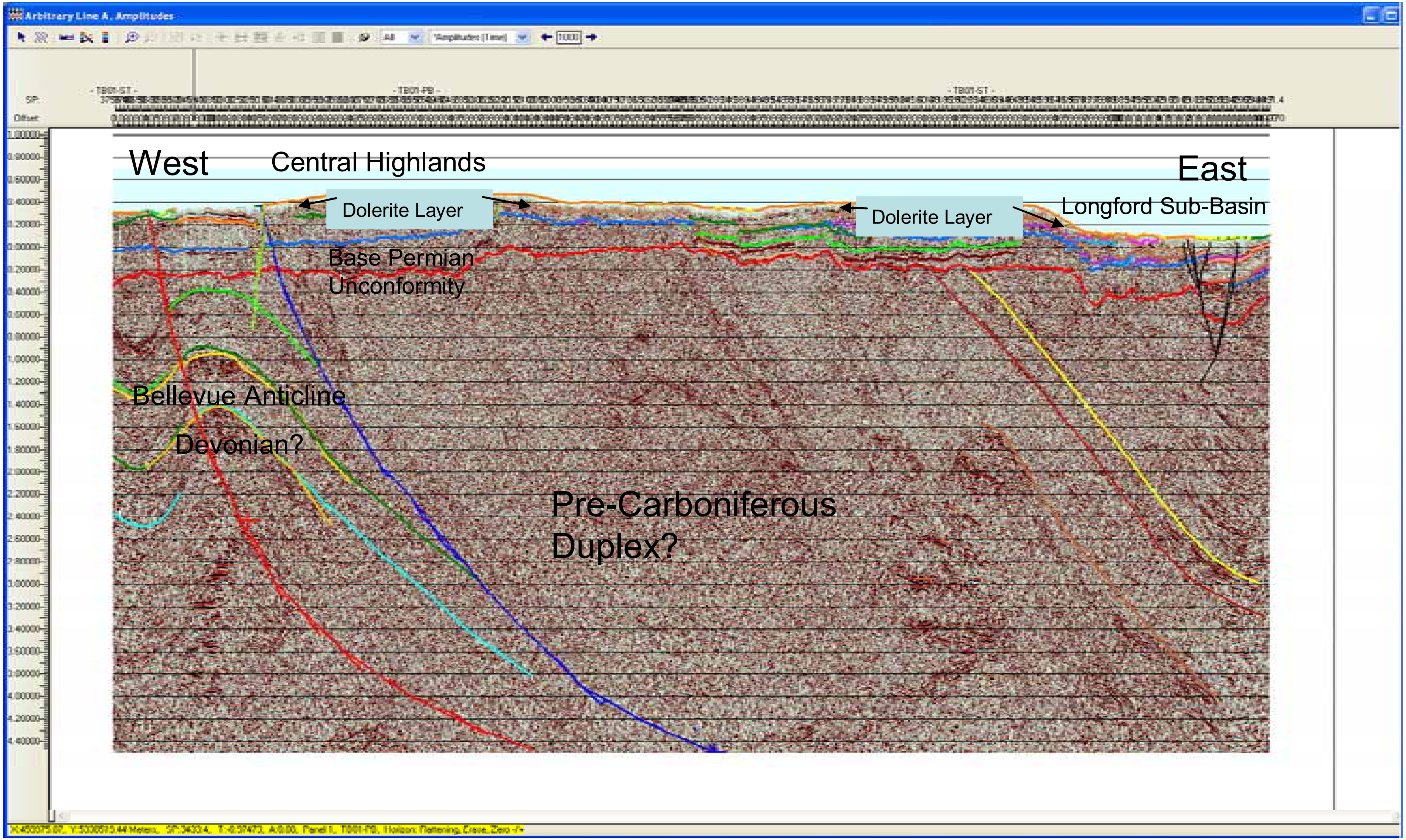

Figure 5 - Arbitrary seismic line through the central part of the Tasmania Basin. For line location, see Figure 4

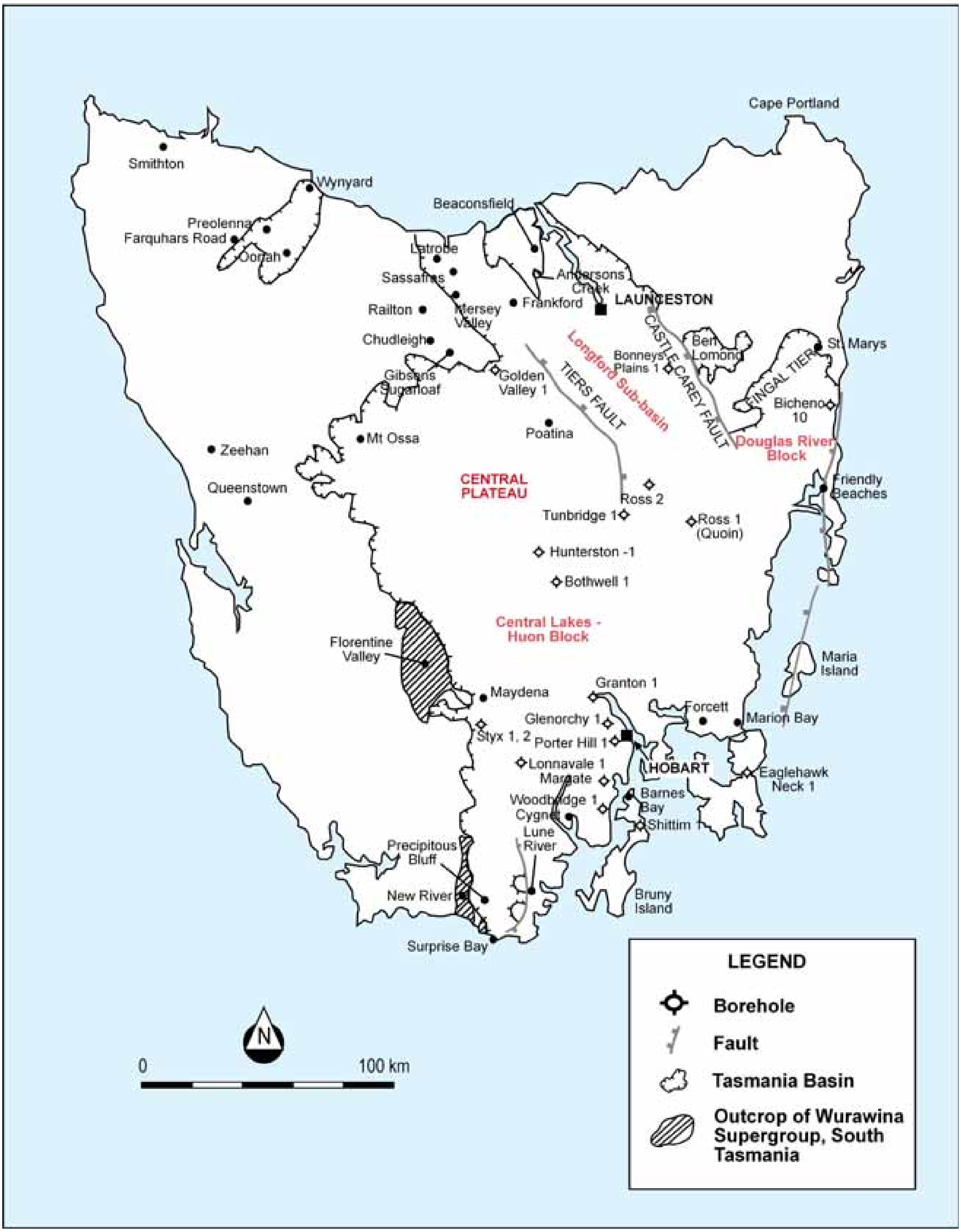

Figure 6 - Tasmania Basin major structural elements (modified from Seymour and Calver 1995a, and Wakefield, 2000)

3.4 Stratigraphy

The generalised stratigraphy of the Tasmania Basin is summarised in Figure 7. The stratigraphy of the basin is understood mainly as a result of the outcrop and the stratigraphic diamond bore holes (Table 5). The following stratigraphic summary is based on Bacon *et al*, (2000). A more detailed discussion can be found in Clarke and Forsyth (1989).

The sediments are separated into two supergroups; the Wurawina Supergroup of Early Palaeozoic age and the Parmeener Supergroup of Late Palaeozoic to Early Mesozoic age. These are separated by a major angular unconformity, associated with the Tabberabberan Orogeny. Each of the supergroups are sub-divided into a number of lower rank lithostratigraphic units (Figure 7).

The Wurawina Supergroup is a Late Cambrian to Early Devonian shelf carbonate and clastic succession (Bacon *et al,* 2000). The supergroup consists of Late Cambrian to Early Ordovician, shallow marine to fluvial siliciclastic rocks (Denison Group) overlain by 1.5 kilometres of predominantly micritic, shallow marine, warm water Ordovician limestone (Gordon Group), then up to 5 kilometres of shallow marine Silurian to Early Devonian siliciclastic rocks (Tiger Range Group) (Bacon *et al*, 2000).

Results from a regional conodont alteration index (CAI) study on the Gordon Group carbonates, performed by Burrett, (1992), indicate that these rocks are mature for hydrocarbon generation in southern Tasmania, showing a CAI typically between 1.5 and 4 (Bacon *et al*, 2000). The results of this work are summarised in Figure 8.

A major orogenic event occurred in the Devonian. This resulted in considerable folding of the Early Palaeozoic strata and was followed by a long hiatus, lasting approximately 80 million years (Figure 7).

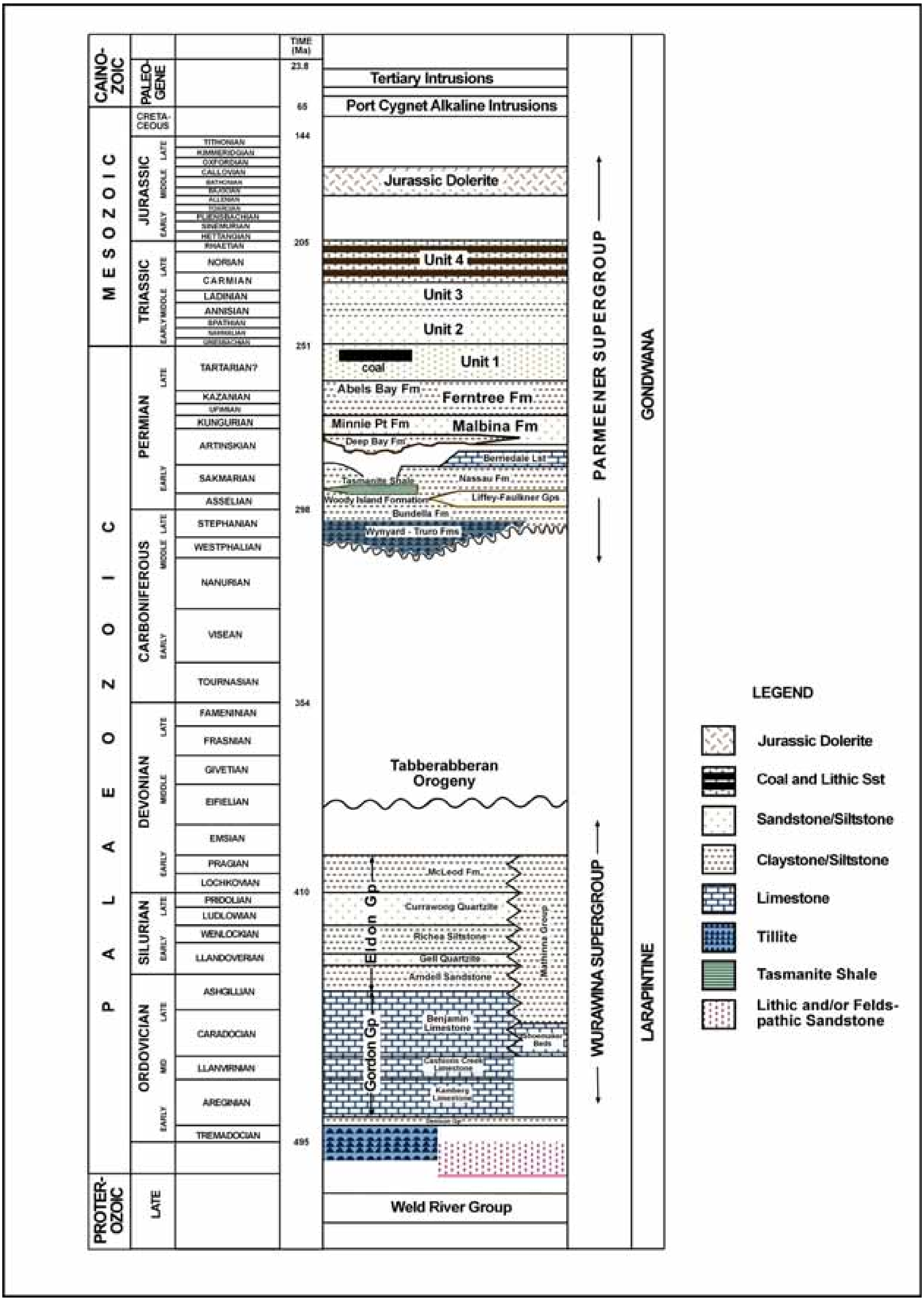

Figure 7 - Stratigraphy detail of the Tasmania Basin (modified from Seymour and Calver 1995b)

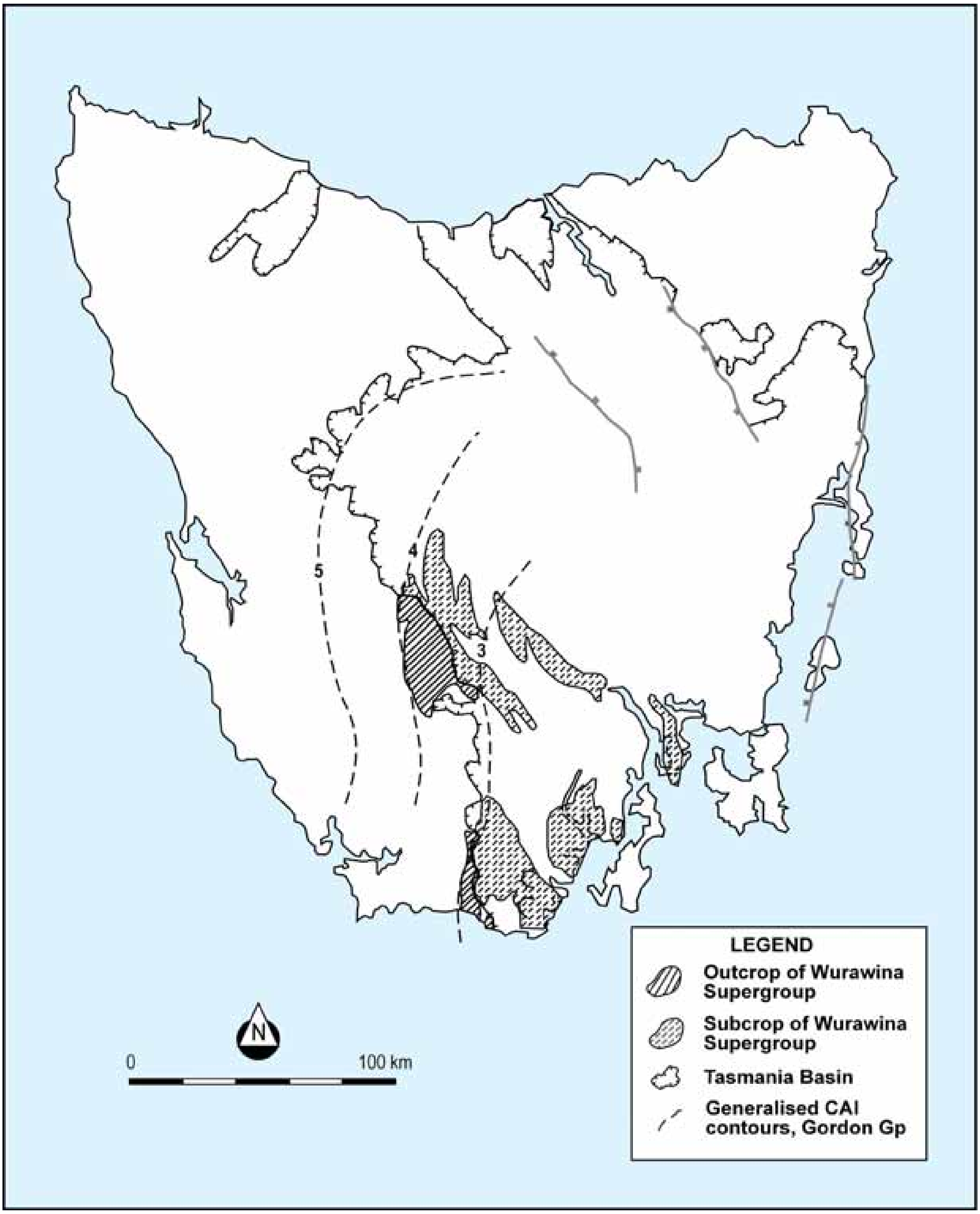

Figure 8 - Generalised CAI contours (modified from Burrett, 1992) with outcrop and inferred subsurface extent of Ordovician - Devonian basement rocks that may be mature for oil and gas generation (Leaman, 1996)

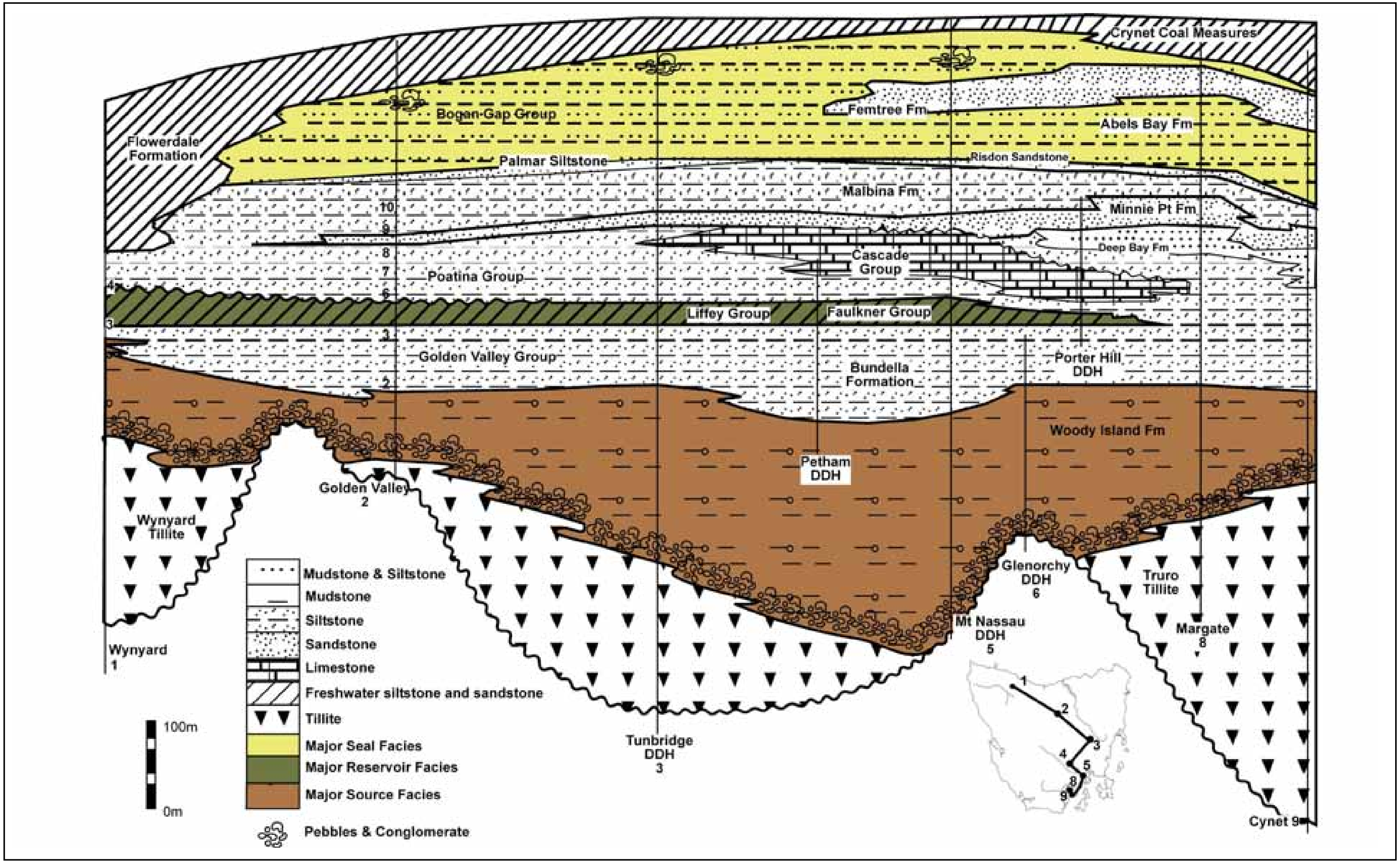

Figure 9 - Time-space diagram of the Lower Parmeener Supergroup (modified from Reid, 2004)

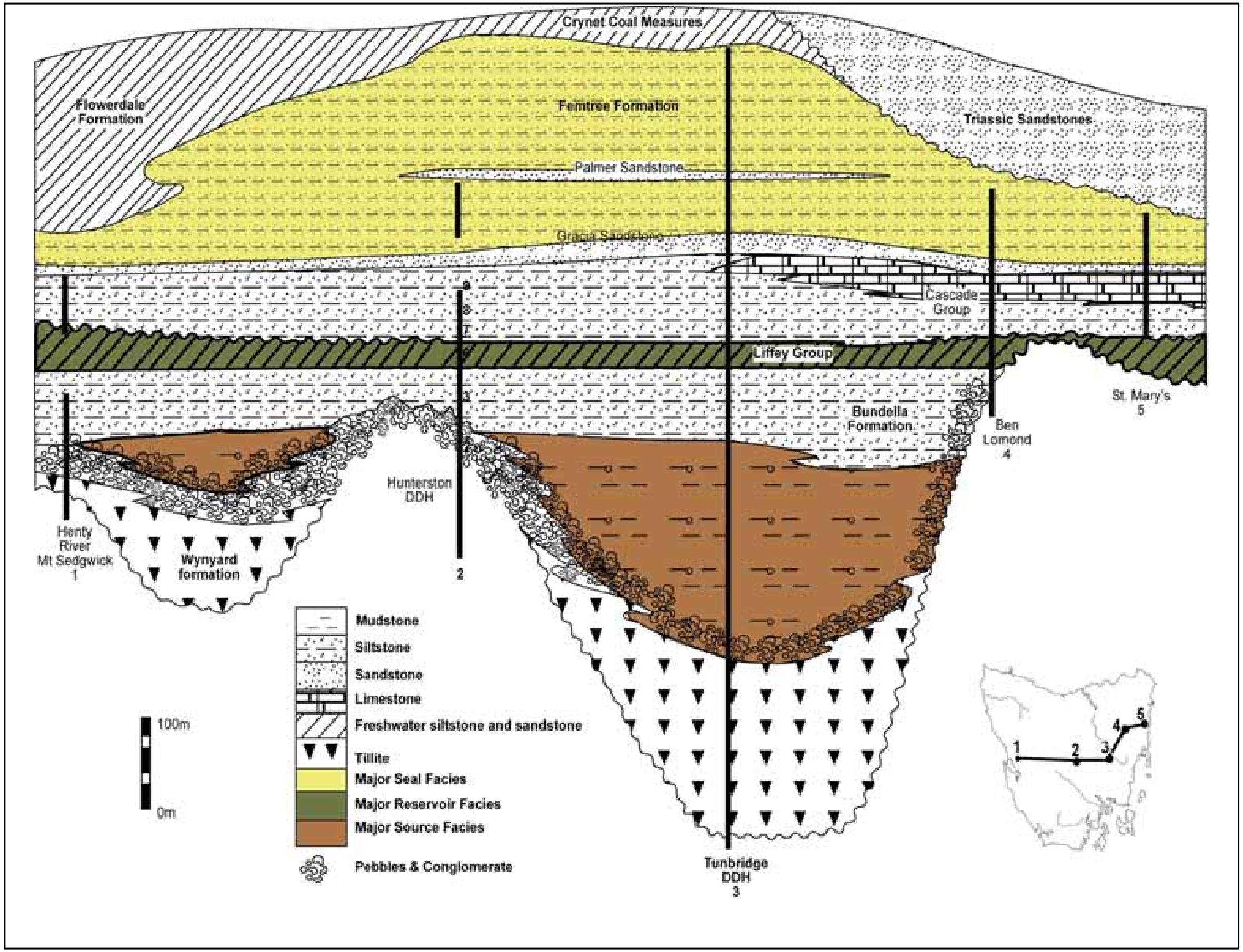

Figure 10 - Time-space diagram of the Lower Parmeener Supergroup (modified from Reid, 2004)

Deposition recommenced in the Carboniferous and the sediments of the Parmeener Supergroup were accumulated (Figure 7, Figure 9 and Figure 10). A flattened stratigraphic section comprised of well and outcrop data, provides an indication of formation thicknesses and depths (Figure 11).

Carboniferous to Permian tillite deposits occur at the base of the supergroup and are widespread throughout the entire basin (Stockers, Wynyard and Truro Tillites, see Figure 7). These are followed by the Woody Island Formation, a 100 to 200 metre thick dark grey monotonous siltstone. In the base of this formation, beds of the alga *Tasmanites punctatus* occur. The Woody Island Formation and the Tasmanite Oil Shale beds are the main potential source rocks and are discussed in Section 3. The distribution of the Woody Island Formation source facies and Tasmanite Oil Shale distribution is shown in Figure 12.

The Woody Island Formation is overlain by the Bundella Formation, a muddy siltstone with little potential as a source rock. These are overlain by the Faulkner Group, consisting of well sorted, laminated, fine to medium sands (Reid and Burrett, 2004). The sandstone beds are generally 6-50 metres thick and modally 21-25 metres and are interbedded with carbonaceous siltstones.

Permian palaeogeography of the Tasmania Basin is presented in Figure 13, and has been modified from Clarke*,* (1989). The thickness and distribution of the Liffey-Faulkner Group is shown in Figure 14. The facies become more marine to the south, suggesting regression in that direction. Recent work has identified a zero edge near Cygnet, which was established by Mineral Resources Tasmania (MRT) from outcrop and several stratigraphic diamond core holes.

The Liffey-Faulkner Group is overlain by silt/clay marginal marine to marine formations, namely the Malbina and Ferntree Formations.

The terrestrial environment of deposition becomes dominant around the end of the Permian. The Lower Parmeneer Supergroup was deposited from the Late Carboniferous to Late Permian. The Upper Parmeener Supergroup was deposited from the Late Permian to Late Triassic, in a non marine environment (Bacon *et al*, 2000). Within the Late Permian to Late Triassic sequence, four stratigraphic units have been defined (Leaman, 1971, and Forsyth, 1989). The following summary is derived from Bacon *et al,* (2000).

Unit 1 is dominantly felspathic with micaceous sandstones. Thin coal is seen in the south on Bruny Island and at Cygnet and is known as the Cygnet Coal Measures. The entire section is generally 20-108 metres thick and is very thin or absent across the northeast of Tasmania.

Unit 2 is 200 to 300 metres thick and was deposited by a fluvial system which flowed from the north-west to the south-east.

Unit 3 is generally 80 metres thick and consists mainly of sandstones with minor conglomerates and rare thin coals.

Unit 4 is mainly lithic sandstone with minor claystone and contains most of Tasmania's economic coal reserves, located mainly in the north-east.

The Upper Parmeener Supergroup (mainly Triassic in age) appears to be a series of fluvial deposition cycles. There is no major marine influence on this group or in the time following, so a widespread regional seal for these sediments seems unlikely.

In the Early Jurassic, 400 to 600 metre thick intrusions of dolerite were emplaced into the existing Permo-Triassic sequences, essentially parallel to bedding. In any given section of the basin, one to three of these bodies may be present. Outcrop observations indicate that each of these bodies is a composite emplacement consisting of several sheets (Burrett, 1992).

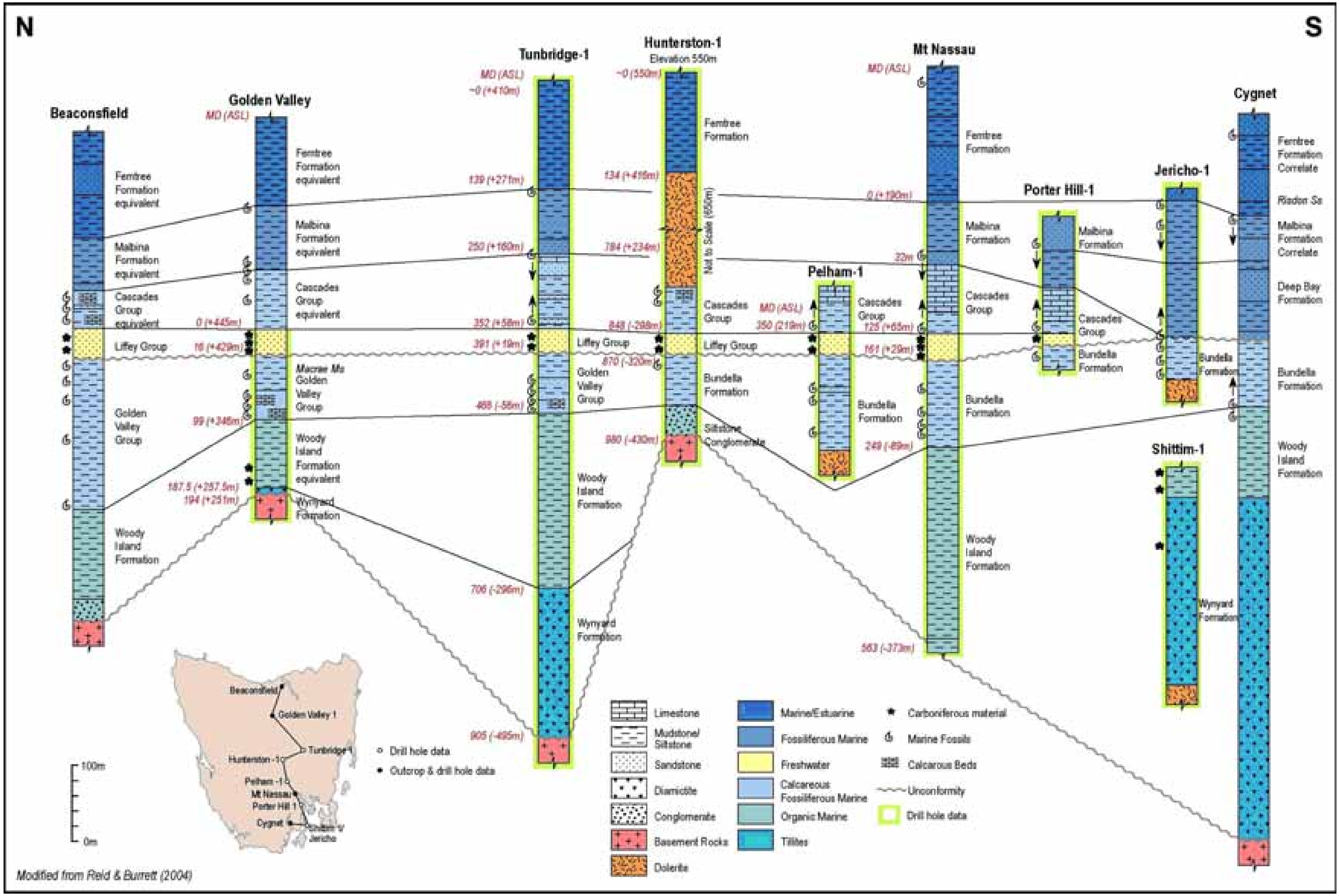

Figure 11 - Stratigraphic cross-section of the Tasmania Basin (modified from Reid and Burrett, 2004)

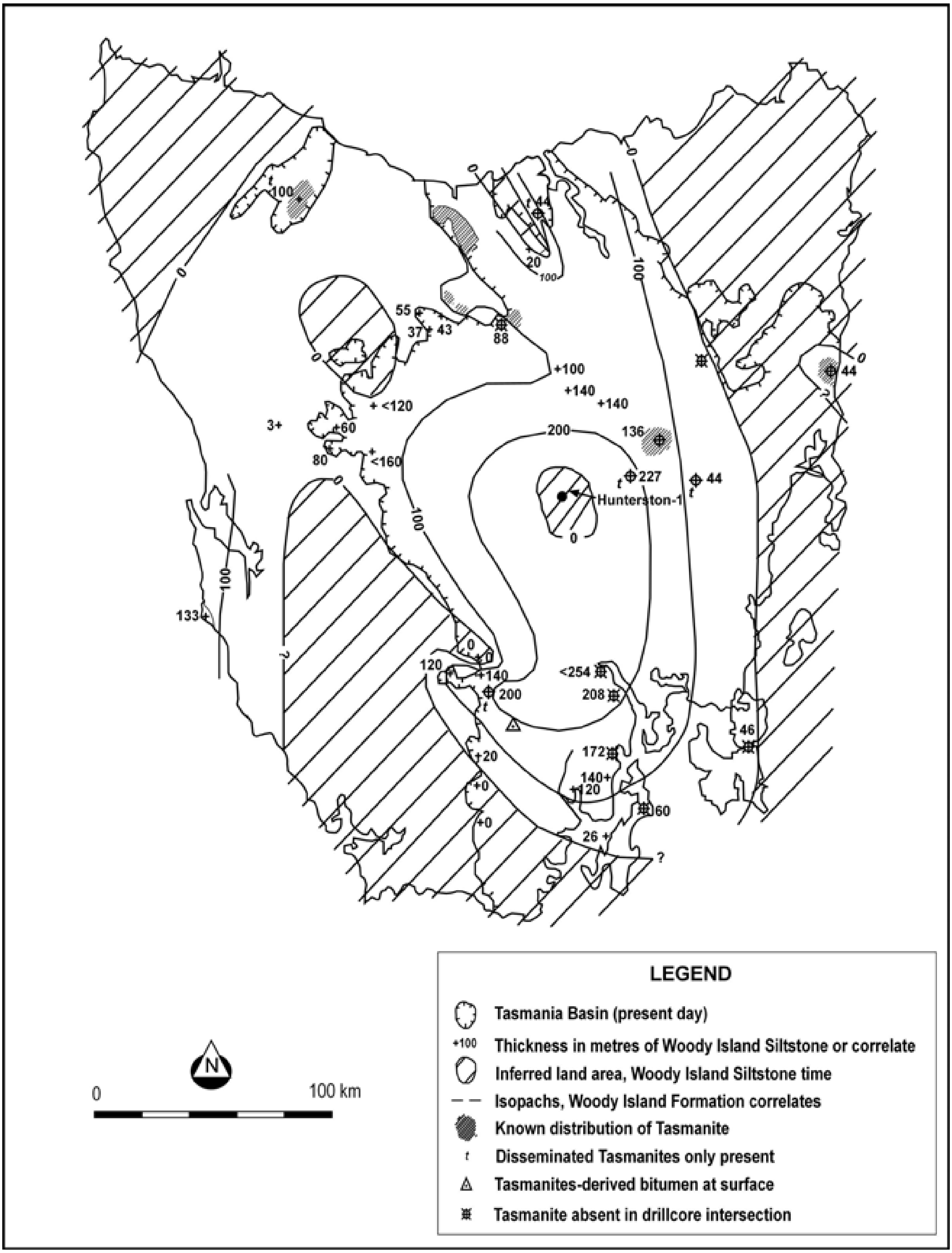

Figure 12 - Known distribution of the Tasmanite Oil Shale with an isopach of the Woody Island Formation (modified from Bacon *et al*, 2000)

The dolerite presents several challenges for petroleum exploration, including the reduction of seismic signal, variations in seismic velocity, hard drilling, localised over-maturation of vitrinite and source rocks and possibly the reduction of reservoir quality.

At the present day, there are no Cretaceous sedimentary rocks in the basin. An apatite fission track study (O'Sullivan and Kohn, 1995) suggests that the basin was uplifted somewhere between 100 and 50 Ma (Late Cretaceous to Early Tertiary) and approximately three to four kilometres of previously deposited Jurassic to Middle Cretaceous rocks were completely eroded. Bacon *et al* (2000) suggests two kilometres of section is more likely, and points out the work of Sutherland (1977) who suggested that zeolites within the Jurassic dolerite indicated a possible burial depth of two kilometres.

Bacon *et al* (2000) suggest that the Mesozoic sediments of the Tasmania Basin were once more widespread. The western margin of the basin is defined by Permian formations truncated by outcrop. This erosion and reduction in basin sediments is inferred to have occurred between Late Cretaceous and Middle Tertiary time.

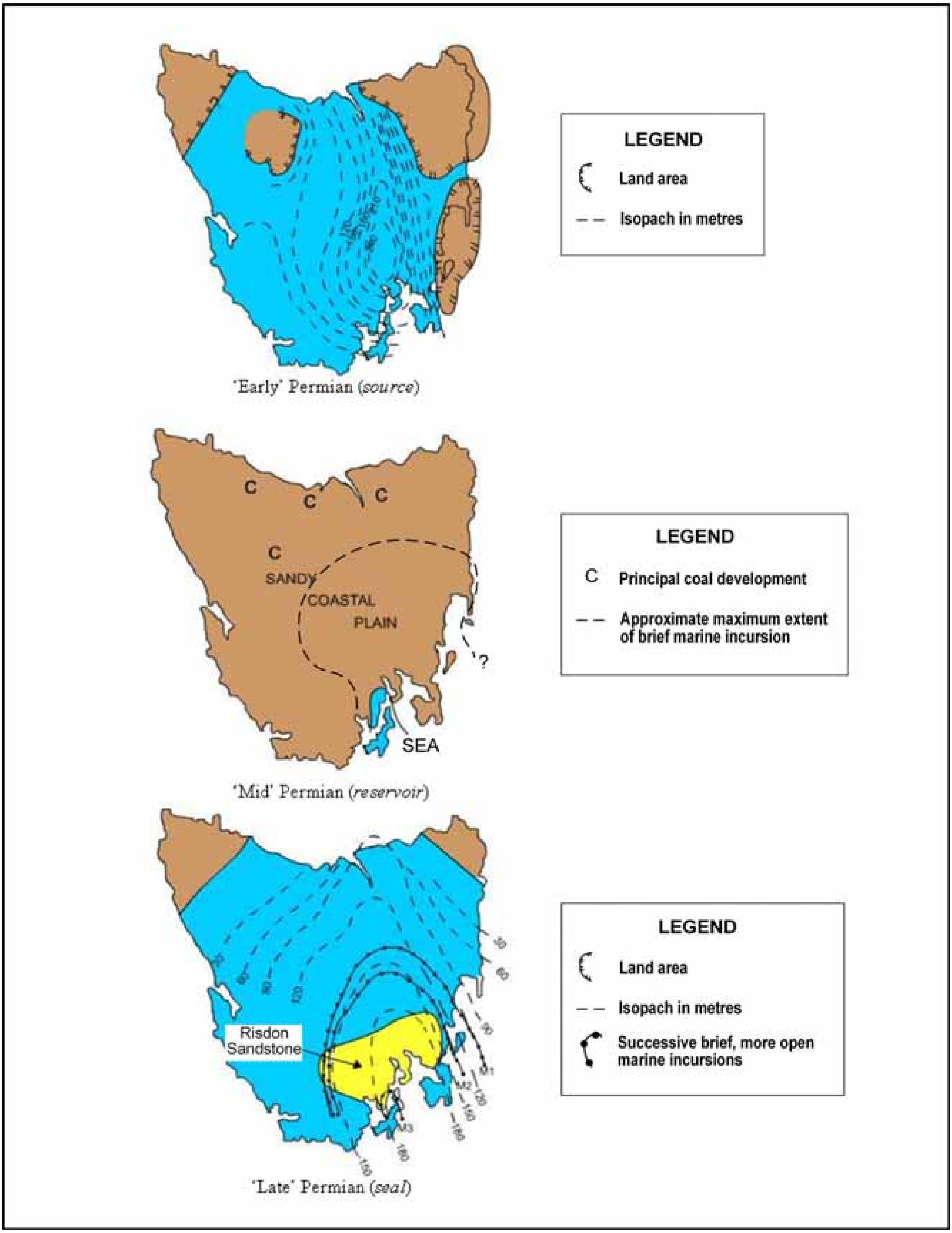

Figure 13 - Permian palaeogeography development of the Tasmania Basin (modified from Clarke, 1989)

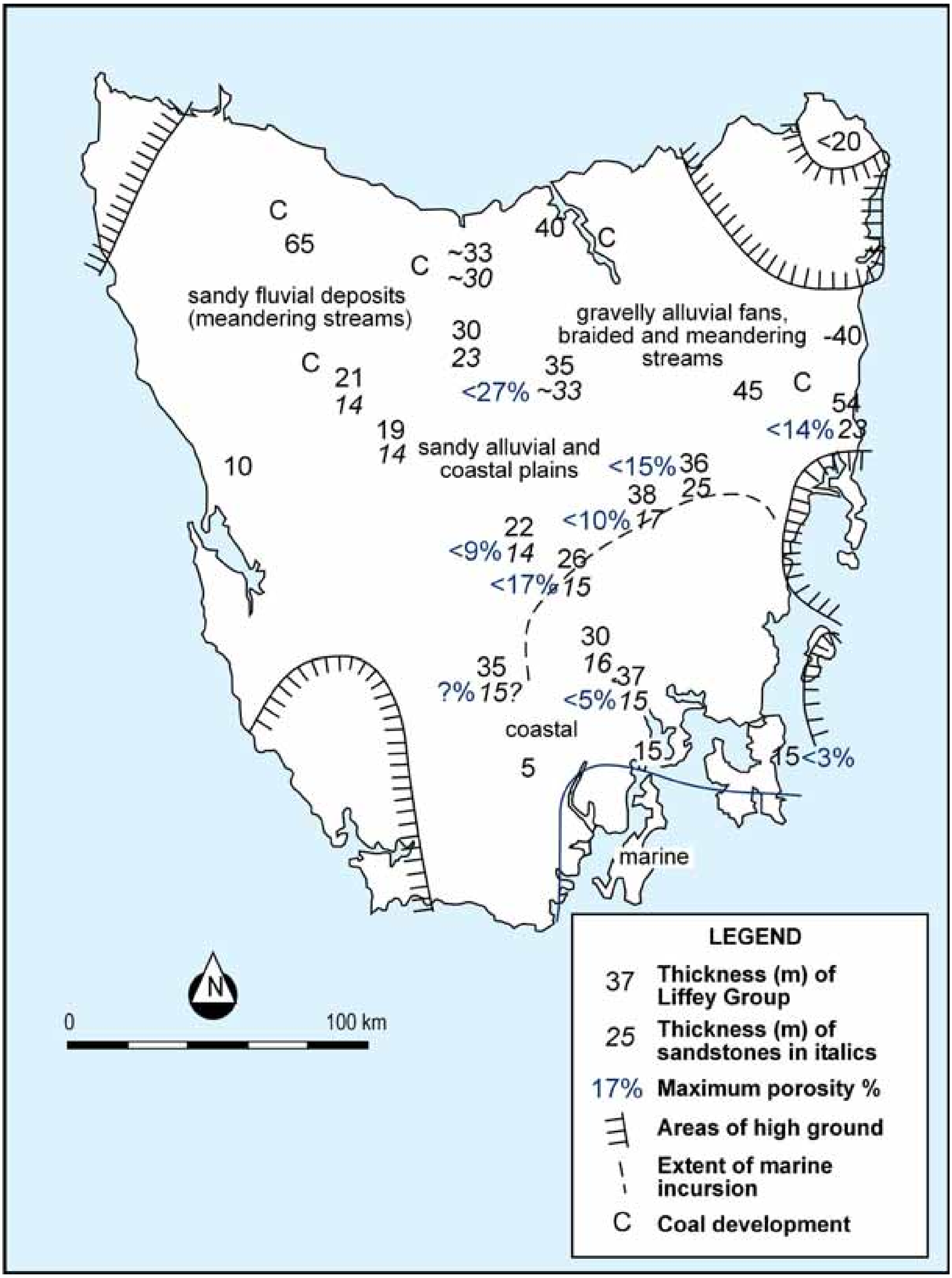

Figure 14 - Thickness and distribution of the Liffey-Faulkner Group. Total thickness of sandstone beds and cycles (black) and some upper porosity values (blue) are also shown (modified from Reid and Burrett, 2004, after Clarke 1989 and Martin and Banks, 1989).

4. PETROLEUM SYSTEM ANALYSIS

To date, there have been no oil or gas fields discovered in the Tasmania Basin although several oil seeps have been reported in Tasmania. Oil seeps can be valuable in signifying the occurrence of mature source rocks in frontier exploration. Currently, the seeps reported in the Tasmania Basin have had limited correlations made to petroleum systems, however, there is a seep in a recently active quarry at Lonnavale, to the southwest of Hobart, that has been correlated with the Permian Tasmanite Oil Shale and is the best indication yet that a significant petroleum system possibly exists in the basin. Two potential petroleum systems could be present. These are the Pre-Carboniferous System (Larapintine) and the Permian System (Gondwana). These two systems are discussed below and schematics are provided in Figure 15 and Figure 16.

4.1 Hydrocarbon Occurrences

Hydrocarbon indications have been reported to the Tasmanian government over the past century. A tabulation of all of these shows and their assessments are provided in Bacon *et al* (2000).

According to Wakefield (2000), over 130 reports of oil and gas seeps have been registered with Mineral Resources Tasmania (MRT). Approximately 10% of these reports have confirmed the presence of naturally occurring hydrocarbons in the form of seeps, tars and bitumens. To date, no bore hole has ever yielded core or cuttings that contained macroscopic hydrocarbon fluorescence although very few wells have been drilled to specifically explore for oil and gas. Of these wells, including those drilled since 1997 by GSLM, none have been drilled on a trap defined by modern seismic.

Mud gas was detected in several of the GSLM wells. Most samples were contaminated with significant amounts of air but, after adjusting for this, levels of C6 up to 50 ppm were detected in Shittim-1 and Jericho-1. Isotopic analysis of the gas at Jericho-1 shows it is thermogenic. Results at Shittim-1 range from biogenic to possible mixed biogenic/thermogenic. However, traces of C3-C9 are encouraging and indicate that there are rocks with the capacity to produce wet gas in the basin.

Low yields of hydrocarbon extracted from a Proterozoic core sample from 1,676 metres in Shittim-1 on Bruny Island and a hydrocarbon extract from a Gordon Group limestone from a quarry were compared by Burrett (1997). The Gordon Group traces are similar in the dominance of n-C18 alkane. The pristane to phytane ratios are reported to be approximately 1 in both (Bacon *et al,* 2000). The Shittim-1 sample seems biodegraded or water washed but, surprisingly, the quarry sample does not appear biodegraded. It has been interpreted that this extracted hydrocarbon probably originated in Ordovician rocks down dip.

Oil and bitumen in Permian sandstone outcrops near Zeehan, Tasmania, have been reported by Cook (2003), who examined samples from these Permian outcrops. One sample of a carbonaceous shale grading to a shaly coal and two sandy samples were thought to have contained possible bitumens. The silty sandstone contained prominent oil inclusions within the sand grains and abundant brightly fluorescing oil, presumably being originally part of the same petroleum system as the bitumens (Cook, 2003).

Cook (2003) also observed that the presence of gas bubbles indicates that the oil to gas ratio of the system was originally relatively high. The Permian sandstones' maturation level is best estimated at 0.7% and may be as high as 0.8% (Cook, 2003) which is consistent with the findings from the previous geochemical reports. Another study by Revill *et al*, (1994), which represented the first organic geochemical comparison of thermally mature and immature Tasmanite Oil Shale samples in relation with a geological evaluation of the sedimentary setting, concluded that at least some deposits of the Tasmanite Oil Shale in Tasmania are near the "oil window".

Rare (< 0.1%) microscopic oil inclusions, in fractures in samples from Hunterston-1, were also observed by Cook (2003). These inclusions apparently appear on fractures through cements in the Liffey Group. They could have emplaced at any point post deposition (i.e. post-Permian). No inclusions have been extracted to determine their source (Reid 2004). An occurrence of oil inclusions < 0.1% does not indicate a breached oil column or migration.

This assessment is based on empirical limits developed by CSIRO in their oil inclusion counting studies GOI™ (Eadington *et al*, 1996). The very low occurrence of inclusions (<0.1%) and the proximity to an intrusion suggests localised maturation of a very small amount of organic matter to the point of expulsion. Oil inclusions of <2% were also observed in the samples of the Liffey Group from Ross-1 where maturity is VR% 0.57 (Reid, 2004).

Rare oil inclusions were also observed in the Liffey Group samples from the Douglas River with a mean maturity of VR% 0.55 (range VR% 0.48-0.64), just barely at the oil window.

4.1.1 The Lonnavale Seep

The hydrocarbon show at the Lonnavale quarry is a bitumen found within joints, in the Jurassic Dolerite. The quarry is based on Jurassic dolerite which has a possible contact with a Permian mudstone, exposed in a nearby quarry, and is known, in other areas of Tasmania, to contain the Tasmanite Oil Shale (Revill, 1996). Geochemical studies were undertaken at the request of Tasmanian Development and Resources (TDR) in 1996. Two samples of possible hydrocarbons were studied. One sample was a swab of what appeared to be hydrocarbon staining and the second was a bitumen from within a fracture in the dolerite.

Seeps were examined at a quarry in Lonnavale (personal observation by P. Vytopil, 2007). The rock is a fractured dolerite, with one section of the quarry showing good oil shows with strong petroliferous odour along the fracture planes. The oil effortlessly smeared when samples were handled and left a dark reddish streak. In areas where samples were not fresh, there was a dark bituminous stain and some samples had a faint odour of H_2S.

The presence of oil shows at Lonnavale has been previously recorded by numerous authors. Bottrill (1996) provides a detailed description of oil shows along two generations of fractures within the dolerite. These factures were filled with calcite and minor globules and flecks of bitumen. The bitumen was dark brown to black, vitreous, soft and sticky on fresh surfaces, as well as hardened and dark on exposed surfaces.

Geochemical analysis indicates that the n-alkane profile from the swab sample is characteristic of a light oil or a petroleum fraction such as diesel. The sample was a stain and had a more liquid character than the bitumen sample taken (Revill, 1996). There are maturity differences between the liquid (oil) and solid (bitumen) although hydrocarbons in both samples share a similar source (Revill, 1996).

Conclusions from the geochemical reports indicate that the seep appears to have been subjected to light biodegradation and the samples taken are likely to have undergone some migration since generation from the source rock. Aromatic maturity indicators indicate that the seep was generated and expelled from a moderately mature source interval (Vitrinite Reflectance (VR_{equiv} = 0.80%) and saturated biomarker maturity indicators support this level of maturity (Wythe and Watson, 1996). Revill (1996) classifies maturity of between 0.57–0.62% for the swab sample and 0.61-0.70% for the bitumen sample.

Revill (1996) states that the source is likely to be a Permian mudstone containing Tasmanite Oil Shale and Wythe and Watson (1996) indicate that the oil seep is likely to have been derived from a mixed algal/terrestrial source containing abundant *Tasmanites* alga that was deposited in an anoxic, marine environment.

The value of VR_{equiv} = 0.80% given by Wythe and Watson (1996) is not anomalous and does fit the regional maturity trend. However, it is still difficult to assess whether this hydrocarbon was expelled as a result of localised heat from dolerite emplacement or from a more widespread burial maturation.

The models put forward by Wythe and Watson (1996) and Revill (1996) suggest that the oil seep consisted of a low sulphur oil derived from a moderately mature *Tasmanite*-rich source rock. The oil then migrated into the late stage dolerite joints when they were open. This can be supported by the data.

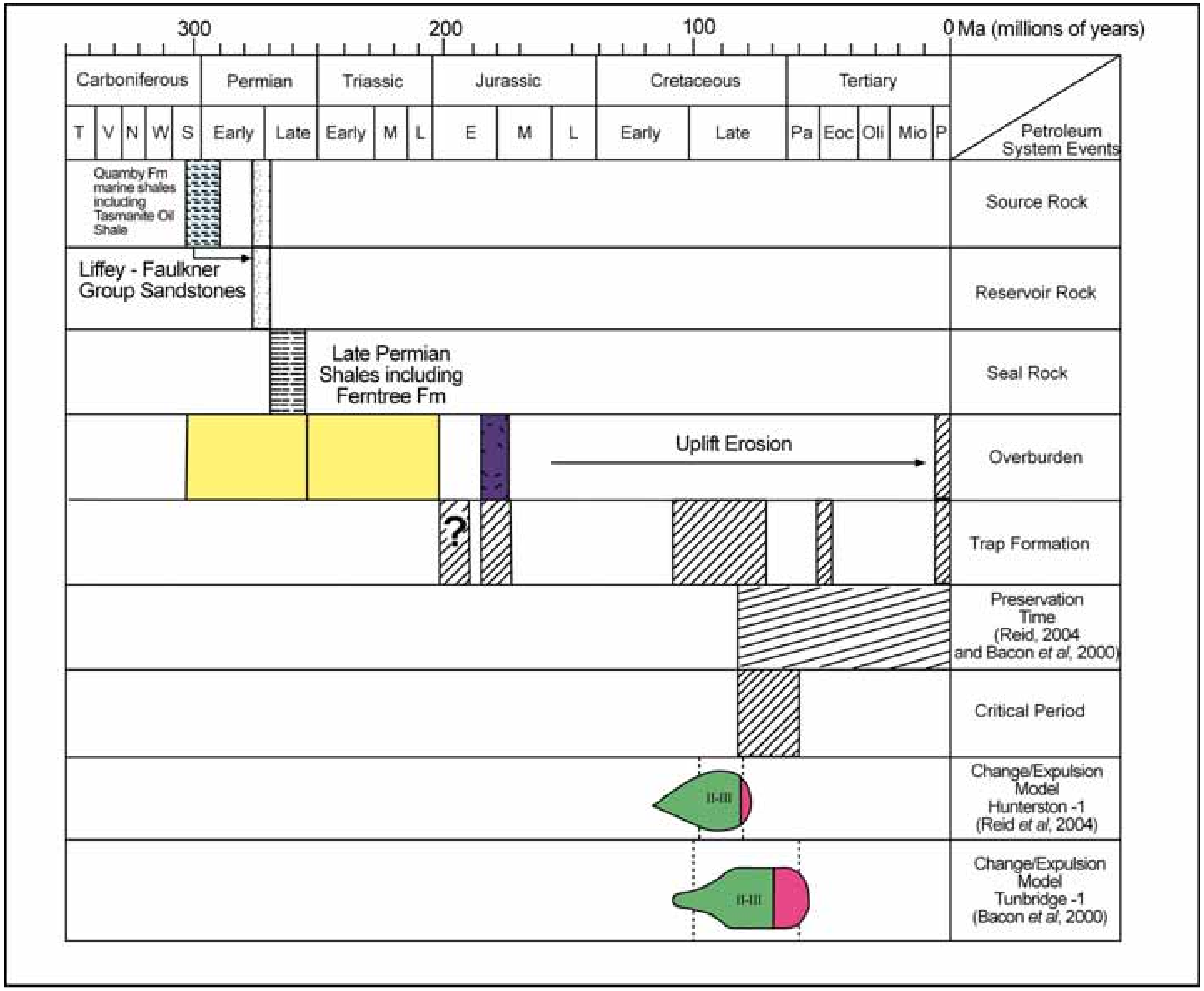

Figure 15 - Hypothetical Permian Petroleum System (modified from Wakefield, 2000)

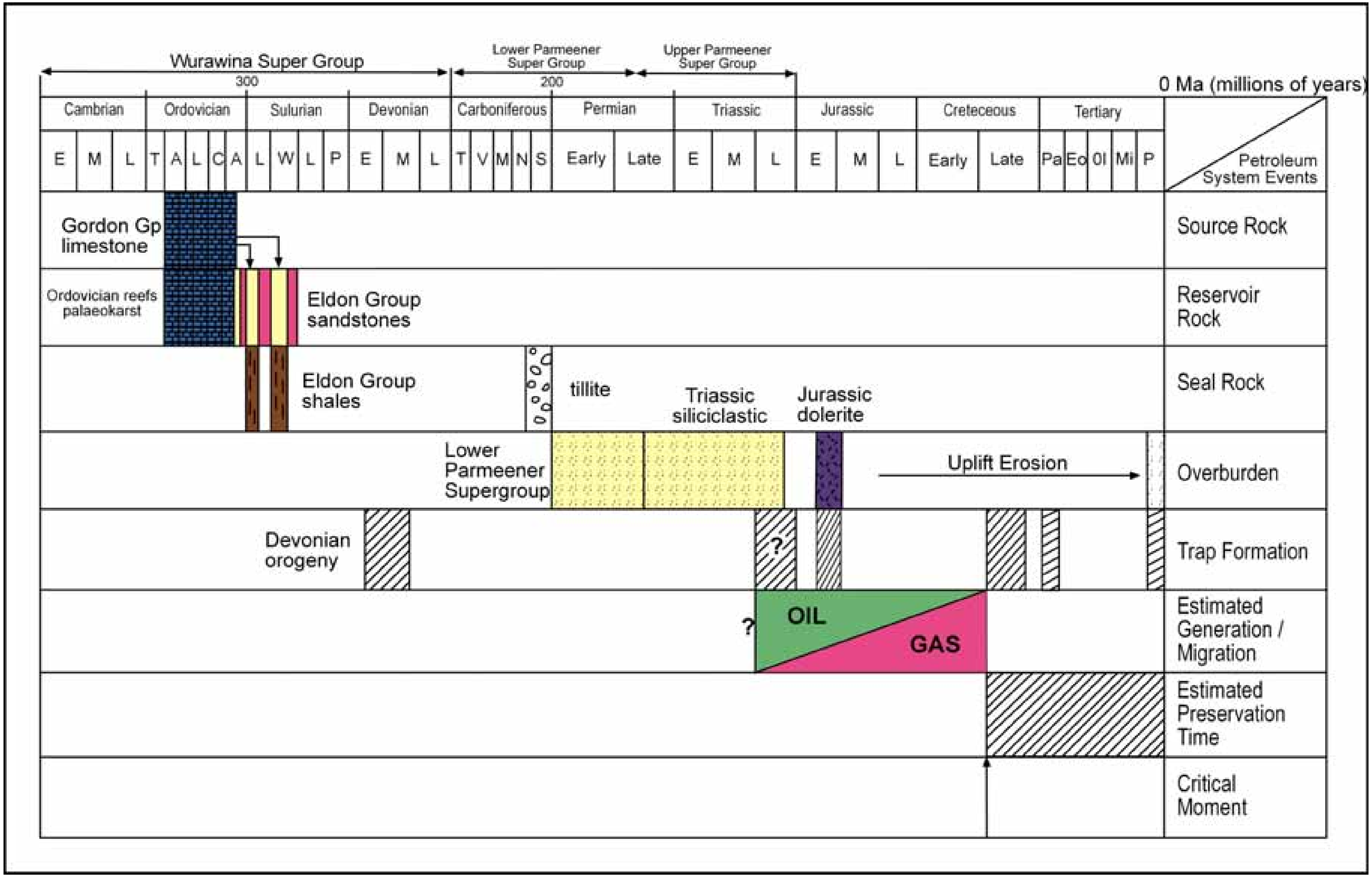

Figure 16 - Hypothetical Pre-Carboniferous Petroleum System (modified from Wakefield, 2000)