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MODELLING OF SOURCE ROCK MATURATION HISTORIES FOR 7 WELLS AND 7 PSEUDO WELLS, GIPPSLAND BASIN DEEP WATER PROJECT

ANEMONE-1A, BASKER-1, BLACKBACK-1, HERMES-1, PISCES-1, SHARK-1, VOLADOR-1 and SEVEN PSEUDO WELLS

GEOTRACK REPORT #741

A report prepared for the
The Petroleum Development Unit,
Department of Natural Resources and Environment, Victoria

Report prepared by: I. R. Duddy

March 2000

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DEEP WELL PROJECT
GIPPSLAND BASIN

Modelling of source rock maturation Histories for 7 wells and 7 Pseudo wells, Gippsland Basin Deep Water Project.

A SUMMARY REPORT

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EXECUTIVE SUMMARY

Hydrocarbon source rocks

1. Latrobe, Golden Beach Group and Emperor sub-group sediments of typical facies are most likely present within the Deep Water Acreage area and therefore the key oil source rock quality and type factors considered necessary for oil accumulations elsewhere in the basin should not be a significant risk factor for hydrocarbon prospectivity in this area.

2. No direct evidence is available for source rock type and quality from the fluviatile sediments of the Early Cretaceous Strzelecki Group. However, by analogy with equivalent stratigraphic units in the Otway Basin (Eumeralla Formation of the Otway Group), suitable oil source rocks are assumed to be present within the Strzelecki Group.

Mid-Santonian uplift and erosion

3. Significant uplift and erosion has been identified on seismic only with the mid-Santonian (~80 Ma) unconformity. For most locations in the Deep Water Acreage uplift and erosion is less than ~400 m and this has little effect on the maturation history. At Pseudo well locations 3 and 5 (Figure 1.1) greater uplift and erosion is identified (up to 1500 m), but even at these locations, the interplay of burial and thermal histories are such that the entire section in these wells reaches maximum maturity at the present-day.

Active hydrocarbon generation

Emperor sub-Group and Golden Beach Group source rock maturation

4. Heat flow is assumed to be declining during deposition of the Emperor sub-Group and Golden Beach Group so that during the initial burial phase, the stratigraphic section may actually be cooling during burial, prior to rapid heating as increasing burial overtakes the cooling effect of basal heat flow decline.

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5. In areas with significant uplift at 80 Ma (e.g. Pseudo well locations 3 and 5), active hydrocarbon generation from the Emperor sub-Group pauses, but essentially continuous burial throughout the deep water area since ~80 Ma means that generation recommences during the Tertiary burial phase.

6. At the locations analysed in this report, source rock horizons within the Emperor sub-Group and Golden Beach Group are best placed to generate oil (from the assumed Type II source rock) from the Late Tertiary to the present-day (Figure i). This timing being the most favourable to charge the youngest structural traps.

Strzelecki Group source rock maturation

7. The interaction of the burial and rift-related thermal histories provide the prime control on the hydrocarbon source rock maturation and generation histories of the Strzelecki Group.

8. Elevated heat flow during the Early Cretaceous results in an episode of hydrocarbon generation from the Strzelecki Group prior to 95 Ma. Decline in elevated heat flow between 95 and 80 Ma, results in a variable period of time during which active hydrocarbon generation pauses due to cooling of the section. The length of this pause depends on the interplay between the rate of deposition of the Emperor sub-Group and Golden Beach Group and the decline in basal heat flow. For example, in areas of the basin accumulating thick Emperor sub-Group, the period of cooling is short and heating and active hydrocarbon generation recommences during deposition of the Emperor sub-Group (e.g. Pseudo well location 1). At such locations, most or all of the Strzelecki Group's oil potential is exhausted in the mid to Late Cretaceous (Figure ii).

9. In areas of thin Emperor sub-Group and Golden Beach Groups, or where there have been some uplift and erosion at the end of Golden Beach Group deposition, two periods of cooling, with an intervening period of minor heating may be created (e.g. Pseudo well locations 3 and 5). At such locations, active hydrocarbon generation from Strzelecki Group source rocks may not recommence until well into the Tertiary (Figure ii). In areas of significant uplift at either 95 Ma or 80 Ma, Tertiary sediment thickness may be insufficient to raise temperatures of Strzelecki Group source rocks above those experienced in the Early Cretaceous, such that active hydrocarbon generation never recommences (e.g. onshore Strzelecki Group outcrops).

Latrobe Group source rock maturation

10. Heat flow is assumed to be constant during deposition of the Latrobe Group, so that the heating is more or less continuous as a result of increasing burial. At all Deep Water Acreage locations analysed in this report, source rock horizons within the Latrobe Group do not reach sufficient maturity to generate significant oil from the assumed Type II source rock at any time since deposition.

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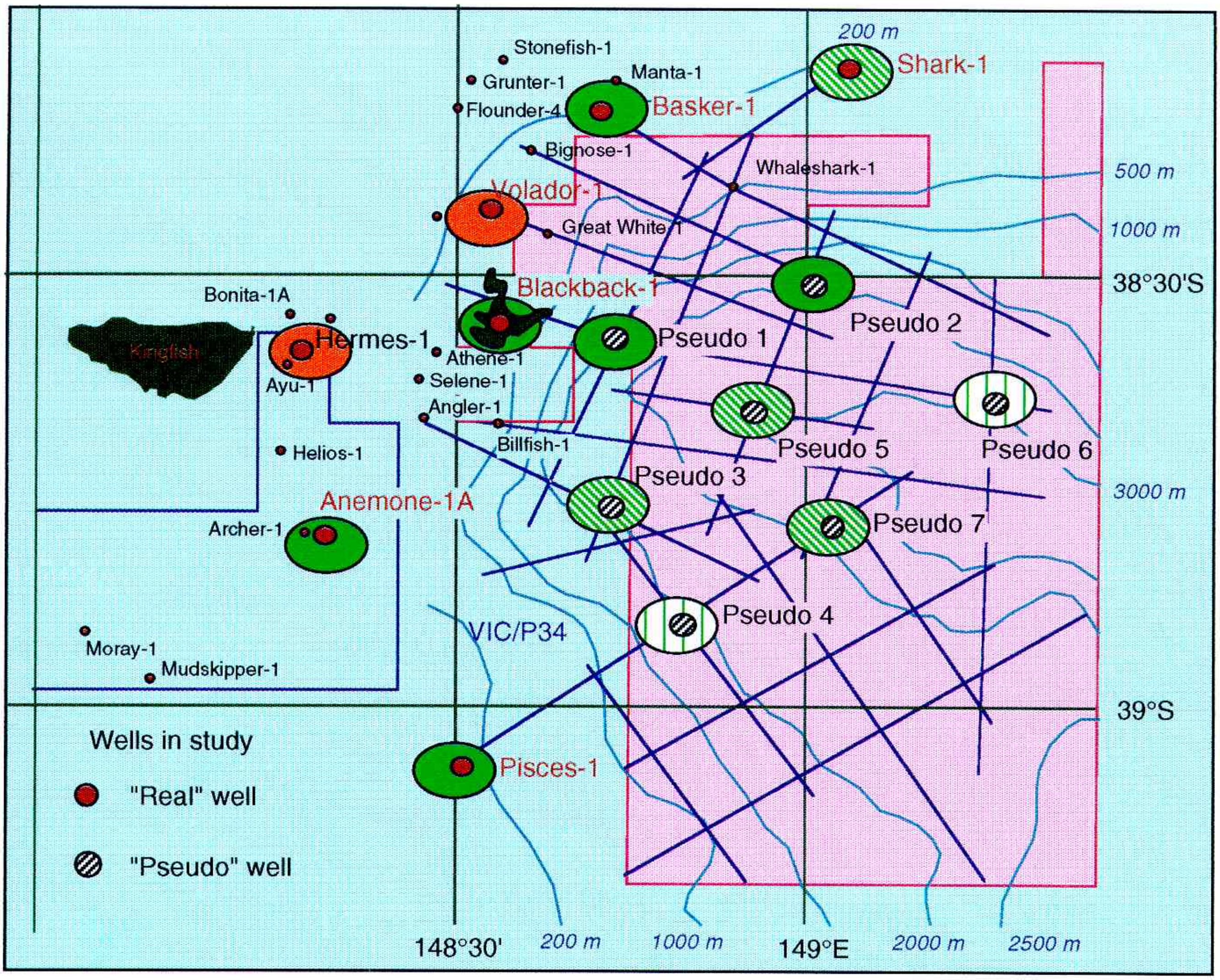
Late Tertiary "In situ Oil" Generation from the Emperor sub-Group, Golden Beach Group and Latrobe Group



Golden Beach Group and Latrobe Group source rocks

Late Tertiary - Recent generation: Golden Beach and Latrobe Groups (none from Emperor sub-Group)

Emperor sub-Group and Golden Beach Group source rocks

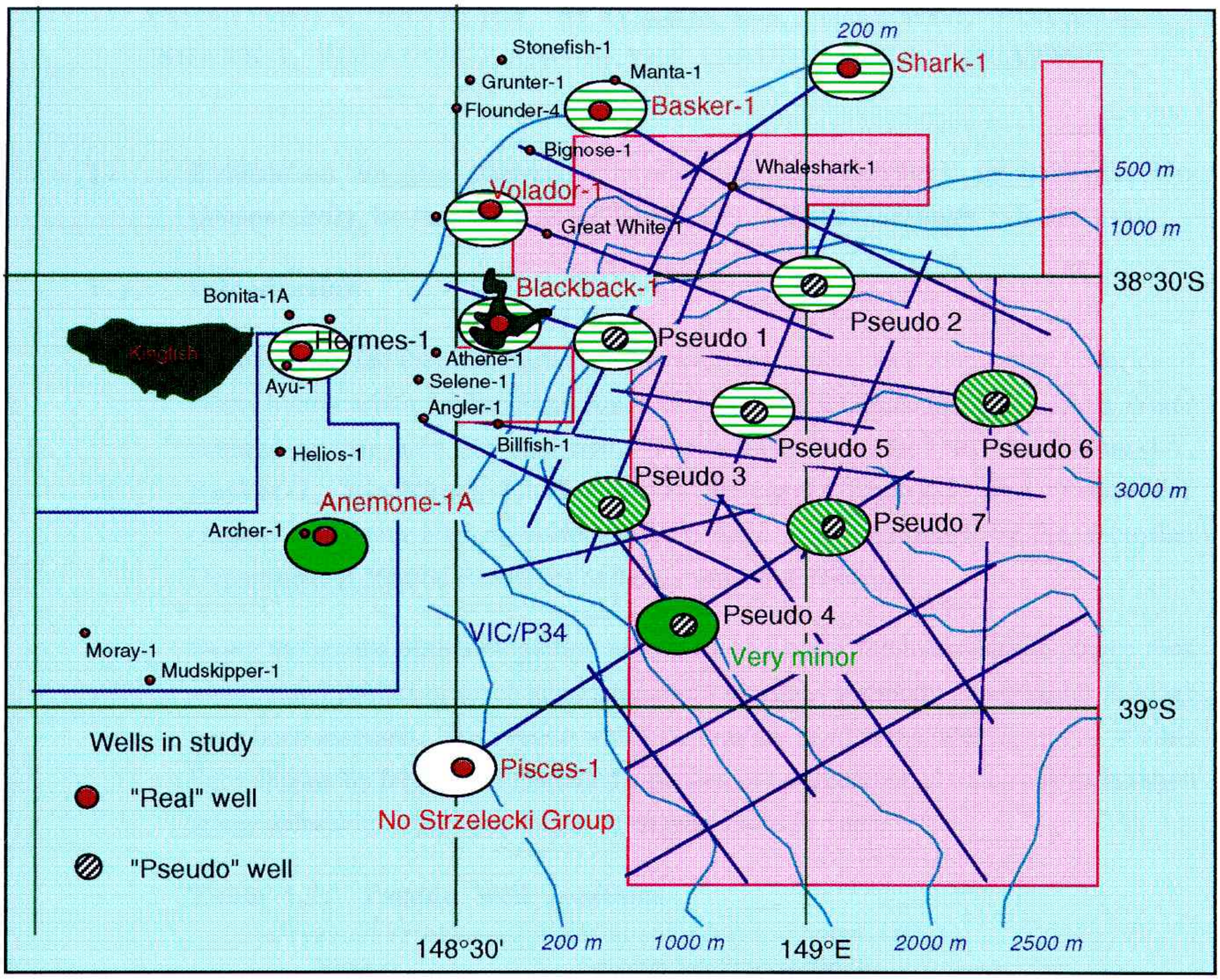
Late Tertiary - Recent generation: Emperor sub-Group and deeper Golden Beach Group

Late Tertiary - Recent generation: deeper Emperor sub-Group only

No generation (at any time)

Figure i: Predicted generation of "in situ oil" from a Type II kerogen for the Emperor sub-Group and Golden Beach Group. For the regional thermal history models used, Late Tertiary generation occurs more prevasively through the stratigraphic section in the north-west of the Deep Water Acreage. See Figures 8.1 to 8.7 for more details of the generation of "in situ oil" with time for the stratigraphic sections at individual Pseudo well locations.

"In situ Oil" Generation from the Strzelecki Group



Strzelecki Group source rocks

- Late Tertiary - Recent generation only from the Strzelecki Group
- Late Tertiary - Recent and mid-Cretaceous generation from the Strzelecki Group
- Mid-Cretaceous to mid-Tertiary generation (no Late Tertiary) from the Strzelecki Group
- No generation

Figure i: Predicted generation of "in situ oil" from a Type II kerogen for the Strzelecki Group for two key time periods in the Gippsland Basin thermal history: Late Tertiary and mid-Cretaceous. Late Tertiary generation is conisdered to be more favourable for the preservation of Strzelecki-sourced oil.

See Figures 8.1 to 8.7 for more details of the generation of "in situ oil" with time for the stratigraphic sections at individual Pseudo well locations.

MODELLING OF SOURCE ROCK MATURATION HISTORIES FOR 7 WELLS AND 7 PSEUDO WELLS, GIPPSLAND BASIN DEEP WATER PROJECT

ANEMONE-1A, BASKER-1, BLACKBACK-1, HERMES-1, PISCES-1, SHARK-1, VOLADOR-1 AND SEVEN PSEUDO WELL LOCATIONS

1. Evaluation on the thermal history and its relevance to hydrocarbon prospectivity in the Gippsland Basin Deep Water acreage release area

1.1 Introduction

In this report, the thermal, burial and hydrocarbon source rock maturation histories of seven hydrocarbon explorations wells adjacent to the Gippsland Basin Deep Water acreage release area are analysed. The real wells studied are **Anemone-1A, Basker-1, Blackback-1, Hermes-1, Pisces-1, Shark-1 and Volador-1** (Figure 1.1), with all data collected from open files maintained by the Victorian Department of Natural Resources and Environment (DNRE).

Using the results of this modelling procedure as a basis, the hydrocarbon source rock maturation histories of seven key Pseudo well locations within the Deep Water Acreage have been assessed. The Pseudo well locations are sited at the intersection of seismic lines chosen by DNRE to illustrate the pattern of hydrocarbon source rock maturation at key areas within the Deep Water acreage as listed in Table 1.1.

Table 1.1: Pseudo well locations

Well	Seismic line intersections
Pseudo well-1:	G92A-3050 and GDW99-04
Pseudo well-2:	GDW99-02 and GDW99-17
Pseudo well-3:	G92A-3076 and GDW99-18
Pseudo well-4:	GDW99-12 and GDW99-08
Pseudo well-5:	GDW99-17 and GDW99-05
Pseudo well-6:	GDW99-04 and GDW99-15
Pseudo well-7:	GDW99-08 at shot point 2000

The Real and Pseudo well locations are shown in Figure 1.1

Modelling results for each well location are presented as a series of figures in the following sections.

1.2 Aims and objectives

The principle aim of this study was to evaluate the thermal, source rock maturation and hydrocarbon generation history in the proposed Gippsland Deep Water Acreage Release Area and vicinity.

More specifically, key objectives of this study were :

1) To use open file VR results (and AFTA results in the case of Anemone-1A) available from DNRE for key wells adjacent to the Gippsland Deep Water Acreage Release Area to evaluate the timing and magnitude of thermal episodes responsible for hydrocarbon generation from potential source rocks.

2) To use the thermal history information obtained from the key well evaluation combined with regional information to infer the hydrocarbon generation history at key Pseudo well locations within Gippsland Deep Water Acreage Release Area.

1.3 Report Structure

The main conclusions of this report are provided in point form in the Executive Summary, and in two schematic maps in Figures i to ii.

A summary of the thermal, burial, source rock maturation and hydrocarbon generation history interpretations for individual wells is provided in a number of comprehensively captioned figures in Sections 7 and 8.

Section 2 briefly explains the principles of interpretation of AFTA and VR data. A brief geological history of the Gippsland Basin relevant to the evolution of the thermal history in the region is provided in Section 3 and a summary of the regional thermal history is provided in Section 4. Section 5 gives a brief introduction to Gippsland basin hydrocarbon source rock types and Section 6 provides background information on the basin modelling approach used in this report.

Section 7 deals, in turn, with the results from each of the seven real wells; Anemone-1A, Basker-1, Blackback-1, Hermes-1, Pisces-1, Shark-1 and Volador-1. Interpretation of the thermal, burial and hydrocarbon generation histories at the seven Pseudo well locations are discussed in Section 8.

Supporting information and data are provided in Appendix A.

1.4 Present-day temperatures

In the application of any technique involving estimation of paleotemperatures, it is critical to control the present temperature profile, since estimation of maximum paleotemperatures proceeds from assessing how much of the observed effect could be explained by the magnitude of present temperatures.

Raw BHT data from each of the wells are corrected using a simplified correction procedure adapted from that of Andrews-Speed et al. (1984) as described in Appendix A. Present-day geothermal gradients determined from corrected BHT data are discussed in detail in Appendix A, with a summary of linear values given in Table 1.2.

Table 1.2: Present-day geothermal gradient summary

Well	Present-day*1 geothermal gradient (°C/km)
Anemone-1A	25.0*2
Basker-1	37.0
Blackback-1	27.7
Hermes-1	35.4
Pisces-1	34.6
Shark-1	35.9
Volador-1	36.7

*1 Estimated from corrected BHT data and a present-day sea bed temperature of 10°C.
*2 Revised lower from 28.9°C/km from BHT data based on AFTA results - see Appendix A.

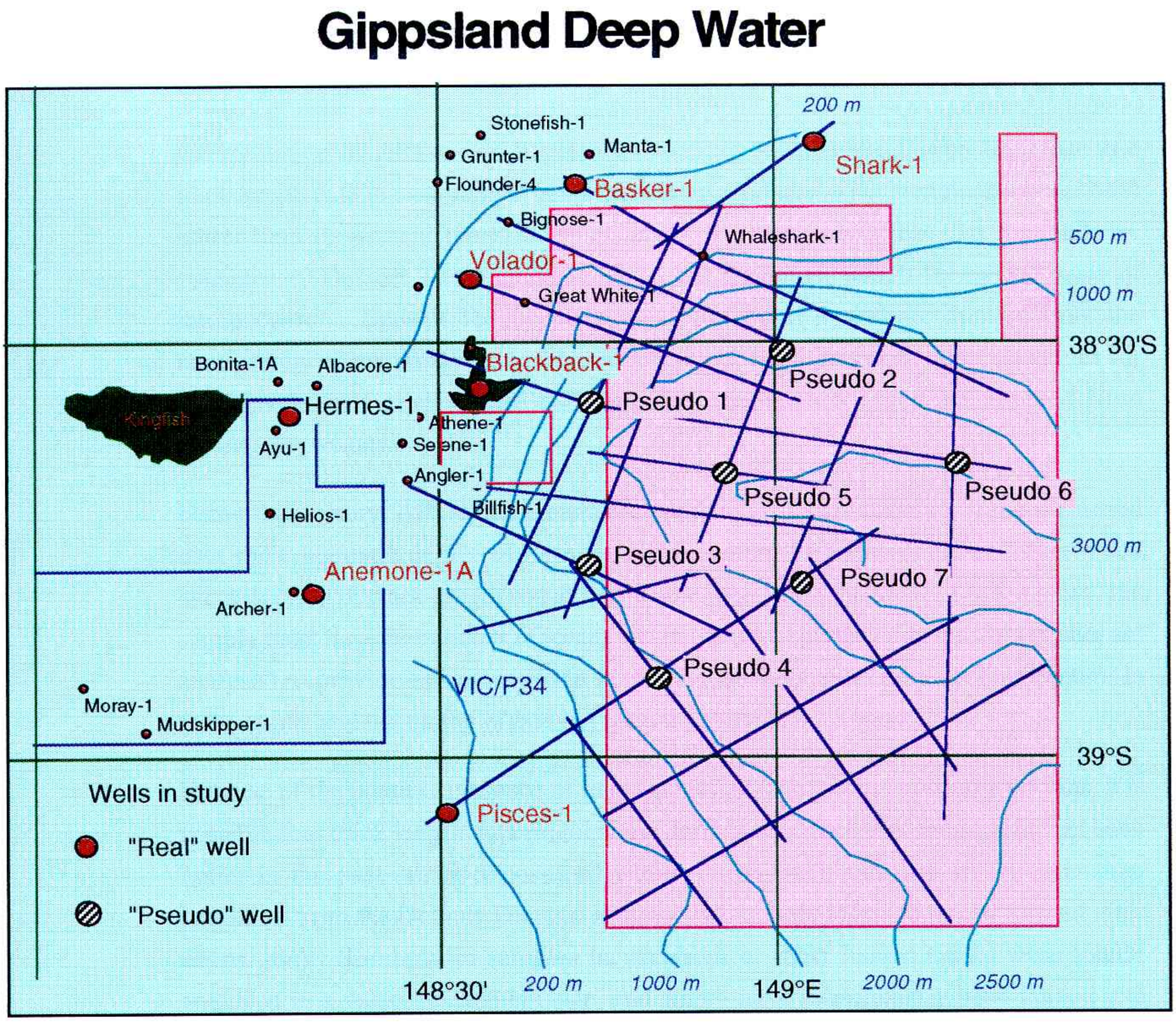


Figure 1.1: Location of real wells and pseudo wells analysed in this report, Gippsland Deepwater Project.

2. Interpretation strategy

2.1 Thermal history interpretation of AFTA data

Basic principles

Interpretation of AFTA data begins by assessing whether the fission track age and track length data in each sample could have been produced if the sample has never been hotter than its present temperature at any time since deposition. To this end, we consider a "Default Thermal History" for each sample, which forms the basis of interpretation. Default Thermal Histories throughout a well are derived from the stratigraphy of the preserved sedimentary section, combined with constant values for paleogeothermal gradient and paleo-surface temperature which are adopted from present-day values.

Using this history, AFTA parameters are predicted for each sample. If the measured data show a greater degree of fission track annealing (in terms of either fission track age reduction or track length reduction) than expected on the basis of this history, the sample must have been hotter at some time in the past. In this case, the AFTA data are analysed to provide estimates of the magnitude of the maximum paleotemperature in that sample, and the timing of cooling from the thermal maximum.

Because of the possible presence of tracks inherited from sediment source terrains, it is possible that track length data might show definite evidence that the sample has been hotter in the past (since deposition) while fission track ages are still greater than predicted from the Default Thermal History (which only refers to tracks formed after deposition). Similarly in samples in which all or most fission tracks were totally annealed in a paleo-thermal episode, and which have subsequently been cooled and then reburied, fission track age data might show clear evidence of exposure to higher temperatures in the past while track length data may be dominated by the present-day thermal regime and will not directly reveal the paleo-thermal effects. In circumstances such as these, evidence from either track length or fission track age data alone is sufficient to establish that a sample has been hotter in the past.

As AFTA data provide no information on the *approach* to a thermal maximum, they cannot independently constrain the heating rate and a value must therefore be assumed in order to interpret the data. The resulting paleotemperature estimates are therefore conditional on this assumed value. AFTA data do provide some control on the history after cooling from maximum paleotemperatures, through the lengths of tracks formed during this period.

Wherever possible, data from each sample are normally interpreted in terms of two episodes of heating and cooling, using assumed heating and cooling rates during each episode. The maximum paleotemperature is assumed to be reached during the earlier episode. The timing of the onset of cooling and the peak paleotemperatures during the two episodes are varied systematically, and by comparing predicted and measured parameters the range of conditions which are compatible with the data can be defined. One additional episode during the cooling history is the limit of resolution from typical AFTA data. Alternatively, if the data can be explained by a single episode of heating and cooling, then a heating rate is assumed and the range of values of maximum paleotemperature and the time of cooling is defined as before.

If AFTA data show a lower degree of fission track annealing (age and/or length reduction) than expected on the basis of the Default Thermal History, this either suggests present temperatures may be overestimated or temperatures have increased very recently. In such cases, the data may allow a more realistic estimate of the present temperature, or an estimate of the time over which temperatures have increased.

AFTA data are predicted using a multi-compositional kinetic model for fission track annealing in apatite developed by Geotrack which is not described in detail here.

Specific to this report

AFTA results were only available from Anemone-1A for this study (Geotrack Report #198, 1989) and these enabled a moderate revision of the present-day geothermal gradient to be made (See Section 4). No AFTA results were available from other real wells. While AFTA data would be desirable as a calibration for the VR results in these other wells, it is felt that the interpretations based on the VR results alone provide adequate constraints on the thermal history for this reconnaissance study.

2.2 Thermal history interpretation of VR data

Basic principles

Vitrinite reflectance is a time-temperature indicator governed by a kinetic response in a similar manner to the annealing of fission tracks in apatite. Interpretation of VR data follows similar principles to those used in interpreting the AFTA data (Section 2.1). If a measured VR value is higher than the value predicted from the Default Thermal History (making due allowance for analytical uncertainty), the sample must have been hotter at some time in the past. In this case, VR data provide an independent estimate of maximum paleotemperature, which can be calculated using an assumed heating rate and timing information provided from AFTA data, if available (assumed, otherwise). Cooling rates do not significantly affect VR data, which are dominated by the maximum paleotemperature provided that cooling occurs immediately after reaching the thermal maximum. If both AFTA and VR data are available from the same sample or well, then an identical heating rate must be used to obtain consistent paleotemperature estimates.

If a measured VR value is lower than expected on the basis of the Default Thermal History, either present temperatures may have been overestimated or temperatures have increased very recently. In such cases, the measured VR value may allow an estimate of the true present-day temperature. Alternatively the measured VR value may underestimate the true maturity for some other reason, e.g., suppression of reflectance in certain organic macerals, misidentification of true "in-situ" vitrinite, presence of caved material etc. Comparison of AFTA and VR data usually allows such factors to be identified, and where applicable they are discussed in the relevant section of text.

Vitrinite reflectance data (specifically $R_o$max values) are predicted using the distributed activation energy model describing the evolution of VR, with temperature and time developed by Burnham and Sweeney (1989) (see also Sweeney and Burnham, 1990).

Specific to this report

In general terms, measured vitrinite reflectance data in all of the real wells are consistent with the profile predicted from the respective Default Thermal Histories (see Section 4). In such cases, the data provides no information on the paleo-thermal history at the respective wells sites, indicating simply that the sampled sections are currently at the maximum temperatures reached at any time since deposition.

2.3 Comparison of paleotemperature estimates from AFTA and VR

Maximum paleotemperatures derived from AFTA and VR ($R_o$max) using the strategies outlined above are usually highly consistent. Estimates of maximum paleotemperature from AFTA are often quoted in terms of a range of paleotemperatures, as the data can often be explained by a variety of scenarios. Paleotemperature estimates from VR are usually quoted to the nearest degree Celsius, as the value which predicts the exact measured reflectance. This is not meant to imply VR data can be used to estimate paleotemperatures to this degree of precision. VR data from individual samples typically show a scatter equivalent to a range of between ±5 and ±10°C. Estimates from a series of samples are normally used to define a paleotemperature profile in samples from a well, or a regional trend in paleotemperatures from outcrop samples.

Specific to this report

Maximum paleotemperatures are not specifically estimated from either AFTA or VR in this report, as the basic VR measurements in all wells are consistent with maximum paleotemperatures being reached at the present-day. In such cases, no *paleo-thermal history* information are available from the AFTA or VR data.

2.4 Paleogeothermal gradients

Basic principles

A series of paleotemperature estimates from AFTA and/or VR over a range of depths can be used to reconstruct a paleotemperature profile through the preserved section. The slope of this profile defines the paleogeothermal gradient. As explained by Bray et al. (1992), the shape of the paleotemperature profile and the magnitude of the paleogeothermal gradient provides unique insights into the origin and nature of the heating and cooling episodes expressed in the observed paleotemperatures.

Linear paleotemperature profiles with paleogeothermal gradients close to the present-day geothermal gradient provide strong evidence that heating was caused by greater depth of burial with no significant increase in basal heat flow, implying in turn that cooling was due to uplift and erosion. Paleogeothermal gradients significantly higher than the present-day geothermal gradient suggest that heating was due, at least in part, to increased basal heat flow, while a component of deeper burial may also be important as discussed in the next section. Paleogeothermal gradients significantly lower than the present-day geothermal gradient suggest that a simple conductive model is inappropriate, and more complex mechanisms must be sought for the observed heating. One common cause of low paleogeothermal gradients is transport of hot fluids shallow in the section. However, the presence of large thicknesses of sediment with uniform lithology dominated by high thermal conductivities can produce similar paleotemperature profiles and each case has to be considered individually.

A paleotemperature profile can only be characterised by a single value of paleogeothermal gradient when the profile is linear. Departures from linearity may occur where strong contrasts in thermal conductivities occur within the section, or where hot fluid movement or intrusive bodies has produced localised heating effects. In such cases a single value of paleogeothermal gradient cannot be calculated. However, it is important to recognise that the validity of the paleotemperatures determined from AFTA and/or VR are independent of these considerations, and can still be used to control possible thermal history models.

Estimation of paleogeothermal gradients in this report

Paleogeothermal gradients were not estimated for this report as the sampled sections in each well are currently at their maximum temperatures for any time since deposition.

2.5 Eroded section

Basic principles

Subject to a number of important assumptions, extrapolation of a linear paleotemperature profile to a paleo-surface temperature allows estimation of the amount of eroded section represented by an unconformity.

Specifically, this analysis assumes:

- The paleotemperature profile through the preserved section is linear;
- The paleogeothermal gradient through the preserved section can be extrapolated linearly through the missing section;
- The paleo-surface temperature is known; and,
- The heating rate used to estimate the paleotemperatures defining the paleogeothermal gradient is correct.

It is important to realise that any method of determining the amount of eroded section based on thermal methods is subject to these and/or additional assumptions. For example methods based on heat-flow modelling must assume values of thermal conductivities in the eroded section, which can never be known with confidence. Such models also require some initial assumption of the amount of eroded section to allow for the effect of compaction on thermal conductivity. Methods based on geothermal gradients, as used in this study, are unaffected by this consideration, and can therefore provide independent estimates of the amount of eroded section. But these estimates are always subject to the assumptions set out above, and should be considered with this in mind.

The analysis used to estimate paleogeothermal gradients is easily extended to provide maximum likelihood values of eroded section, for an assumed paleo-surface temperature, together with ±95% confidence limits. These parameters are quoted for the specific paleo-thermal episodes in which the paleotemperature profiles suggest that past heating may have been due, at least in part, to deeper burial. However, it is emphasised that such interpretations are not unique, and alternative interpretations are always possible. For instance, where the eroded section was dominated by units with high thermal conductivities the paleogeothermal gradient through the missing section may have been much higher than in the preserved section, and extrapolation of a linear gradient will lead to overestimation of the eroded section.

Estimation of eroded section in this report

Removed section was not estimated for any **Real well** in this report as the sampled sections in each well are currently at their maximum temperatures for any time since deposition, and thus the AFTA and VR data provide no evidence for any cooling episodes that might be attributed to uplift and erosion.

Estimates of removed section for each **Pseudo well** location were determined from seismic sections by David Wong of DNRE. The potential for significant uplift and erosion was only observed for the top-Golden Beach Group unconformity (see Section 3). A range of estimates were provided for each Pseudo well as listed in Table 2.1.

Table 2.1: Uplift and erosion on the top-Golden Beach Group (80 Ma) unconformity estimated from seismic (provided by David Wong, DNRE).

Location (m)	Uplift and erosion
Pseudo-1	200 - 400
Pseudo-2	200 - 400
Pseudo-3	750 - 1500
Pseudo-4	0 - 200
Pseudo-5	500 - 1000
Pseudo-6	0 - 200
Pseudo-7	0 - 200

3. A brief geological and tectonic history of the Gippsland Basin

A generalised stratigraphic and tectonic column for the Gippsland Basin is presented in Figure 3.1.

3.1 Jurassic-Cretaceous Rifting

From the Latest Jurassic (~145 Ma) to mid-Cretaceous (~95 Ma), the Gippsland Basin was part of a major continental rift system stretching across what is now southern Australia. These rift basins, with typical half-graben geometries accumulated non-marine sediments, ranging from alluvial fan, through fluvial to lacustrine, up to 6 km (and perhaps more) kilometres thick. In the Gippsland Basin, these sediments are known as the Strzelecki Group.

The key characteristic of Strzelecki Group non-marine sediments is that they are dominantly composed of quartz-poor detritus, mostly rock fragments, derived from contemporaneous dacitic volcanism. However, volcanic detritus is less abundant near basin margins where quartz-rich sandstones and conglomerates derived from Paleozoic rocks form alluvial fans (e.g. Tyers Group).

3.2 Mid-Cretaceous tectonism (~95 Ma): Southern Ocean episode

At the end of the Early Cretaceous, at ~95 Ma, to the west of approximately 147° 30' E Longitude, major tectonic rearrangements resulted in large scale uplift and erosion of the Strzelecki Group and some areas of basin margin Paleozoic rocks (Duddy and Green, 1992). This region encompasses the major domal uplifts of outcropping Strzelecki Group in the Strzelecki Ranges, and the southern margin uplifts of Paleozoic rocks - Cape Woolamai, Cape Liptrap and the eastern-most uplift on the Bassian rise, in the vicinity of the Groper-1 well. Other workers (eg Lowry, 1985; Lowry and Longley, 1987) have considered that the Gippsland Basin did not experience this "Southern Ocean" tectonic episode, instead attributing post-Strzelecki Group tectonism to a Campanian (~80 Ma) event related to the opening of the Tasman Sea. Fission track results from the region show, in fact, that both events, each represented by high magnitude uplift and erosion, are present in Gippsland; the "Tasman Sea" episode being restricted to the north-eastern and eastern margins of the basin, and the Southern Ocean episode is restricted to the far western, north-western and south-western margins of the Gippsland Basin (Duddy and Green, 1992).

Most of these uplifted blocks have remained largely positive features since 95 Ma, and most have been reactivated at least once during the Tertiary. The segmented Bassian Rise uplifts are an exception, in that these Paleozoic blocks subsided again in the

Eocene as the southern Strzelecki Terrace was incorporated into the widening Gippsland Basin.

This strong "Southern Ocean" event did not effect the Strzelecki Group section within the Central Deep of the Gippsland Basin where everywhere it is interpreted (seismic) to be overlain by the Strzelecki Group, of Turonian (91 - 87 Ma), or older age (P. mawsonii, or older). The boundary between the Strzelecki Group and Emperor sub -Group in the Central Deep appears to be either conformable, or to be only mildly erosional. Recent revisions of the Cretaceous stratigraphy (A. Partridge, unpublished) suggest that a time gap representing the entire Cenomanian (~97.5 to 91 Ma) may be present in both the Gippsland and Otway Basins, but even if such a time gap exists, the geological evidence suggests that it is most likely a period of non-deposition or only very minor erosion. Certainly these is no evidence of the kilometre-scale erosion with an associated 40 Ma time gap that characterises the boundary between the Strzelecki Group and the Latrobe Group (or younger sediments) in the western part of the basin.

The Southern Ocean event also marks the simultaneous cessation of explosive volcanism throughout the Southern Margin Rift System and results in a fundamental change in sediment detritus from the labile volcanic-lithics of the Strzelecki Group to more stable, terrigenous quartzose material derived from surrounding Paleozoic terrains that characterise the Emperor, Golden Beach and Latrobe Groups during the Late Cretaceous and Tertiary.

3.3 Late Cretaceous deposition (~95 to 80 Ma): Emperor Sub-Group and Golden Beach Group

As mentioned above, recent biostratigraphic studies suggest a time break of up to ~6.5 Ma between the Strzelecki Group and the overlying Emperor sub-Group. The Emperor sub-Group as currently defined (informal) is known only from a limited number of well intersections in areas outside the central deep of the Gippsland Basin. The basal unit may either be an un-named non-marine sandstone or a dark shale, the Kipper Shale, considered to be a deep water lacustrine deposit. As defined, the Emperor sub-Group is entirely within the P. mawsonii zone, of Turonian age (~91 to 89 Ma).

The upper boundary of Emperor sub-Group is also considered to be an unconformity, with a minor time gap representing most of the Coniacian and the basal Santonian (~89 to 86 Ma), to the overlying Chimeara Sandstone of the Golden Beach Group. The remainder of the Golden Beach Group consists of a series of non-marine deltaic sandstone, siltstones and shales ranging in age from Early Santonian to Early Campanian (~86 to 80 Ma ; T. apoxyexinus and N. senectus zones).

It should be noted, that the limited sampling of the Emperor sub-Group and Golden Beach Group means it is possible that deposition in the Central Deep was more or less continuous through the Albian to Santonian and even minor unconformable relationships are restricted to marginal areas of the basin.

Marine sediments first appear in wells at the eastern end of the Gippsland Basin in the Campanian, and this is interpreted to have followed immediately upon the initial opening of the Tasman Sea, coeval with major uplift and erosion of the eastern end of the Gippsland Basin. Basaltic lavas are present throughout the Campanian section in a number if wells, particularly in the northern Strzelecki Terrace area. These lavas are also represented onshore by a series of dykes and plugs that intrude the outcropping Strzelecki Group. These lavas are also considered to reflect local volcanism associated with the opening of the Tasman Sea.

3.4 Late Cretaceous tectonism (~80 Ma): Tasman Sea episode

The end of Golden Beach Group deposition is marked by major uplift and erosion in the northern Strzelecki Terrace area and the eastern end of the basin, interpreted to be a consequence of opening of the Tasman Sea (Lowry, 1985; Lowry and Longley, 1987; Duddy and Green , 1992; Megallaa, 1993).

As noted above however, this event appears to been of only limited importance in the Central Deep of the basin, where deposition through the Cretaceous is essentially continuous.

3.5 Late Cretaceous - Eocene deposition (~80 to 35 Ma): Latrobe Group

Dominantly quartzose terrigenous sediments of the Latrobe Group were supplied to the basin following Tasman Sea opening in the Campanian and the onset of carbonate sedimentation in the Oligocene. The Latrobe Group hosts the majority of the commercial hydrocarbon discoveries in the basin.

Only minor uplift and erosional events and periods of channelling, possibly related to fluctuation of sea-level, have affected the basin during the Tertiary, such that the overall pattern of sedimentation throughout the basin is one of essentially continuous burial. This is not to say that these erosional and channelling events are not extremely important in hydrocarbon exploration, but rather it is emphasised only that they have a minor impact on the burial and thermal histories and the *generation* of hydrocarbons.

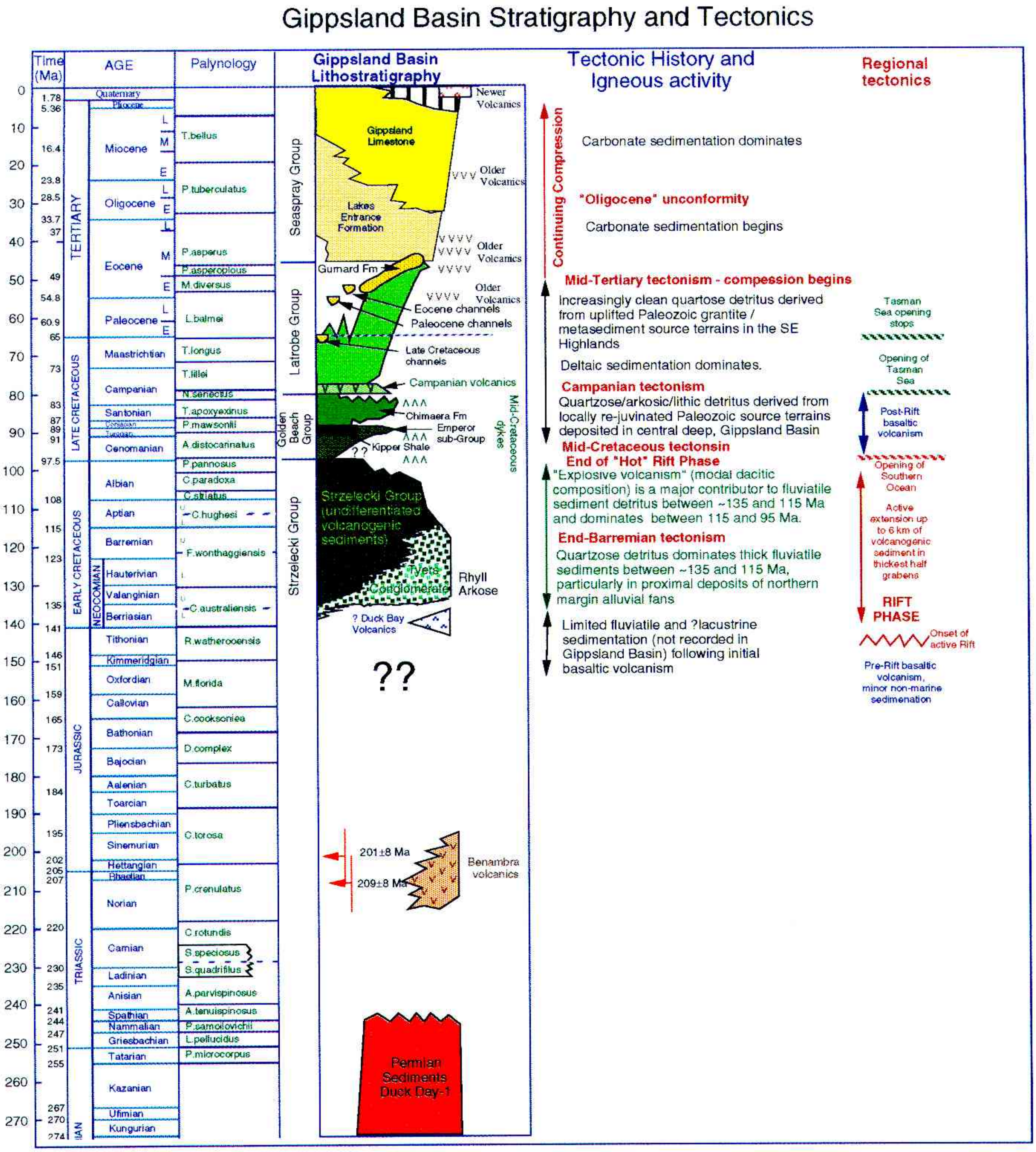


Figure 3.1: Generalised litho- and chronostratigraphy of the Gippsland Basin, with notes on recognised tectonic events and associated sedimentation (after Duddy, in prep). Jurassic and Early Cretaceous lithostratigraphy after Duddy (in prep.). Time scale after AGSO (1995).

4. Regional thermal history considerations

Based on the regional thermal history derived from analysis of AFTA and VR results from Gippsland Basin outcrops and wells (Duddy et al;, 1991; Duddy and Green, 1992; unpublished results), the following regional thermal history has been defined:

1. Heat flow at the beginning of rifting was similar to present-day levels.
   (Rifting is assumed to have commenced at ~145 Ma)

2. Heat flow at ~95 Ma was approximately double present-day levels.
   (That is, heat flow reached a peak at the end of Strzelecki Group deposition, which is also considered to represent the end of the thermal rift phase).

3. Heat flow began to decline rapidly at 95 Ma, reaching present-day levels by 80 Ma.
   (That is, heat flow during deposition of the Golden Beach Group was in decline, consistent with the Gippsland basin during this time as a "strike-slip" basin that was not undergoing active, rift-related extension).

4. Heat flow from 80 Ma to the present day is assumed to have been the same as measured at the present-day in the individual wells.
   (That is, heat flow during deposition of the Latrobe and Seaspray Group was constant and therefore heating of the stratigraphic section during this time was simply due to burial).

5. Gippsland Basin source rock type and quality

5.1 Introduction

Recent summaries of source rock type and quality in the Gippsland Basin have been given by Esso in Rahmanian et al. (1990), and Moore et al. (1992) and in Shell Report SDA 901, Vic/P21 (1989; Open File DNRE). Most studies have concentrated on the Late Cretaceous - Early Tertiary Latrobe and Golden Beach Groups with the underlying Early Cretaceous Strzelecki Group considered "economic basement", without source potential. This latter assessment, while probably realistic in relation to source rocks with oil potential, may be unduly pessimistic for gas, as discussed further below.

5.2 Emperor sub-Group, Golden Beach and Latrobe Groups

Most, if not all, hydrocarbons in the Gippsland Basin are considered to have been sourced from the Late Cretaceous to Early Tertiary section represented by the Emperor sub-Group, Golden Beach and Latrobe Groups. The following conclusions can be drawn from studies published by Rahmanian et al. (1990), and Moore et al. (1992) and Shell Australia (SDA 901, Vic/P21, 1989):

1. The majority of oil and condensate accumulations in the Gippsland Basin have been generated from source rocks with equivalent vitrinite reflectance maturities of ~1.15 to 1.35 % R_V(max), with gas generated from source rocks at maturities of ~1.25 to 2.0 % R_V(max).

2. Most oil and condensate accumulations have involved considerable vertical (2000 m+) and lateral migration from the source kitchens (e.g., 15 km, or so, lateral migration for Barracouta and considerably more implied by the onshore occurrence of shallow oil at Lakes Entrance).

3. The actual source rocks from which oil and condensate were generated have not been penetrated by the drill and are inferred to be present in the Early Tertiary basal Latrobe Groups and Late Cretaceous Emperor sub-Group Golden Beach Group.

4. High quality source rocks are thought to be approximately a 50:50 mixture of Type II and Type III kerogens of dominantly land plant origin. Total organic (TOC) carbon in source rock shales averages ~2.4 wt%

5. Oil prone (Type II) source rocks are considered to be concentrated in the Campanian Golden Beach Group in the south and south east of the basin, possibly associated with coastal plain swamp and lagoon facies. Most of the area in Deep Water Acreage, may be within this area of favourable oil prone facies.

6. Oil accumulations tend to occur in areas where the Emperor sub-Group, Latrobe and Golden Beach Groups are locally wholly oil mature. Similarly, gas accumulations tend to be located where these units are mature to overmature for oil. On this basis the occurrence of oil and gas is considered to be related to the temperature to which the source rock was exposed, and not to gross variation in source rock type (Figure 13 in Rahmanian et al., 1990).

5.3 Strzelecki Group

The Early Cretaceous Strzelecki Group is present over most of the Gippsland Basin proper and is present at relatively shallow depths in the southern part of the Vic 097/03 permit application area, being intersected in Omeo-l and Tarra-l. Reasonable quality oil-prone Type III source rocks are recorded from the Strzelecki Group in Omeo-l (Amdel data, Omeo-l well completion report), whereas typical gas-prone Strzelecki Group source rocks are known more widely in the Gippsland Basin and in equivalent sequences in the Otway Basin where they have sourced the Port Campbell Embayment gas fields, including the 500 Bcf Minerva discovery (BHP). Therefore, provided the thermal history is favourable, in particular the timing of source rock maturation, the Strzelecki Group should be considered a viable gas source in some parts of the Gippsland Basin Deep Water permit application area.

6. Basin Modelling

6.1 Hydrocarbon source rock type

In this modelling exercise, hydrocarbon source rocks of Type II organic matter have been assumed to be present in all stratigraphic units. This is undoubtedly a gross simplification, particularly for the Strzelecki Group which is generally considered to be dominated by Type III, gas prone organic matter. However, Type II-like source rocks are widely recorded in the Early Cretaceous rift sediments (eg Tupper et al., 1993), and therefore assumption of a common source rock type is adequate to illustrate the broad pattern of oil hydrocarbon generation within the basin.

6.2 Explanation of the source rock maturation figures

In the summary figures presented for each Real and Pseudo well location in sections 7 and 8, the source rock maturation history is illustrated with a diagram of the "predicted variation of vitrinite reflectance maturity with time" and the hydrocarbon generation history is illustrated with a diagram of "in situ oil versus time for a Type II source rock". As an illustration of how these figures can be used to assess key aspects of the hydrocarbon prospectivity at each location, Figure 6.1 presents this same information on a single diagram for four separate units within the **Pseudo-1 well.**

It is emphasised that the maturation history depends on the thermal history and the kinetics of the VR (Burnham and Sweeney, 1989) while the hydrocarbon generation history depends on the thermal history and the source rock type assumed (LLNL kinetics). The Burnham and Sweeney (1989) VR kinetics are widely accepted as giving a good description of the VR system for a wide range of geological and laboratory heating rates, and as such can be used with confidence for prediction of maturity. On the other hand, the source rocks responsible for the Gippsland Basin oils have not been sampled, so their exact nature is in doubt.

For the purposes of illustrating the general pattern of hydrocarbon generation in this report a typical Type II source rock has been assumed, and it is emphasised that the relationships between source rock maturation level and extent of hydrocarbon generation discussed below is specific for this assumption.

Diagram A: Strzelecki Group Unit 3. The cyan box on this figure shows that the base of Strzelecki Group unit 3 reaches a vitrinite reflectance level of 0.9% at ~98 Ma and 1.1% at ~96 Ma. This VR range in considered to be responsible for generation of the bulk of Gippsland Basin oils, but the timing for other maturation levels can also be simply assessed if required. The figure also shows that during this time interval (98 to 96 Ma) the assumed Type II source rock in Strzelecki Group unit 3 will have generated the last half of its oil potential, as shown by the height of the yellow peak in the "in situ hydrocarbon" plot. The decline in the height of the yellow peak as time progresses towards the present-day indicates the progressive cracking of in situ oil to gas.

Diagram B: Emperor sub-Group Unit 5. Maturity levels between 0.9 and 1.1% are reached between ~85 and 83 Ma, corresponding to a Type II source rock generating the last 50% of its oil potential.

Diagram C: Emperor sub-Group Unit 1. Maturity levels between 0.9 and 1.1% are reached between ~18 Ma and the present-day, corresponding to a Type II source rock generating the last 50% of its oil potential.

Diagram D: Golden Beach Group Unit 3. Maturity levels of 0.9 to 1.1% are not reached. Just over 70% of a Type II source rock's oil potential is generated between 40 Ma and the present-day.

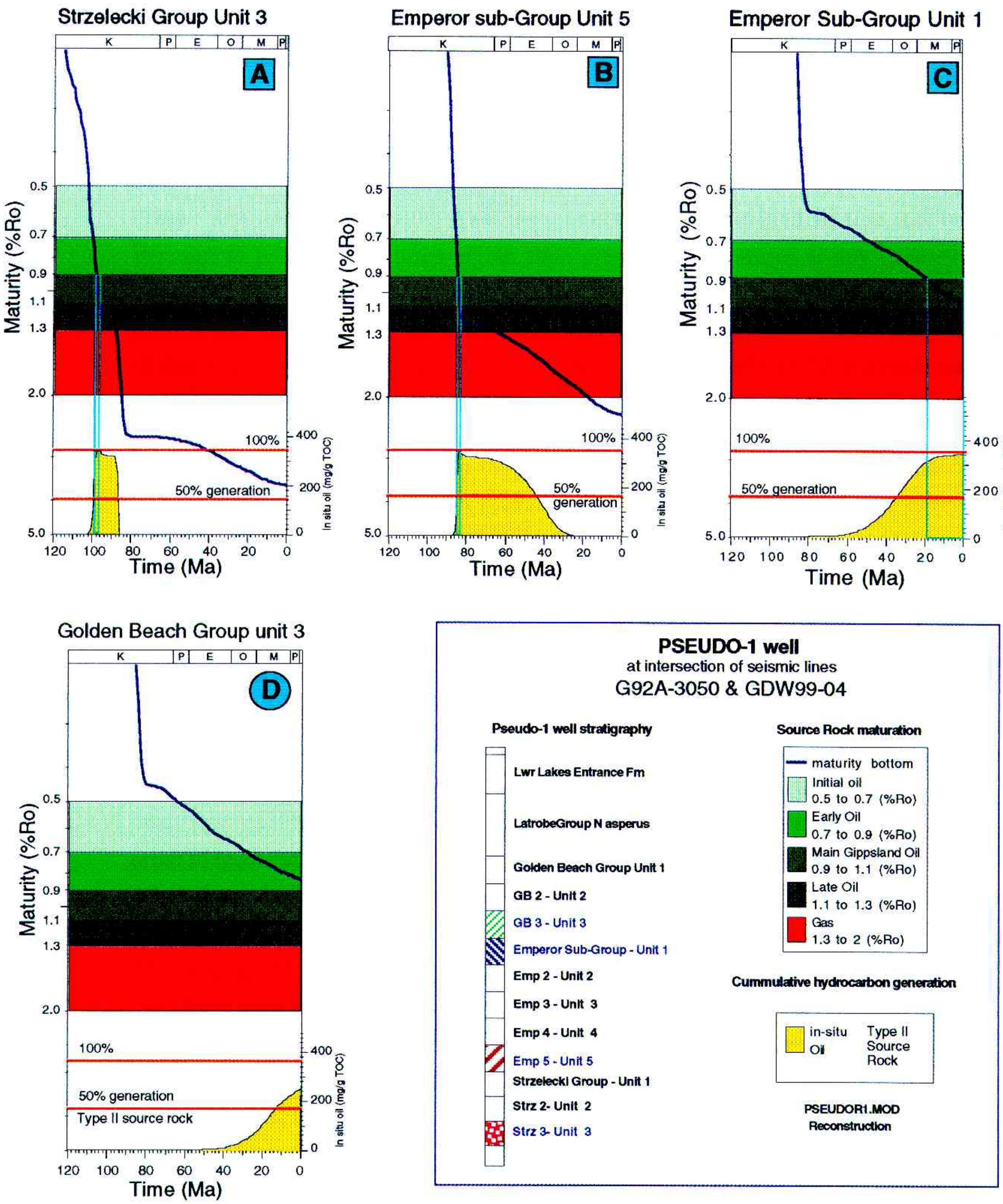


Figure 6.1: Interpretation of source rock maturation and hydrocarbon generation figures presented in Sections 7 and 8.

Diagram A: Strzelecki Group Unit 3. The cyan box on this figure shows that the base of Strzelecki Group unit 3 reaches a vitrinite reflectance level of 0.9% at ~98 Ma and 1.1% at ~96 Ma. This VR range in considered to be responsible for generation of the bulk of Gippsland Basin oils, but the timing for other maturation levels can also be simply assessed if required. The figure also shows that during this time interval (98 to 96 Ma) the assumed Type II source rock in Strzelecki Group unit 3 will have generated the last half of its oil potential, as shown by the height of the yellow peak in the "in situ hydrocarbon" plot. The decline in the height of the yellow peak as time progresses towards the present-day indicates the progressive cracking of in situ oil to gas.

Diagram B: Emperor sub-Group Unit 5. Maturity levels between 0.9 and 1.1% are reached between ~85 and 83 Ma, corresponding to a Type II source rock generating the last 50% of its oil potential.

Diagram C: Emperor sub-Group Unit 1. Maturity levels between 0.9 and 1.1% are reached between ~18 Ma and the present-day, corresponding to a Type II source rock generating the last 50% of its oil potential.

Diagram D: Golden Beach Group Unit 3. Maturity levels of 0.9 to 1.1% are not reached. Just over 70% of a Type II source rock's oil potential is generated between 40 Ma and the present-day.

7. Modelling of the Real wells

7.1 Anemone-1

Basic data: AFTA (Geotrack Report #198, 1989) and vitrinite reflectance results (Table A.3 and Figure 7.1B) show no evidence that the drilled section has been exposed to paleotemperatures higher than present-temperatures at any time since deposition. The AFTA results indicate, in fact, that the present temperatures based on a present-day geothermal gradient of 28.9°C/km derived from the corrected BHT data (Table A.2) are slightly too high (Geotrack Report #198, 1989), and that a gradient of ~25°C/km is a better estimate of the present-day thermal conditions (Appendix A).

Burial history: A burial history based on the preserved stratigraphy but extended below TD based on seismic picks provided by DNRE (Table A.1) has been assumed (i.e. no significant uplift and erosion episodes have been included), as shown in Figure 7.1A. The burial history also shows superimposed maturity windows derived from the thermal history shown in Figure 7.1C.

Thermal History: As the AFTA and VR results indicate that maximum paleotemperatures are at the present-day, there is no direct evidence available to constrain the paleo-thermal history at this well location. However, there is abundant evidence for variation in paleo-heat flow in the basin, particularly the occurrence of a heat flow maximum in the mid-Cretaceous, as discussed in Section 4. Therefore, in order to reconstruct the source rock maturation and hydrocarbon generation histories, a paleo-thermal history based on the regional thermal history discussed in Section 4 has been assumed. For Anemone-1A, the assumed history involves a gradient of 25°C/km at 135 Ma increasing progressively to a maximum value of 50°C/km at 95 Ma, decreasing linearly to 25°C/km at 80 Ma and maintaining this level through to the present day. The resulting thermal history for key stratigraphic units is shown in Figure 7.1C.

Source rock maturation and hydrocarbon generation histories: Figure 7.1B depicts the measured VR results (see Table A.3) and the predicted VR profile (Burnham and Sweeney, 1989) derived from the thermal history shown in Figure 7.1C. The good fit between the measured and predicted VR indicates that the assumed thermal history is viable.

The generation of "in situ oil "(Type II source rock) with time for key stratigraphic horizons in **Anemone-1A** based on the thermal history shown in Figure 7.1C is illustrated in Figure 7.1D.

Deeper parts of the **Strzelecki Group** (Strz 4 & 3) begin generation in the earliest Tertiary while the upper 500 m generates all of its oil potential over the last ~25 Ma (Miocene to Recent).

The whole **Emperor sub-Group** begins generating at ~25 Ma exhausting ~75% of its potential by the present-day.

The **Golden Beach Group** generates over the same period, but exhausts less than ~30% of its potential by the present-day.

No generation has occurred from the **Latrobe Group** in **Anemone-1A** due to insufficient heating.

7.2 Basker-1

Basic data: Vitrinite reflectance results (Table A.3 and Figure 7.2B) show no evidence that the drilled section has been exposed to paleotemperatures higher than present-temperatures at any time since deposition. A present-day geothermal gradient of 37.0°C/km derived from the corrected BHT data has been calculated (Table A.2, Appendix A).

Burial history: A burial history based on the preserved stratigraphy but extended below TD based on seismic picks provided by DNRE (Table A.1) has been assumed (i.e. no significant uplift and erosion episodes have been included), as shown in Figure 7.2A. The burial history also shows superimposed maturity windows derived from the thermal history shown in Figure 7.2C.

Thermal History: The VR results indicate that maximum paleotemperatures are at the present-day, and therefore there is no direct evidence available to constrain the paleo-thermal history at this well location. However, there is abundant evidence for variation in paleo-heat flow in the basin, particularly the occurrence of a heat flow maximum in the mid-Cretaceous, as discussed in Section 4. Therefore, in order to reconstruct the source rock maturation and hydrocarbon generation histories, a paleo-thermal history based on the regional thermal history discussed in Section 4 has been assumed. For **Basker-1**, the assumed history involves a gradient of 37°C/km at 135 Ma increasing progressively to a maximum value of 60°C/km at 95 Ma, decreasing linearly to 37°C/km at 80 Ma and maintaining this level through to the present day. The resulting thermal history for key stratigraphic units is shown in Figure 7.2C.

Source rock maturation and hydrocarbon generation histories: Figure 7.2B depicts the measured VR results (see Table A.3) and the predicted VR profile

(Burnham and Sweeney, 1989) derived from the thermal history shown in Figure 7.2C. The good fit between the measured and predicted VR indicates that the assumed thermal history is viable.

The generation of "in situ oil "(Type II source rock) with time for key stratigraphic horizons in **Basker-1** based on the thermal history shown in Figure 7.2C is illustrated in Figure 7.2D.

Deeper parts of the **Strzelecki Group** (Strz 3 & 2) begin generation in the mid-Cretaceous (~90 Ma), and due to increasing burial heating, have any "in situ oil" entirely cracked to gas by the mid-Tertiary (~40 Ma). The upper 500 m of the Strzelecki Group begins oil generation at around 75 Ma, and is totally exhausted at about 65 Ma, with "in situ oil" progressively cracked to gas until completion in the late Tertiary.

The deepest unit of the **Emperor sub-Group** (Emp 3) begins generation in the latest Cretaceous (~70 Ma) and is totally exhausted at about 60 Ma, with little change in "in situ oil" occurring until the latest Tertiary (~10 Ma) due to a relatively little burial between ~50 and 20 Ma. Increased burial heating since ~20 Ma results in any "in situ oil" being progressively cracked to gas until effective completion at the present-day. The middle part of the **Emperor sub-Group** (Emp 2) begins generation in the early Tertiary (~65 Ma) and undergoes progressive generation until total exhaustion at about the present-day. The upper part of the **Emperor sub-Group** begins generation in the early Tertiary (~65 Ma) but generates the majority of its potential between ~20 Ma and the present-day.

The **Golden Beach Group** generates approximately 75% of its potential over about the last 5 Ma, while **the Latrobe Group (T. lillei unit)** generates approximately 25% of its potential over the same time interval.

7.3 Blackback-1

Basic data: Vitrinite reflectance results (Table A.3 and Figure 7.3B) show no evidence that the drilled section has been exposed to paleotemperatures higher than present-temperatures at any time since deposition. A present-day geothermal gradient of 27.7°C/km derived from the corrected BHT data has been calculated (Table A.2, Appendix A).

Burial history: A burial history based on the preserved stratigraphy but extended below TD based on seismic picks provided by DNRE (Table A.1) has been assumed (i.e. no significant uplift and erosion episodes have been included), as shown in

Figure 7.3A. The burial history also shows superimposed maturity windows derived from the thermal history shown in Figure 7.3C.

Thermal History: The VR results indicate that maximum paleotemperatures are at the present-day, and therefore there is no direct evidence available to constrain the paleo-thermal history at this well location. However, there is abundant evidence for variation in paleo-heat flow in the basin, particularly the occurrence of a heat flow maximum in the mid-Cretaceous, as discussed in Section 4. Therefore, in order to reconstruct the source rock maturation and hydrocarbon generation histories, a paleo-thermal history based on the regional thermal history discussed in Section 4 has been assumed. For **Blackback-1**, the assumed history involves a gradient of 27.7°C/km at 135 Ma increasing progressively to a maximum value of 55°C/km at 95 Ma, decreasing linearly to 27.7°C/km at 80 Ma and maintaining this level through to the present day. The resulting thermal history for key stratigraphic units is shown in Figure 7.3C.

Source rock maturation and hydrocarbon generation histories: Figure 7.3B depicts the measured VR results (see Table A.3) and the predicted VR profile (Burnham and Sweeney, 1989) derived from the thermal history shown in Figure 7.3C. The good fit between the measured and predicted VR indicates that the assumed thermal history is viable.

The generation of "in situ oil "(Type II source rock) with time for key stratigraphic horizons in **Blackback-1** based on the thermal history shown in Figure 7.3C is illustrated in Figure 7.3D.

The deepest part of the **Strzelecki Group** (Strz 3) begins generation in the mid-Cretaceous (~90 Ma) and is totally exhausted at about 65 Ma, with in situ oil progressively cracked to gas until completion in the late Tertiary (~10 Ma). The upper 500 m of the Strzelecki Group begins oil generation at around 70 Ma, and is almost totally exhausted by about 60 Ma, with little additional in "in situ oil" generation occurring until the latest Tertiary (~10 Ma) due to a the low burial rate between ~60 and 10 Ma. Between 10 Ma and the present-day the "in situ oil" is progressively cracked to gas until completion.

The deepest unit of the **Emperor sub-Group** (Emp 3) begins generation in the latest Cretaceous (~70 Ma) and is totally exhausted at about 10 Ma, with minor cracking to gas between ~10 Ma and the present-day. The middle part of the **Emperor sub-Group** (Emp 2) also begins generation at ~70 Ma and undergoes progressive generation to about 40% until ~10 Ma. Between 10 Ma and 5 Ma rapid generation occurs until total exhaustion of the oil potential. Minor cracking to gas occurs between ~5 Ma and the present-day. The upper part of the **Emperor sub-Group** does not begin significant generation of "in situ oil" until the late Tertiary (~10 Ma) but then undergoes rapid generation to total exhaustion at about the present-day.

The **Golden Beach Group** rapidly generates approximately 60% of its potential over about the last 5 Ma. while no part of the **Latrobe Group** is sufficiently heated to generate significant oil from the assumed Type II source rock.

7.4 Hermes-1

Basic data: Vitrinite reflectance results (Table A.3 and Figure 7.4B) show no evidence that the drilled section has been exposed to paleotemperatures higher than present-temperatures at any time since deposition. A present-day geothermal gradient of 35.4°C/km derived from the corrected BHT data has been calculated (Table A.2, Appendix A).

Burial history: A burial history based on the preserved stratigraphy but extended below TD based on seismic picks provided by DNRE (Table A.1) has been assumed (i.e. no significant uplift and erosion episodes have been included), as shown in Figure 7.4A. The burial history also shows superimposed maturity windows derived from the thermal history shown in Figure 7.3C.

Thermal History: The VR results indicate that maximum paleotemperatures are at the present-day, and therefore there is no direct evidence available to constrain the paleo-thermal history at this well location. However, there is abundant evidence for variation in paleo-heat flow in the basin, particularly the occurrence of a heat flow maximum in the mid-Cretaceous, as discussed in Section 4. Therefore, in order to reconstruct the source rock maturation and hydrocarbon generation histories, a paleo-thermal history based on the regional thermal history discussed in Section 4 has been assumed. For **Hermes-1**, the assumed history involves a gradient of 35.4°C/km at 135 Ma increasing progressively to a maximum value of 60°C/km at 95 Ma, decreasing linearly to 35.4°C/km at 80 Ma and maintaining this level through to the present day. The resulting thermal history for key stratigraphic units is shown in Figure 7.4C.

Source rock maturation and hydrocarbon generation histories: Figure 7.4B depicts the measured VR results (see Table A.3) and the predicted VR profile (Burnham and Sweeney, 1989) derived from the thermal history shown in Figure 7.4 C. The predicted VR profile passes through the most recent data set analysed by Keiraville Konsultants (Table A.3) but falls above the larger, but older, data sets. We consider the predicted profile, based on the present-day geothermal gradient of 35.4°C/km, and which matches the newer data, gives the best representation of the thermal history for Hermes-1. The cause of systematic problems with the older VR data sets is unknown.

The generation of "in situ oil "(Type II source rock) with time for key stratigraphic horizons in **Hermes-1** based on the thermal history shown in Figure 7.4C is illustrated in Figure 7.4D.

The upper 500 m of the **Strzelecki Group** begins generation in the mid-Cretaceous (~85 Ma) and is totally exhausted by about 75 Ma, with "in situ oil" rapidly cracked to gas with completion in the late Cretaceous (~70 Ma).

The deepest unit of the **Emperor sub-Group** (Emp 3) begins generation in the mid-Cretaceous (~85 Ma) and is totally exhausted by about 75 Ma, with "in situ oil" rapidly cracked to gas until completion at ~65 Ma. The middle part of the **Emperor sub-Group** (Emp 2) begins generation at ~75 Ma and undergoes rapid generation with completion at ~70 Ma followed by progressive cracking to gas until completion at ~10 Ma. The upper part of the **Emperor sub-Group** begins generation at ~65 Ma and undergoes rapid generation with completion at ~60 Ma followed by slow, progressive cracking to gas until ~15 Ma, followed by rapid cracking with completion at ~10 Ma.

The deepest unit of the **Golden Beach Group** (GB 2) begins generation in the early Tertiary (~65 Ma) and is totally exhausted by about 10 Ma, with "in situ oil" rapidly cracked to gas until completion at ~10 Ma. The upper part of the **Golden Beach Group** undergoes slow generation (to about 25%) from ~60 to 15 Ma, but then undergoes rapid generation to total exhaustion at about 10 Ma. Between 10 Ma and the present-day the "in situ oil" is rapidly cracked to gas until completion.

The **T. lillei Latrobe Group** undergoes rapid generation between 10 Ma and 5 Ma until total exhaustion of the oil potential. Minor cracking (~25%) to gas occurs between ~5 Ma and the present-day. The **T. longus Latrobe Group** rapidly generates approximately 60% of its potential over about the last 5 Ma.

7.5 Pisces-1

Basic data: Vitrinite reflectance results (Table A.3 and Figure 7.5B) show no evidence that the drilled section has been exposed to paleotemperatures higher than present-temperatures at any time since deposition. A present-day geothermal gradient of 34.6°C/km derived from the corrected BHT data has been calculated (Table A.2, Appendix A).

Burial history: A burial history based on the preserved stratigraphy but extended below TD based on seismic picks provided by DNRE (Table A.1) has been assumed (i.e. no significant uplift and erosion episodes have been included), as shown in Figure 7.5A. The burial history also shows superimposed maturity windows derived from the thermal history shown in Figure 7.5C.

Thermal History: The VR results indicate that maximum paleotemperatures are at the present-day, and therefore there is no direct evidence available to constrain the paleo-thermal history at this well location. However, there is abundant evidence for variation in paleo-heat flow in the basin, particularly the occurrence of a heat flow maximum in the mid-Cretaceous, as discussed in Section 4. Therefore, in order to reconstruct the source rock maturation and hydrocarbon generation histories, a paleo-thermal history based on the regional thermal history discussed in Section 4 has been assumed. For **Pisces-1**, the assumed history involves a gradient of 34.6°C/km at 135 Ma increasing progressively to a maximum value of 60°C/km at 95 Ma, decreasing linearly to 34.6°C/km at 80 Ma and maintaining this level through to the present day. The resulting thermal history for key stratigraphic units is shown in Figure 7.5C.

Source rock maturation and hydrocarbon generation histories: Figure 7.5B depicts the measured VR results (see Table A.3) and the predicted VR profile (Burnham and Sweeney, 1989) derived from the thermal history shown in Figure 7.5C. The predicted VR profile shows a reasonable fit to the data set , especially considering the fairly large scatter in the shallow part of the well.

The generation of "in situ oil "(Type II source rock) with time for key stratigraphic horizons in **Pisces-1** based on the thermal history shown in Figure 7.5C is illustrated in Figure 7.5D.

No **Strzelecki Group** or **Emperor sub-Group** is present at the **Pisces-1** location, with the well penetrating **Golden Beach Group** overlying **Paleozoic basement.**

The deepest unit of the **Golden Beach Group** (GB 4) begins generation in the late Cretaceous (~75 Ma) and undergoes slow generation (to about 40%) from 75 to about 15 Ma, but then undergoes rapid generation to total exhaustion at about 5 Ma. Between 5 Ma and the present-day the "in situ oil" undergoes minor cracking to gas. The middle part of the **Golden Beach Group** (GB 3) undergoes rapid generation between 10 Ma and the present-day, exhausting ~90% of its oil potential.

Shallower units of the **Golden Beach Group** and the entire **Latrobe Group** do not generate any significant oil due to insufficient heating.

7.6 Shark-1

Basic data: Vitrinite reflectance results (Table A.3 and Figure 7.6B) show no evidence that the drilled section has been exposed to paleotemperatures higher than present-temperatures at any time since deposition. A present-day geothermal gradient of 35.9°C/km derived from the corrected BHT data has been calculated (Table A.2, Appendix A).

Burial history: A burial history based on the preserved stratigraphy but extended below TD based on seismic picks provided by DNRE (Table A.1) has been assumed (i.e. no significant uplift and erosion episodes have been included), as shown in Figure 7.6A. The burial history also shows superimposed maturity windows derived from the thermal history shown in Figure 7.6C.

Thermal History: The VR results indicate that maximum paleotemperatures are at the present-day, and therefore there is no direct evidence available to constrain the paleo-thermal history at this well location. However, there is abundant evidence for variation in paleo-heat flow in the basin, particularly the occurrence of a heat flow maximum in the mid-Cretaceous, as discussed in Section 4. Therefore, in order to reconstruct the source rock maturation and hydrocarbon generation histories, a paleo-thermal history based on the regional thermal history discussed in Section 4 has been assumed. For **Shark-1**, the assumed history involves a gradient of 35.9°C/km at 135 Ma increasing progressively to a maximum value of 60°C/km at 95 Ma, decreasing linearly to 35.9°C/km at 80 Ma and maintaining this level through to the present day. The resulting thermal history for key stratigraphic units is shown in Figure 7.6C.

Source rock maturation and hydrocarbon generation histories: Figure 7.6B depicts the measured VR results (see Table A.3) and the predicted VR profile (Burnham and Sweeney, 1989) derived from the thermal history shown in Figure 7.6C. The good fit between the majority of the measured VR data and the predicted profile indicates that the assumed thermal history is viable.

The generation of "in situ oil "(Type II source rock) with time for key stratigraphic horizons in **Shark-1** based on the thermal history shown in Figure 7.6C is illustrated in Figure 7.6D.

The upper 500 m of the **Strzelecki Group** begins generation in the mid-Cretaceous (~85 Ma) and is totally exhausted at about 65 Ma. The "in situ oil" is slowly cracked to gas between 65 and ~10 Ma, with a rapid increase in cracking from 10 Ma until completion just prior to the present-day.

The deepest unit of the **Emperor sub-Group** (Emp 5) begins generation in the Late Cretaceous (~80 Ma) and undergoes fairly rapid generation to about 70% by about 60

Ma, slowly generating its remaining potential between 60 and ~10 Ma. Minor cracking to gas occurs between ~10 Ma and the present-day. **Emperor sub-Group unit Emp 4** begins generation at ~70 Ma and undergoes relatively slow generation to about 50% by ~10 Ma. Between 10 Ma and 5 Ma rapid generation occurs until total exhaustion of the oil potential. Minor cracking to gas occurs between ~5 Ma and the present-day. **Emperor sub-Group unit Emp 3** does not begin significant generation of "in situ oil" until the late Tertiary (~10 Ma) but then undergoes rapid generation to total exhaustion at about the present-day. **Emperor sub-Group unit Emp 2** rapidly generates approximately 30% of its potential over about the last 5 Ma.

No part of the **Golden Beach or Latrobe Groups** is sufficiently heated to generate significant oil from the assumed Type II source rock.

7.7 Volador-1

Basic data: Vitrinite reflectance results (Table A.3 and Figure 7.7B) show no evidence that the drilled section has been exposed to paleotemperatures higher than present-temperatures at any time since deposition. A present-day geothermal gradient of 36.7°C/km derived from the corrected BHT data has been calculated (Table A.2, Appendix A).

Burial history: A burial history based on the preserved stratigraphy but extended below TD based on seismic picks provided by DNRE (Table A.1) has been assumed (i.e. no significant uplift and erosion episodes have been included), as shown in Figure 7.7A. The burial history also shows superimposed maturity windows derived from the thermal history shown in Figure 7.7C.

Thermal History: The VR results indicate that maximum paleotemperatures are at the present-day, and therefore there is no direct evidence available to constrain the paleo-thermal history at this well location. However, there is abundant evidence for variation in paleo-heat flow in the basin, particularly the occurrence of a heat flow maximum in the mid-Cretaceous, as discussed in Section 4. Therefore, in order to reconstruct the source rock maturation and hydrocarbon generation histories, a paleo-thermal history based on the regional thermal history discussed in Section 4 has been assumed. For **Volador-1**, the assumed history involves a gradient of 36.7°C/km at 135 Ma increasing progressively to a maximum value of 60°C/km at 95 Ma, decreasing linearly to 36.7°C/km at 80 Ma and maintaining this level through to the present day. The resulting thermal history for key stratigraphic units is shown in Figure 7.7C.

Source rock maturation and hydrocarbon generation histories: Figure 7.7B depicts the measured VR results (see Table A.3) and the predicted VR profile

(Burnham and Sweeney, 1989) derived from the thermal history shown in Figure 7.7C. The good fit between the majority of the measured VR data and the predicted profile indicates that the assumed thermal history is viable.

The generation of "in situ oil "(Type II source rock) with time for key stratigraphic horizons in **Volador-1** based on the thermal history shown in Figure 7.7C is illustrated in Figure 7.7D.

The upper 500 m of the **Strzelecki Group** begins generation in the mid-Cretaceous (~85 Ma) and is totally exhausted at about 7 Ma. The "in situ oil" is rapidly cracked to gas, with completion by about 65 Ma.

The deepest unit of the **Emperor sub-Group** (Emp 2) begins generation in the Late Cretaceous (~80 Ma) and undergoes rapid generation to completion by about 70 Ma, with complete cracking to gas between 70 and ~30 Ma. The uppermost **Emperor sub-Group** (P. mawsonii) begins generation in the Late Cretaceous (~80 Ma) and undergoes rapid generation to completion by about 65 Ma. Between 65 and ~20 Ma slow, progressive cracking to gas occurs, with complete cracking occurring rapidly between 20 and ~10 Ma.

The deepest unit of the **Golden Beach Group** (GB 4) begins generation in the Late Cretaceous (~70 Ma) and undergoes rapid generation to near completion by about 60 Ma, with very slow generation of the last few percent of oil potential between 60 and 20 Ma. Rapid cracking to gas occurs between 20 and 10 Ma. **Golden Beach Group unit GB 3** begins generation at ~65 Ma and undergoes relatively slow generation to completion by ~10 Ma. Between 10 Ma and 5 Ma rapid cracking to gas occurs to completion. **Golden Beach Group unit GB 2** begins generation at ~60 Ma and undergoes relatively slow generation to about 25% potential by 10 Ma then proceeds rapidly to completion by ~10 Ma. Between 10 Ma and the present-day rapid cracking to gas occurs, almost to completion. The uppermost unit of the **Golden Beach Group** (N. senectus) does not begin significant generation of "in situ oil" until the late Tertiary (~10 Ma) but then undergoes rapid generation to total exhaustion at about the present-day.

The **T. lillei Latrobe Group** undergoes rapid generation between 10 Ma and the present-day reaching effective total exhaustion of the oil potential. The **T. longus Latrobe Group** rapidly generates approximately 70% of its potential over about the last 5 Ma.

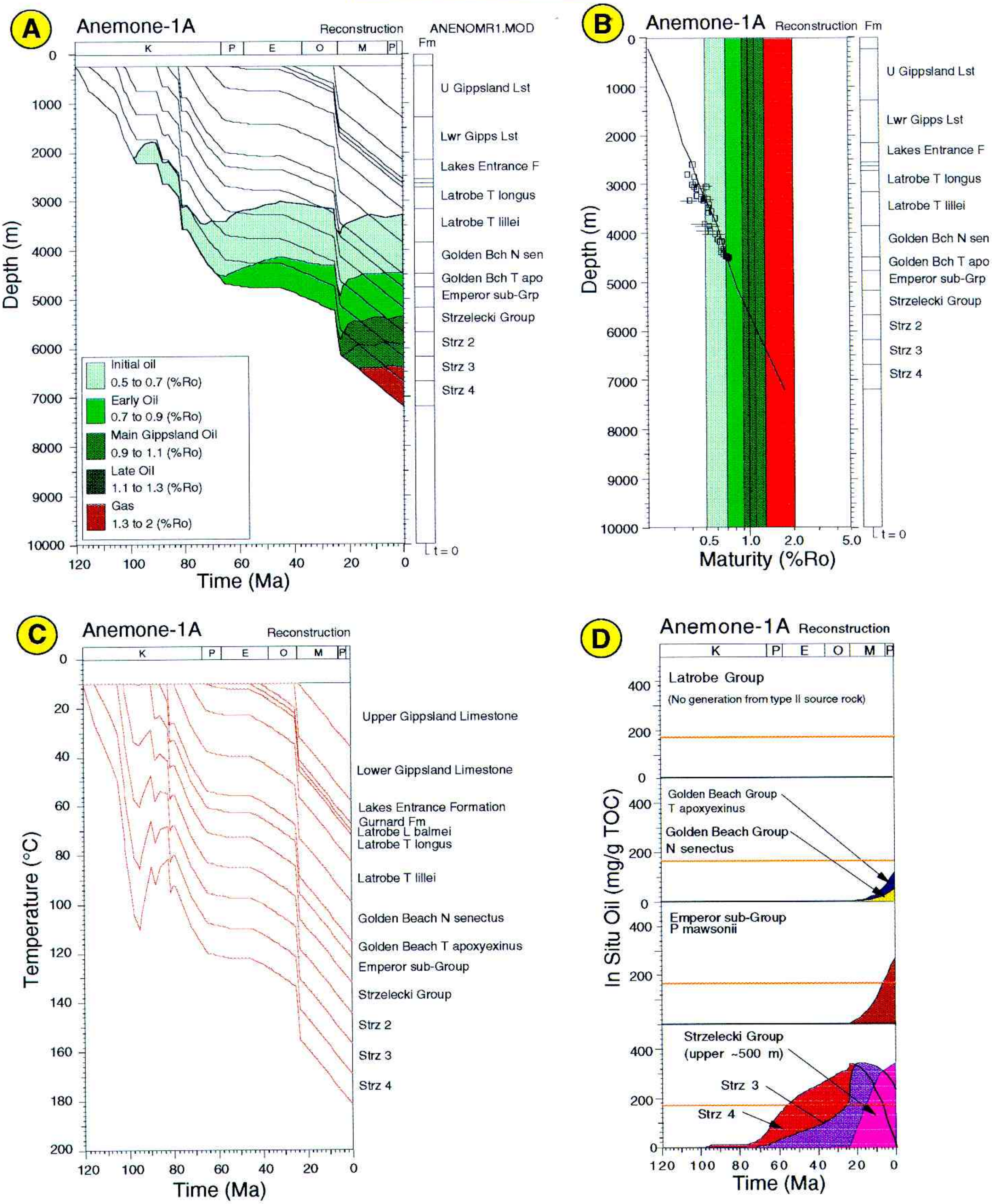


Figure 7.1: Anemone-1A, Source rock maturation summary

A. Reconstructed burial history with vitrinite reflectance source rock maturation windows

B. Measured vitrinite reflectance and maturity profile predicted from the reconstructed thermal history shown in C.

C. Reconstructed thermal history based on the present-day geothermal conditions and the regional thermal history model discussed in the text.

D. In situ oil versus time for a Type II source rock derived from the reconstructed thermal history shown in C. The Strzelecki Group has been divided arbitrarily into a number of units of equal thickness (~ 400 to 600 m) in order to better illustrate the variation in timing of active hydrocarbon generation within this thick unit. (The horizontal line at 175 mg/g TOC represents 50% oil generation from the assumed Type II source rock).

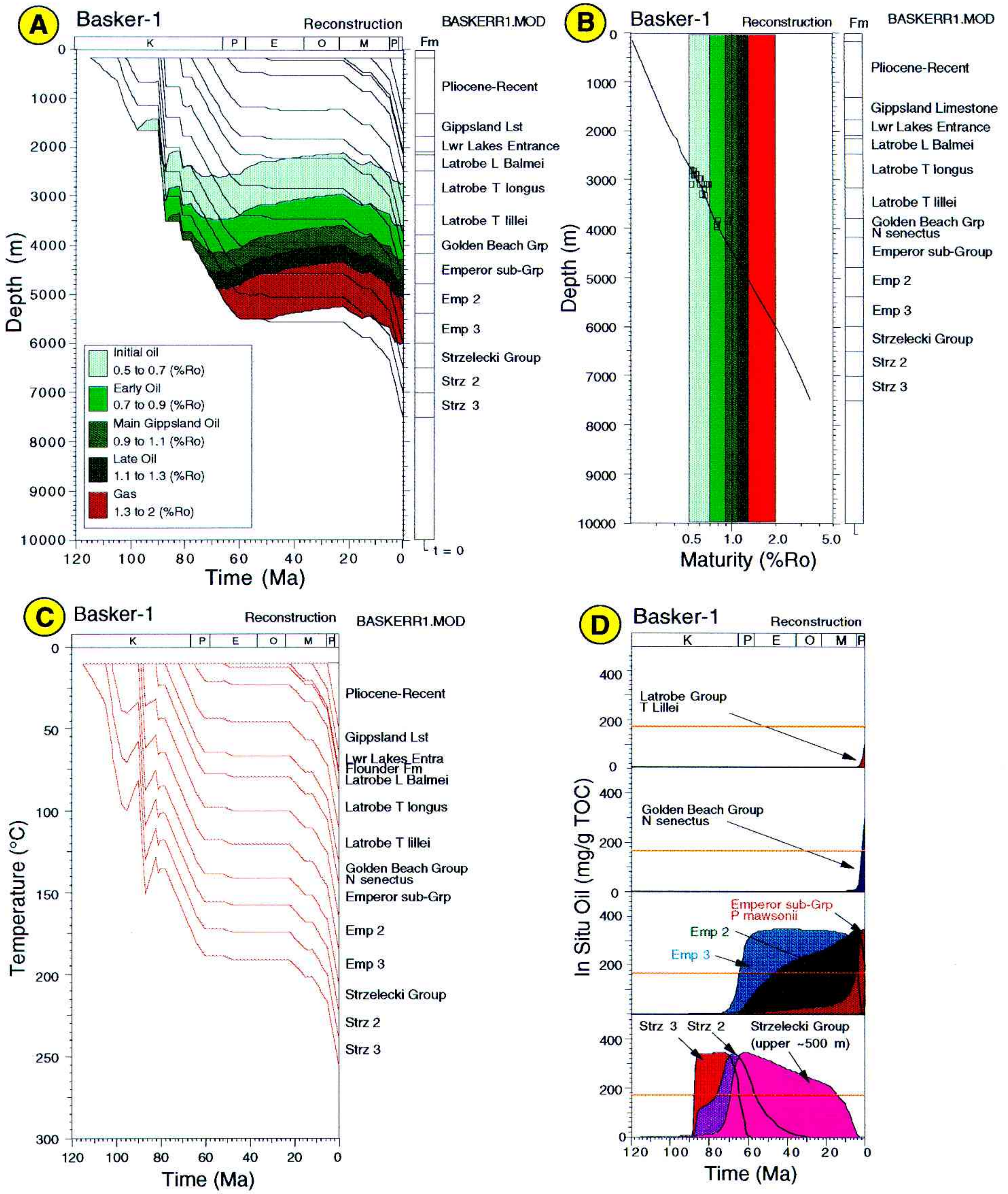


Figure 7.2: Basker-1, Source rock maturation summary

A. Reconstructed burial history with vitrinite reflectance source rock maturation windows

B. Measured vitrinite reflectance and maturity profile predicted from the reconstructed thermal history shown in C.

C. Reconstructed thermal history based on the present-day geothermal conditions and the regional thermal history model discussed in the text.

D. In situ oil versus time for a Type II source rock derived from the reconstructed thermal history shown in C. The Strzelecki Group and Emperor sub-Group have been divided arbitrarily into a number of units of equal thickness (~ 400 to 600 m) in order to better illustrate the variation in timing of active hydrocarbon generation within this thick unit. (The horizontal line at 175 mg/g TOC represents 50% oil generation from the assumed Type II source rock).

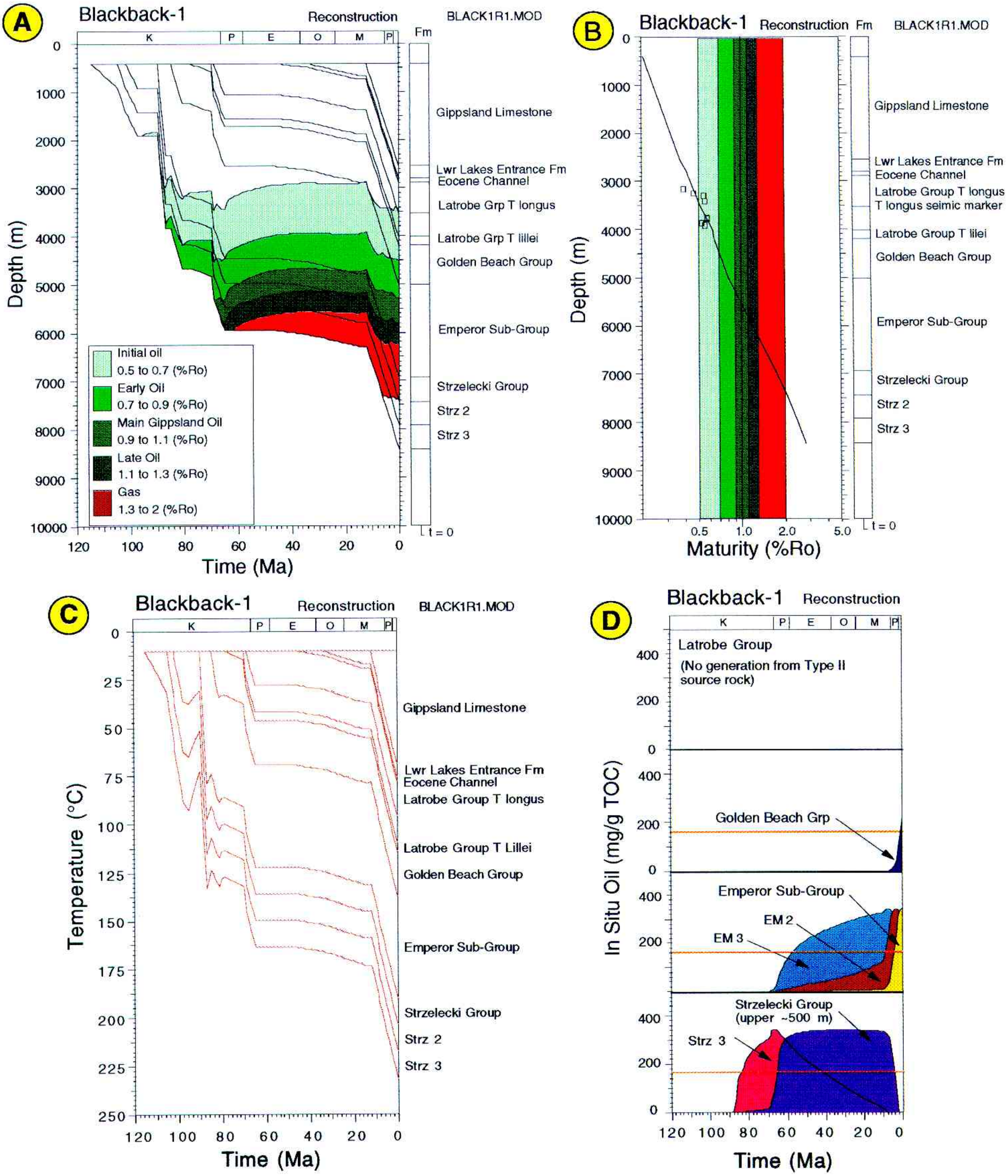


Figure 7.3: Blackback-1, Source rock maturation summary

A. Reconstructed burial history with vitrinite reflectance source rock maturation windows

B. Measured vitrinite reflectance and maturity profile predicted from the reconstructed thermal history shown in C.

C. Reconstructed thermal history based on the present-day geothermal conditions and the regional thermal history model discussed in the text.

D. In situ oil versus time for a Type II source rock derived from the reconstructed thermal history shown in C. The Strzelecki Group and Emperor sub-Group have been divided arbitrarily into a number of units of equal thickness (~ 400 to 600 m) in order to better illustrate the variation in timing of active hydrocarbon generation within this thick unit. (The horizontal line at 175 mg/g TOC represents 50% oil generation from the assumed Type II source rock).

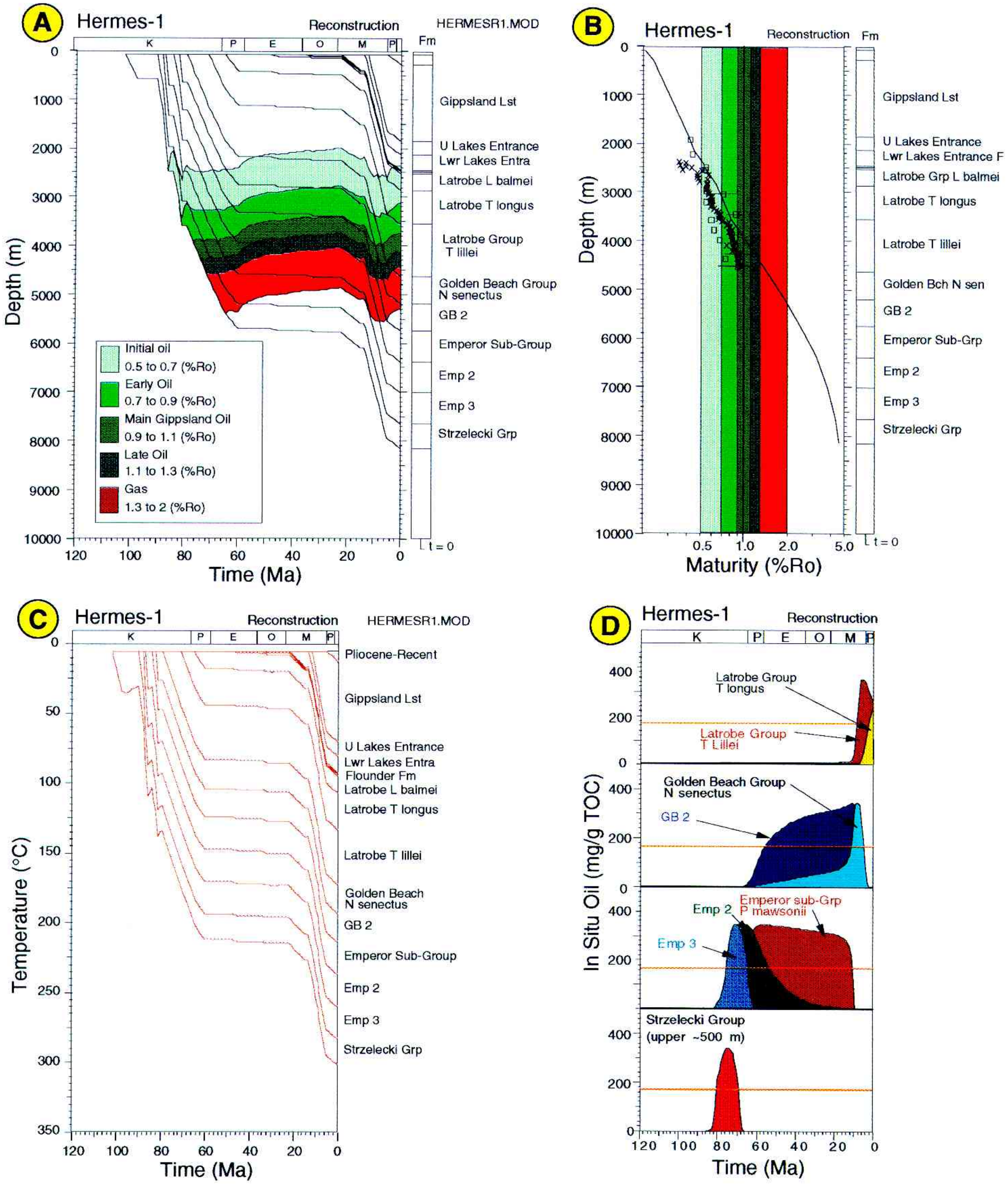


Figure 7.4: Hermes-1, Source rock maturation summary

A. Reconstructed burial history with vitrinite reflectance source rock maturation windows

B. Measured vitrinite reflectance and maturity profile predicted from the reconstructed thermal history shown in C.

C. Reconstructed thermal history based on the present-day geothermal conditions and the regional thermal history model discussed in the text.

D. In situ oil versus time for a Type II source rock derived from the reconstructed thermal history shown in C. The Golden Beach Group and the Emperor sub-Group have been divided arbitrarily into a number of units of equal thickness (~ 400 to 600 m) in order to better illustrate the variation in timing of active hydrocarbon generation within these thick units. (The horizontal line at 175 mg/g TOC represents 50% oil generation from the assumed Type II source rock).

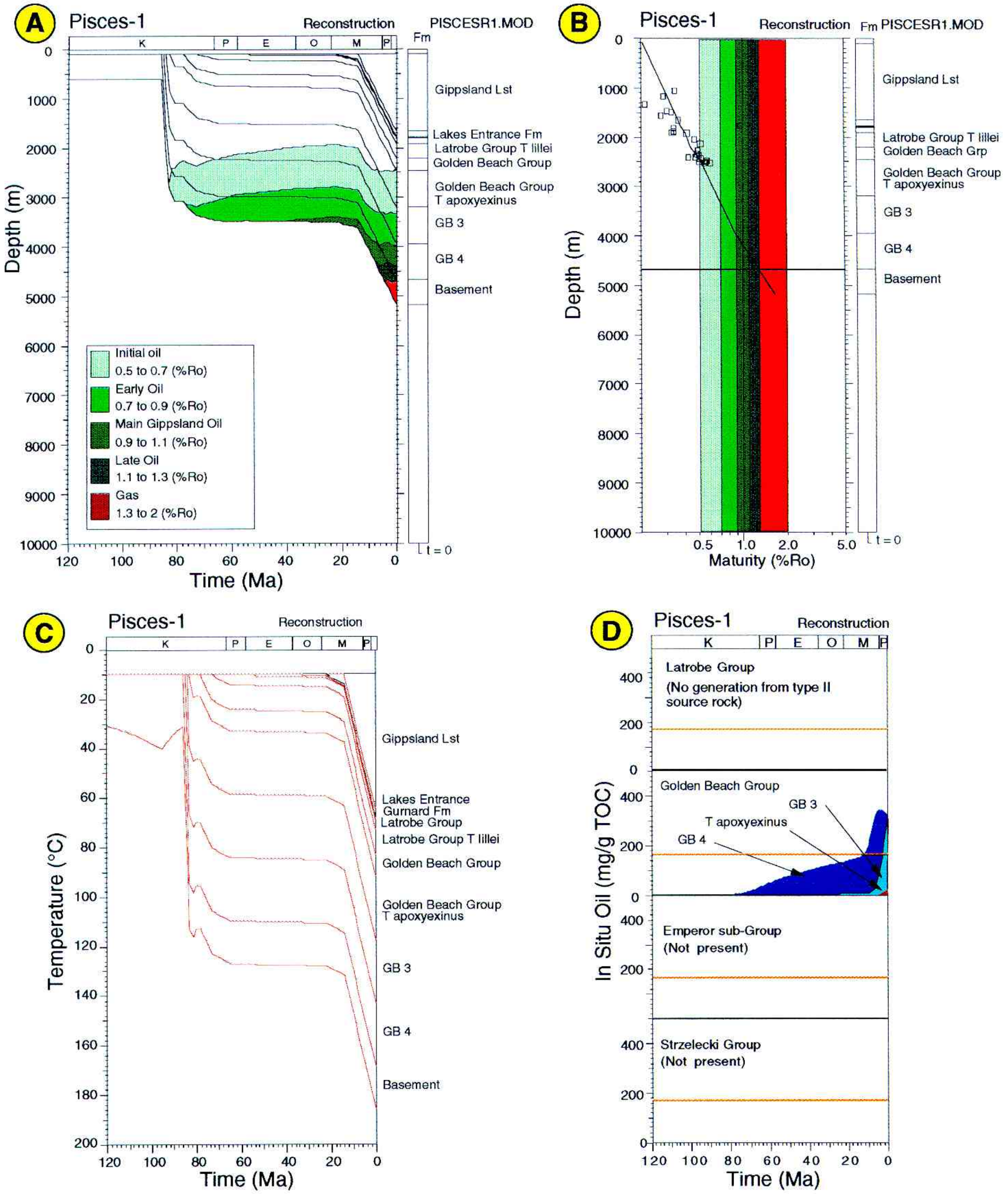


Figure 7.5: Pisces-1, Source rock maturation summary

A. Reconstructed burial history with vitrinite reflectance source rock maturation windows

B. Measured vitrinite reflectance and maturity profile predicted from the reconstructed thermal history shown in C.

C. Reconstructed thermal history based on the present-day geothermal conditions and the regional thermal history model discussed in the text.

D. In situ oil versus time for a Type II source rock derived from the reconstructed thermal history shown in C. The Golden Beach Group has been divided arbitrarily into a number of units of equal thickness (~ 400 to 600 m) in order to better illustrate the variation in timing of active hydrocarbon generation within this thick unit. (The horizontal line at 175 mg/g TOC represents 50% oil generation from the assumed Type II source rock).

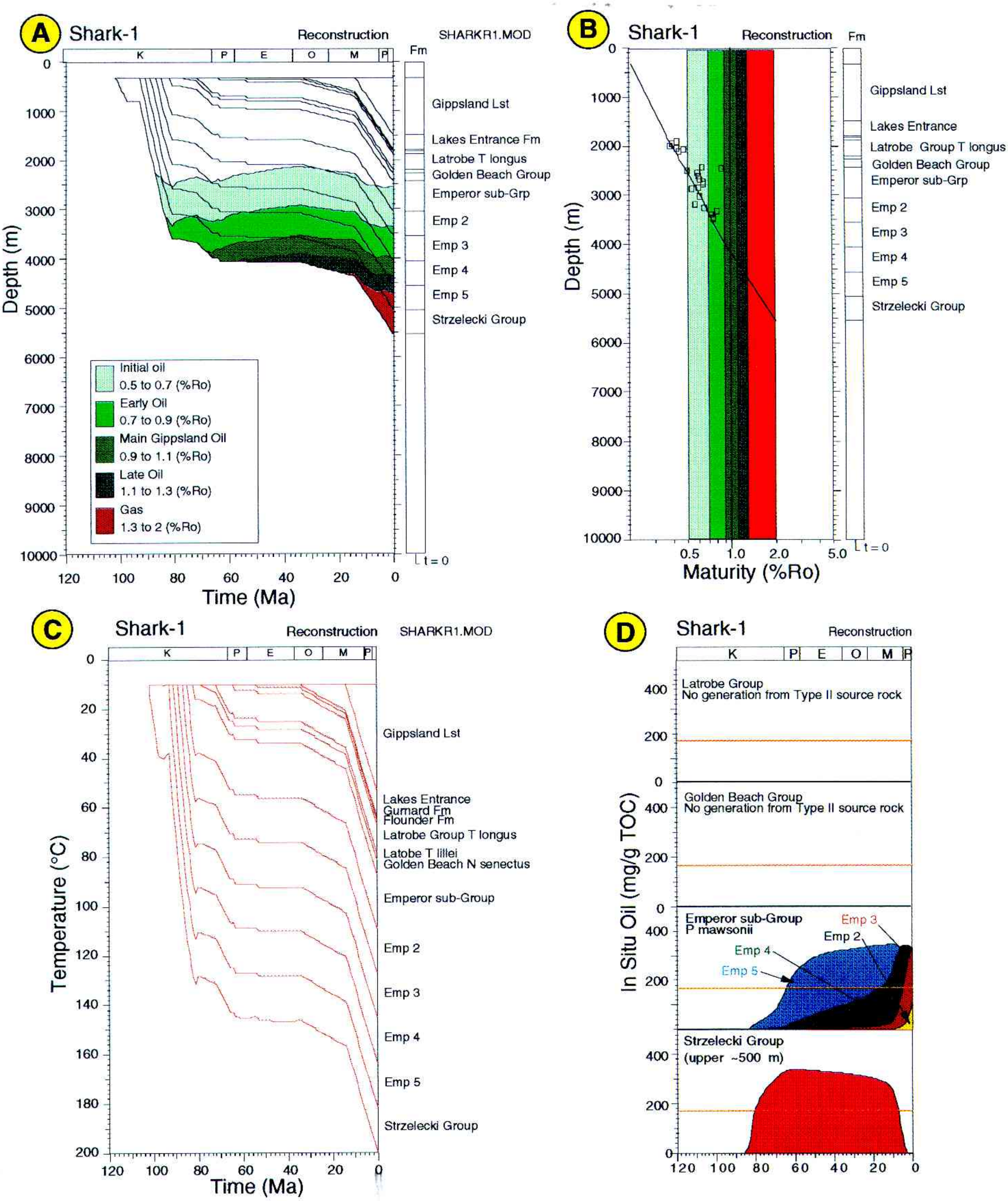


Figure 7.6: Shark-1, Source rock maturation summary

A. Reconstructed burial history with vitrinite reflectance source rock maturation windows

B. Measured vitrinite reflectance and maturity profile predicted from the reconstructed thermal history shown in C.

C. Reconstructed thermal history based on the present-day geothermal conditions and the regional thermal history model discussed in the text.

D. In situ oil versus time for a Type II source rock derived from the reconstructed thermal history shown in C. The Emperor sub-Group has been divided arbitrarily into a number of units of equal thickness (~ 400 to 600 m) in order to better illustrate the variation in timing of active hydrocarbon generation within this thick unit. (The horizontal line at 175 mg/g TOC represents 50% oil generation from the assumed Type II source rock).

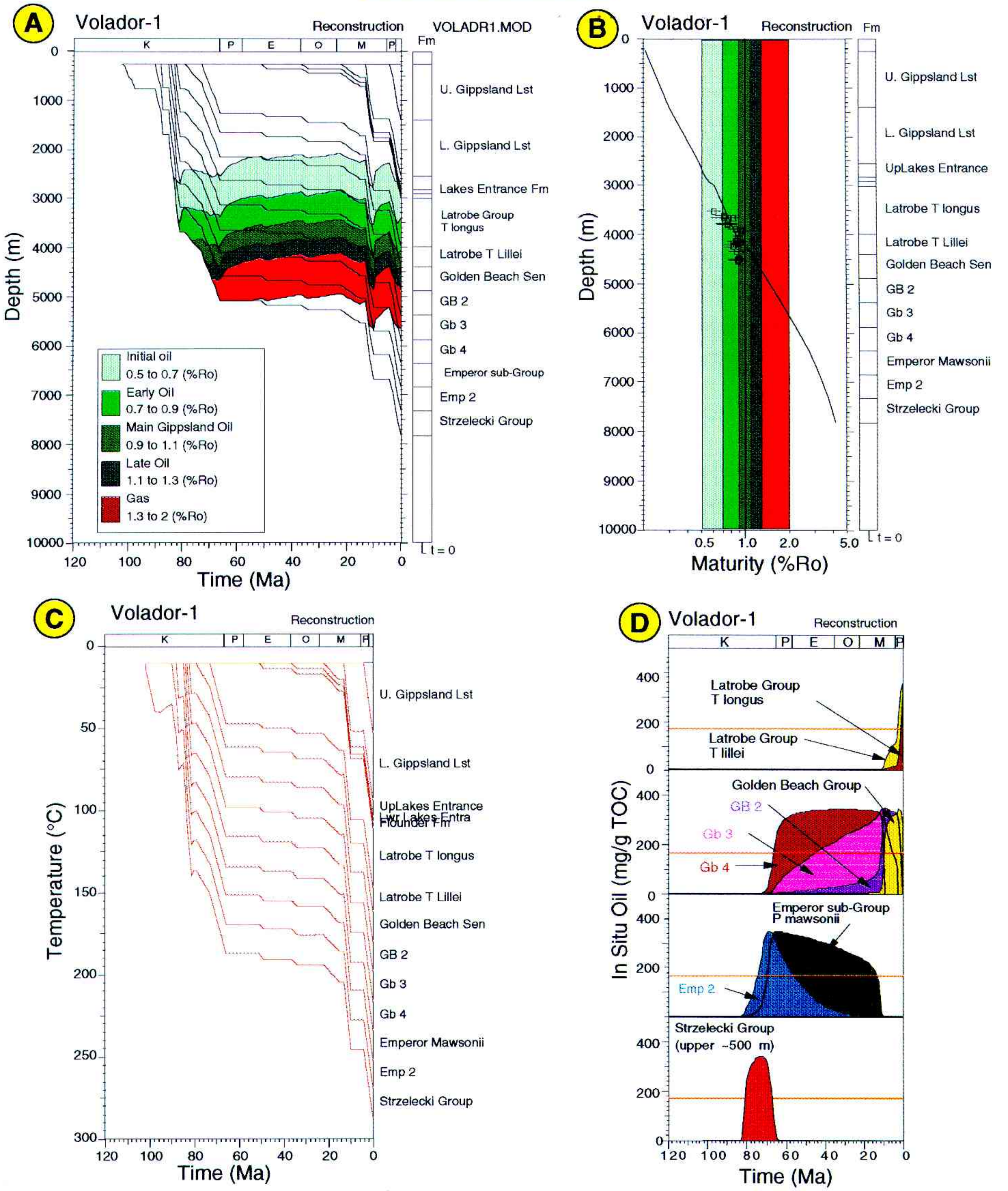


Figure 7.7: Volador-1, Source rock maturation summary

A. Reconstructed burial history with vitrinite reflectance source rock maturation windows

B. Measured vitrinite reflectance and maturity profile predicted from the reconstructed thermal history shown in C.

C. Reconstructed thermal history based on the present-day geothermal conditions and the regional thermal history model discussed in the text.

D. In situ oil versus time for a Type II source rock derived from the reconstructed thermal history shown in C. The Golden Beach Group and the Emperor sub-Group have been divided arbitrarily into a number of units of equal thickness (~ 400 to 600 m) in order to better illustrate the variation in timing of active hydrocarbon generation within these thick units. (The horizontal line at 175 mg/g TOC represents 50% oil generation from the assumed Type II source rock).

8. Modelling of the Pseudo wells

8.1 Introduction

Thermal conditions

For all Pseudo wells a uniform thermal history has been used: A present-day geothermal gradient of 28°C/km, a sea bed temperature of 5°C and a paleogeothermal gradient history increasing linearly from 28°C/km at 135 Ma, peaking at 55°C/km in the mid-Cretaceous (95 Ma), and declining linearly to 28°C/km by 80 Ma.

Uplift and erosion

Significant uplift and erosion has been identified on seismic only associated with the mid-Santonian (~80 Ma) unconformity. For most locations this is less than ~400 m and has little effect on the maturation history. At Pseudo well locations 3 and 5 greater uplift and erosion is identified but even at these locations, the interplay of burial and thermal histories are such that the entire section in all wells reaches maximum maturity at the present-day. The diagrams provided use the maximum uplift and erosion values for each Pseudo well location listed in Table 2.1.

Summary figures

Four summary figures have been provided for each Pseudo well location:

A. Reconstructed burial history with vitrinite reflectance-based source rock maturation windows, including a notional Gippsland optimum generation window of 0.9 to 1.% Ro.

B. Variation of maturity with time including maturity windows

C. Thermal history based on assumed geothermal gradient conditions and the regional thermal history model.

D. In situ Oil versus time for Type II source rock in various stratigraphic units derived from the assumed thermal history shown in C.

Where a large thickness of a particular unit is encountered in a well, this has been split into a number of units of equal thickness between ~ 400 and 600 m in order to provide better resolution on the timing at which specific maturation levels were reached. Typically this applies to the Golden Beach (GB 2, GB 3, etc.) and Emperor sub-Groups (EM 2, etc.). In the case of the Strzelecki Group, a variable number of units (eg Strz 2 etc.) of 500 m thickness have been defined to illustrate the variation in timing of maturation resulting from the rapid decline in heat flow (Paleogeothermal gradient) between 95 ad 80 Ma.

8.2 Pseudo-1

Burial history: Pseudo-1 is sited in 2347 m of water. A burial history based on seismic picks provided by DNRE (Table A.1) with 400 m of uplift and erosion between 80 and 78 Ma (Table 2.1) has been assumed, as shown in Figure 8.1A. The burial history also shows superimposed maturity windows derived from the thermal history shown in Figure 8.1C.

Source rock maturation and hydrocarbon generation histories: Figure 8.1B depicts the variation of predicted maturity (Burnham and Sweeney, 1989) with time derived from the thermal history shown in Figure 8.1C. The history shows that potential source rocks in various units enter the main Gippsland oil generation window (~0.9 to 1.1% Ro) at this location, more or less continuously from the Late Cretaceous (~80 Ma) to the present-day.

The generation of "in situ oil" (Type II source rock) with time for key stratigraphic horizons in **Pseudo-1** based on the thermal history shown in Figure 8.1C is illustrated in Figure 8.1D.

The deepest unit of the **Strzelecki Group** (Strz 3) begins generation in the mid-Cretaceous (~90 Ma) and undergoes rapid generation to completion by about 85 Ma, with complete cracking to gas between 85 and ~65 Ma. Mid-placed **Strzelecki Group** (Strz 2) also begins generation in the mid-Cretaceous (~90 Ma) and undergoes rapid generation to completion by about 85 Ma. Cracking to gas begins at ~85 Ma and progresses relatively slowly to completion by ~50 Ma. The upper 500 m of the **Strzelecki Group** begins generation at ~85 Ma and is totally exhausted by about 80 Ma. Cracking to gas proceeds slowly between ~85 and ~60 Ma and the progresses to completion by ~30 Ma.

The deepest unit of the **Emperor sub-Group** (Emp 5) begins generation in the Late Cretaceous (~85 Ma) and undergoes rapid generation to near completion (~90%) by about 80 Ma, slowly reaching total exhaustion at ~60 Ma. Complete cracking to gas occurs progressively between ~60 Ma and 20 Ma. **Emperor sub-Group unit Emp 3** begins generation at ~80 Ma and undergoes relatively slow generation to completion by ~25 Ma. Between 25 Ma and the present-day slow cracking to gas occurs. The uppermost **Emperor sub-Group** begins generation at ~40 Ma and undergoes relatively slow generation to ~80% completion at the present-day.

The deepest unit of the **Golden Beach Group** (GB 3) begins generation in the Late Tertiary (~25 Ma) and undergoes relatively slow generation to ~25% completion by the present-day. No part of the shallower **Golden Beach or Latrobe Groups** is sufficiently heated to generate significant oil from the assumed Type II source rock.

8.3 Pseudo-2

Burial history: **Pseudo-2** is sited in 2442 m of water. A burial history based on seismic picks provided by DNRE (Table A.1) with 400 m of uplift and erosion between 82 and 80 Ma (Table 2.1) has been assumed, as shown in Figure 8.2A. The burial history also shows superimposed maturity windows derived from the thermal history shown in Figure 8.2C.

Source rock maturation and hydrocarbon generation histories: Figure 8.2B depicts the variation of predicted maturity (Burnham and Sweeney, 1989) with time derived from the thermal history shown in Figure 8.2C. The history shows that potential source rocks in various units enter the main Gippsland oil generation window (~0.9 to 1.1% R_0) at this location more or less continuously from the Late Cretaceous (~80 Ma) to the present-day.

The generation of "in situ oil" (Type II source rock) with time for key stratigraphic horizons in **Pseudo-2** based on the thermal history shown in Figure 8.2C is illustrated in Figure 8.2D.

The deepest unit of the **Strzelecki Group** (Strz 3) begins generation in the mid-Cretaceous (~90 Ma) and undergoes rapid generation to completion by about 85 Ma, with complete cracking to gas between 85 and ~80 Ma. The upper 500 m of the **Strzelecki Group** also begins generation in the mid-Cretaceous (~90 Ma) and undergoes rapid generation to completion by about 85 Ma. Cracking to gas begins at ~85 Ma and progresses relatively slowly to completion by ~40 Ma.

The deepest unit of the **Emperor sub-Group** (Emp 5) begins generation in the Late Cretaceous (~85 Ma) and undergoes rapid generation to near completion (~95%) by about 80 Ma, slowly reaching total exhaustion at ~65 Ma. Complete cracking to gas occurs progressively between ~65 Ma and 20 Ma. **Emperor sub-Group unit Emp 3** begins generation at ~80 Ma and undergoes relatively slow generation to completion by ~25 Ma. Between 25 Ma and the present-day slow cracking to gas occurs. The uppermost **Emperor sub-Group** begins generation at ~40 Ma and undergoes relatively slow generation to ~60% completion at the present-day.

The deepest unit of the **Golden Beach Group** (GB 3) begins generation in the Early Tertiary (~25 Ma) but only achieves ~10% generation by the present-day. No part of the shallower **Golden Beach or Latrobe Groups** is sufficiently heated to generate significant oil from the assumed Type II source rock.

8.4 Pseudo-3

Burial history: **Pseudo-3** is sited in 2212 m of water. A burial history based on seismic picks provided by DNRE (Table A.1) with 1500 m of uplift and erosion between 82 and 80 Ma (Table 2.1) has been assumed, as shown in Figure 8.3A. This location represents one of the potentially most uplifted blocks within the deep water acreage area. The burial history also shows superimposed maturity windows derived from the thermal history shown in Figure 8.3C.

Source rock maturation and hydrocarbon generation histories: Figure 8.3B depicts the variation of predicted maturity (Burnham and Sweeney, 1989) with time derived from the thermal history shown in Figure 8.3C. The history shows that only potential Strzelecki Group source rocks enter the main Gippsland oil generation window (~0.9 to 1.1% R_0) at this location. Deeper Strzelecki Group enters in the Late Cretaceous (~80 Ma) while shallower units enter between ~20 Ma and the present-day.

The generation of "in situ oil" (Type II source rock) with time for key stratigraphic horizons in **Pseudo-3** based on the thermal history shown in Figure 8.3C is illustrated in Figure 8.3D.

The deepest unit of the **Strzelecki Group** (Strz 4) begins generation in the mid-Cretaceous (~90 Ma) and undergoes rapid generation between ~85 and completion at ~80 Ma. Little active generation occurs between 80 and ~25 Ma, at which point accelerated heating causes rapid cracking of "in situ oil' to gas which is almost completed by the present-day. A similar pattern of generation is shown by **Strzelecki Group** unit Strz 3. The upper 500 m of the **Strzelecki Group** also begins generation in the late Cretaceous (~80 Ma) but little generation (<15%) occur until a rapid generation phase commencing at ~20 Ma proceeds to ~90% completion by the present-day.

The deepest unit of the **Emperor sub-Group** (Emp 3) begins generation in the Early Tertiary (~25 Ma) and undergoes fairly rapid generation to ~40% completion by the present-day. **Emperor sub-Group unit** Emp 2 shows only minor generation (<10%) over the last 20 Ma.

No part of the shallower **Emperor sub-Group, the Golden Beach or Latrobe Groups** is sufficiently heated to generate significant oil from the assumed Type II source rock.

8.5 Pseudo-4

Burial history: **Pseudo-4** is sited in 2050 m of water. A burial history based on seismic picks provided by DNRE (Table A.1) with 200 m of uplift and erosion between 82 and 80 Ma (Table 2.1) has been assumed, as shown in Figure 8.4A. This location has Paleozoic basement at a relatively shallow depth. The burial history also shows superimposed maturity windows derived from the thermal history shown in Figure 8.4C.

Source rock maturation and hydrocarbon generation histories: Figure 8.4B depicts the variation of predicted maturity (Burnham and Sweeney, 1989) with time derived from the thermal history shown in Figure 8.4C. The history shows that no part of the Mesozoic-Tertiary sedimentary section at this location enters the main Gippsland oil generation window (~0.9 to 1.1% R_o).

The generation of "in situ oil" (Type II source rock) with time for key stratigraphic horizons in **Pseudo-4** based on the thermal history shown in Figure 8.4C is illustrated in Figure 8.4D.

The deepest unit of the **Strzelecki Group** (Strz 3) shows only minor generation (<10%) over the last 20 Ma and no part of the shallower **Strzelecki Group, the Emperor sub-Group, the Golden Beach or Latrobe Groups** is sufficiently heated to generate significant oil from the assumed Type II source rock at this location.

8.6 Pseudo-5

Burial history: **Pseudo-5** is sited in 2790 m of water. A burial history based on seismic picks provided by DNRE (Table A.1) with 1000 m of uplift and erosion (the second largest magnitude in the study) between 82 and 80 Ma (Table 2.1) has been assumed, as shown in Figure 8.5A. The burial history also shows superimposed maturity windows derived from the thermal history shown in Figure 8.5C.

Source rock maturation and hydrocarbon generation histories: Figure 8.5B depicts the variation of predicted maturity (Burnham and Sweeney, 1989) with time derived from the thermal history shown in Figure 8.5C. The history shows that only potential source rocks in the Strzelecki Group enter the main Gippsland oil generation window (~0.9 to 1.1% R_0) at this location, more or less continuously from the Late Cretaceous (~80 Ma) to the present-day.

The generation of "in situ oil" (Type II source rock) with time for key stratigraphic horizons in **Pseudo-5** based on the thermal history shown in Figure 8.5C is illustrated in Figure 8.5D.

The deepest unit of the **Strzelecki Group** (Strz 2) begins generation in the Late Cretaceous (~85 Ma) and undergoes rapid generation to near completion (~95%) by about 80 Ma, slowly reaching total exhaustion at ~40 Ma. Minor cracking to gas occurs progressively between ~40 Ma and the present-day. The upper 500 m of the **Strzelecki Group** also begins generation in the Late Cretaceous (~85 Ma) and undergoes a rapid initial generation phase reaching ~40% completion by about 80 Ma, progressing slowly to near total completion at the present-day.

The deepest unit of the **Emperor sub-Group** (Emp 3) begins generation in the Late Cretaceous (~80 Ma), progressing steadily to ~75% completion at the present-day. **Emperor sub-Group unit Emp 2** begins generation at ~60 Ma, but only achieves ~20% completion by the present-day.

The shallowest unit of the **Emperor sub-Group** begins generation in the Early Tertiary (~25 Ma) but only achieves ~5% generation by the present-day. No part of the **Golden Beach or Latrobe Groups** is sufficiently heated to generate significant oil from the assumed Type II source rock.

8.7 Pseudo-6

Burial history: **Pseudo-6** is sited in 2685 m of water. A burial history based on seismic picks provided by DNRE (Table A.1) with 200 m of uplift and erosion between 82 and 80 Ma (Table 2.1) has been assumed, as shown in Figure 8.6A. The burial history also shows superimposed maturity windows derived from the thermal history shown in Figure 8.6C.

Source rock maturation and hydrocarbon generation histories: Figure 8.6B depicts the variation of predicted maturity (Burnham and Sweeney, 1989) with time derived from the thermal history shown in Figure 8.6C. The history shows that only potential source rocks in the deeper Strzelecki Group enter the main Gippsland oil generation window (~0.9 to 1.1% R_0) at this location, beginning at ~30 Ma.

The generation of "in situ oil" (Type II source rock) with time for key stratigraphic horizons in **Pseudo-6** based on the thermal history shown in Figure 8.6C is illustrated in Figure 8.6D.

The deepest unit of the **Strzelecki Group** (Strz 4) begins generation in the mid-Cretaceous (~95 Ma) progressing fairly steadily to total completion at about the present-day. **Strzelecki Group** unit Strz 3 begins generation in the Late Cretaceous (~80 Ma) progressing steadily to near total completion at the present-day. **Strzelecki Group** unit Strz 2 begins generation in the mid-Tertiary (~40 Ma) progressing to ~40% generation at the present-day. The upper 500 m of the **Strzelecki Group** begins generation in the Early Tertiary (~20 Ma) but only achieves ~5% generation by the present-day.

No part of the **Emperor sub-Group, the Golden Beach Group or Latrobe Group** is sufficiently heated to generate significant oil from the assumed Type II source rock.

8.8 Pseudo-7

Burial history: **Pseudo-7** is sited in 2672 m of water. A burial history based on seismic picks provided by DNRE (Table A.1) with 200 m of uplift and erosion between 82 and 80 Ma (Table 2.1) has been assumed, as shown in Figure 8.7A. The burial history also shows superimposed maturity windows derived from the thermal history shown in Figure 8.7C.

Source rock maturation and hydrocarbon generation histories: Figure 8.7B depicts the variation of predicted maturity (Burnham and Sweeney, 1989) with time derived from the thermal history shown in Figure 8.7C. The history shows that only potential source rocks in the deeper Strzelecki Group enter the main Gippsland oil generation window (~0.9 to 1.1% R_0) at this location, beginning in the Late Cretaceous at ~80 Ma.

The generation of "in situ oil" (Type II source rock) with time for key stratigraphic horizons in **Pseudo-7** based on the thermal history shown in Figure 8.7C is illustrated in Figure 8.7D.

The deepest unit of the **Strzelecki Group** (Strz 3) begins generation in the Late Cretaceous (~85 Ma) and undergoes rapid generation to near completion (~90%) by about 80 Ma, slowly reaching total exhaustion at ~60 Ma. Minor cracking to gas occurs progressively between ~40 Ma and the present-day. **Strzelecki Group** unit Strz 3 also begins generation in the Late Cretaceous (~85 Ma) and undergoes a rapid initial generation phase reaching ~30% completion by about 80 Ma, progressing slowly to total completion at the present-day. The upper 500 m of the **Strzelecki Group** begins generation in the Late Cretaceous (~80 Ma) progressing steadily to near total completion at the present-day.

The deepest unit of the **Emperor sub-Group** (Emp 3) begins generation in the Late Cretaceous (~80 Ma) progressing steadily to ~40% generation at the present-day.

No part of the **shallower Emperor sub-Group, the Golden Beach Group or Latrobe Group** is sufficiently heated to generate significant oil from the assumed Type II source rock.

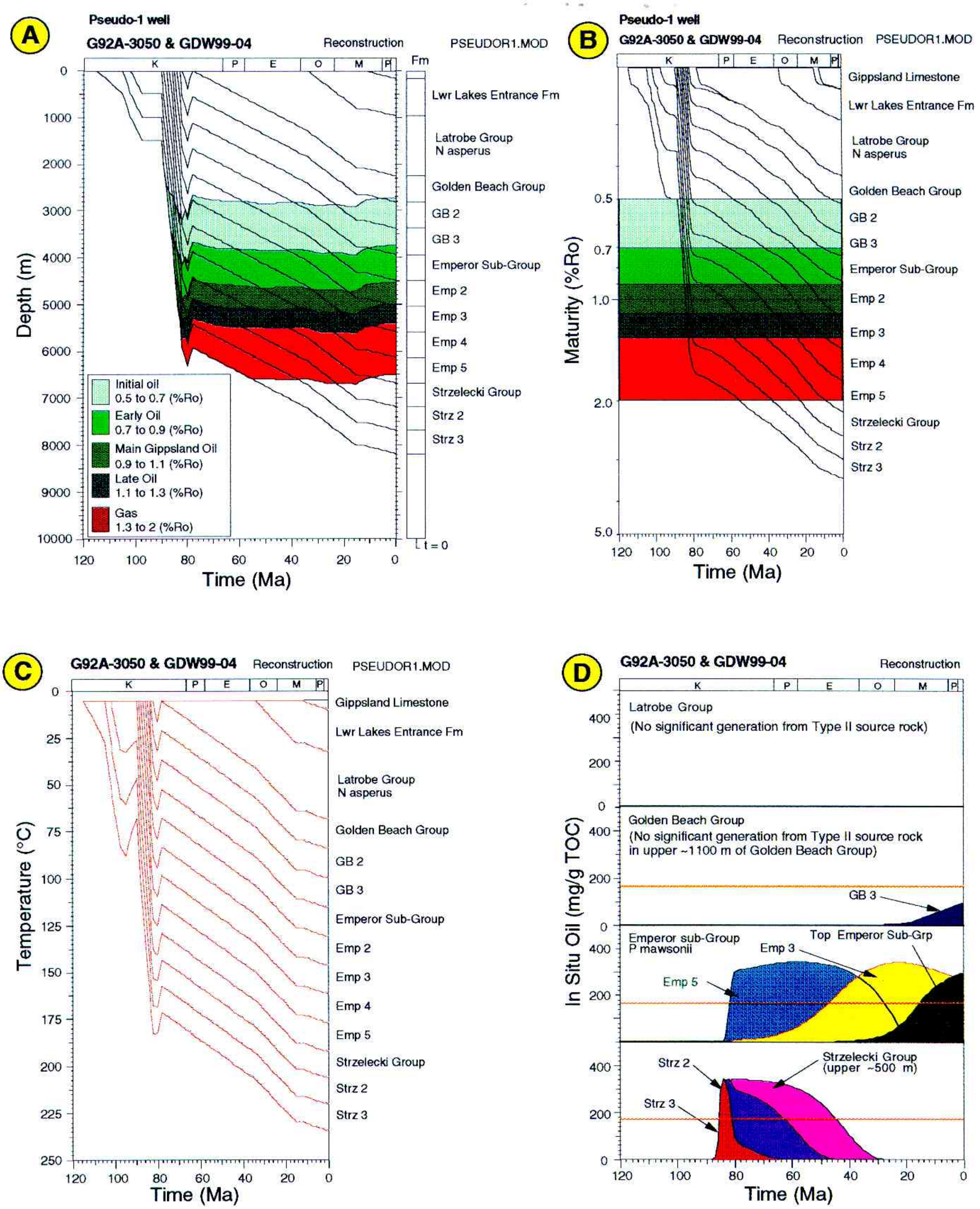


Figure 8.1: Pseudo-1 well, source rock maturation summary

A. Reconstructed burial history with vitrinite reflectance source rock maturation windows

B. Variation of vitrinite reflectance maturity with time predicted from the reconstructed thermal history shown in C.

C. Reconstructed thermal history based on the present-day geothermal conditions and the regional thermal history model discussed in the text.

D. In situ oil versus time for a Type II source rock derived from the reconstructed thermal history shown in C. The Golden Beach Group, Emperor sub-Group and Strzelecki Group have been divided arbitrarily into a number units of equal thickness (~ 400 to 600 m) in order to better illustrate the variation in timing of active hydrocarbon generation within these thick units. (The horizontal line at 175 mg/g TOC represents 50% oil generation from the assumed Type II source rock).

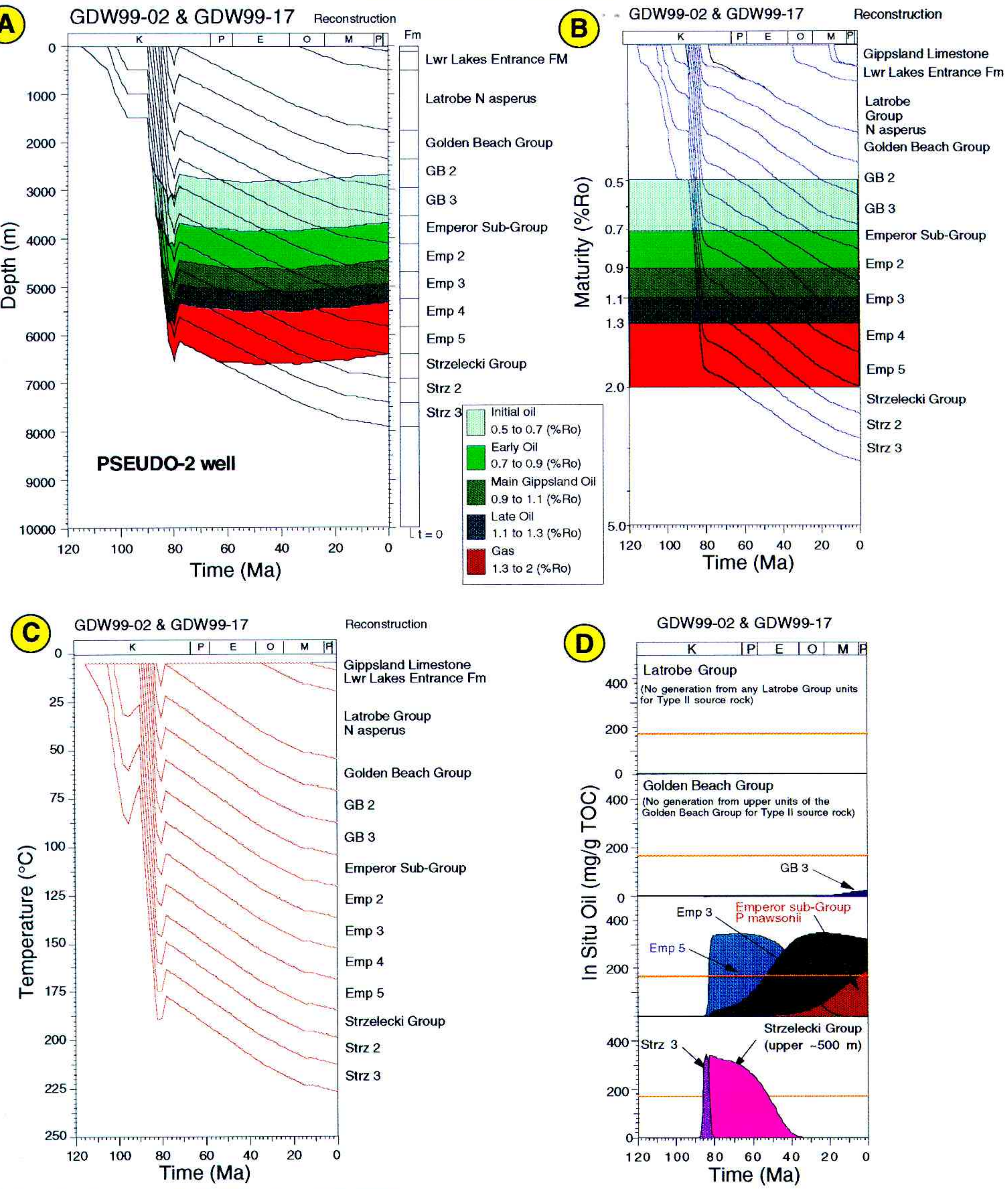


Figure 8.2: Pseudo-2 well, source rock maturation summary

A. Reconstructed burial history with vitrinite reflectance source rock maturation windows

B. Variation of vitrinite reflectance maturity with time predicted from the reconstructed thermal history shown in C.

C. Reconstructed thermal history based on the present-day geothermal conditions and the regional thermal history model discussed in the text.

D. In situ oil versus time for a Type II source rock derived from the reconstructed thermal history. The Strzelecki Group, Emperor sub-Group and Golden Beach Group have been divided arbitrarily into a number units of equal thickness (~ 400 to 600 m) in order to better illustrate the variation in timing of active hydrocarbon generation within these thick units. (The horizontal line at 175 mg/g TOC represents 50% oil generation from the assumed Type II source rock).

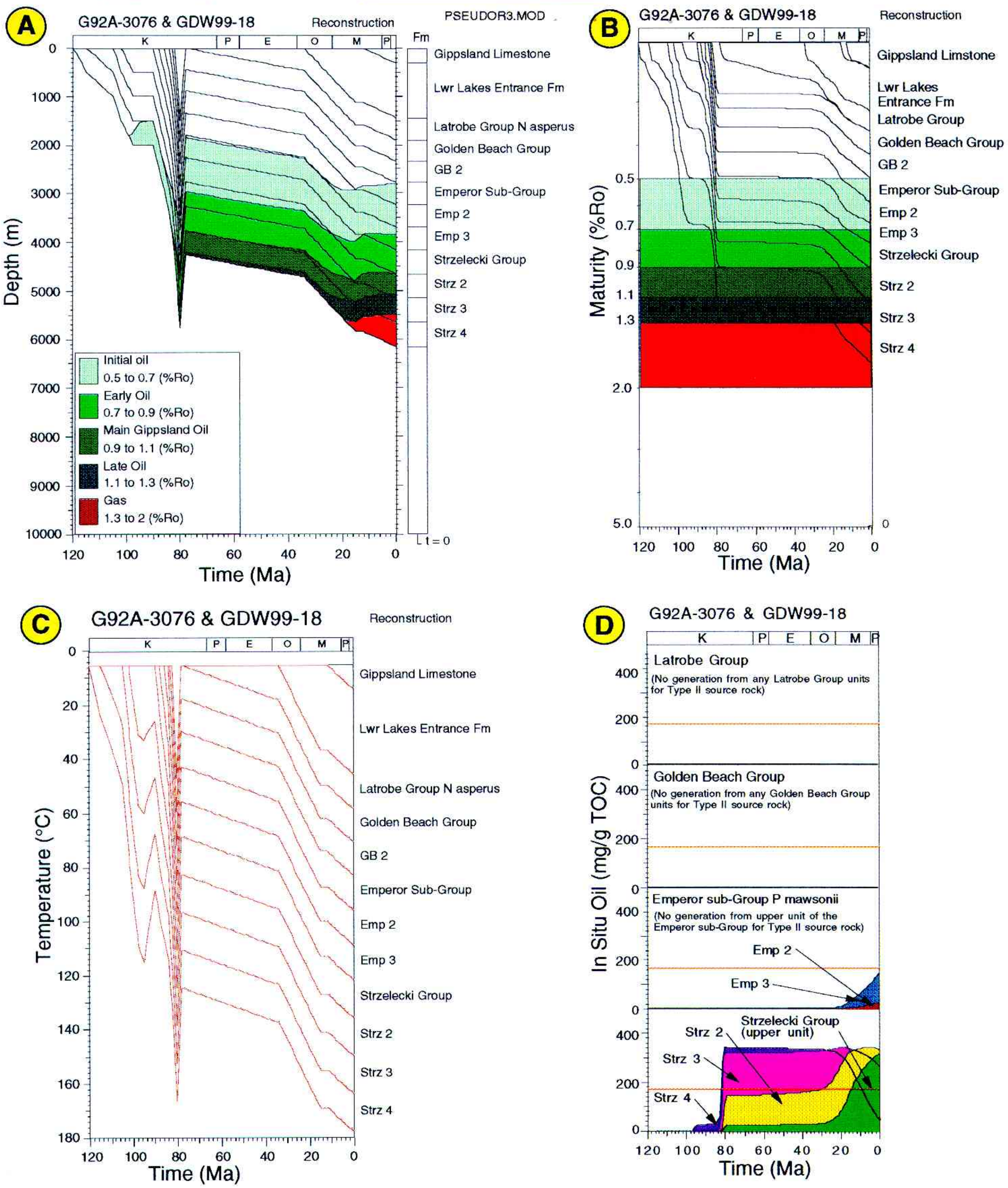


Figure 8.3: Pseudo-3 well, source rock maturation summary

A. Reconstructed burial history with vitrinite reflectance source rock maturation windows

B. Variation of vitrinite reflectance maturity with time predicted from the reconstructed thermal history shown in C.

C. Reconstructed thermal history based on the present-day geothermal conditions and the regional thermal history model discussed in the text.

D. In situ oil versus time for a Type II source rock derived from the reconstructed thermal history. The Strzelecki Group, Emperor sub-Group and Golden Beach Group have been divided arbitrarily into a number units of equal thickness (~ 400 to 600 m) in order to better illustrate the variation in timing of active hydrocarbon generation within these thick units. (The horizontal line at 175 mg/g TOC represents 50% oil generation from the assumed Type II source rock).

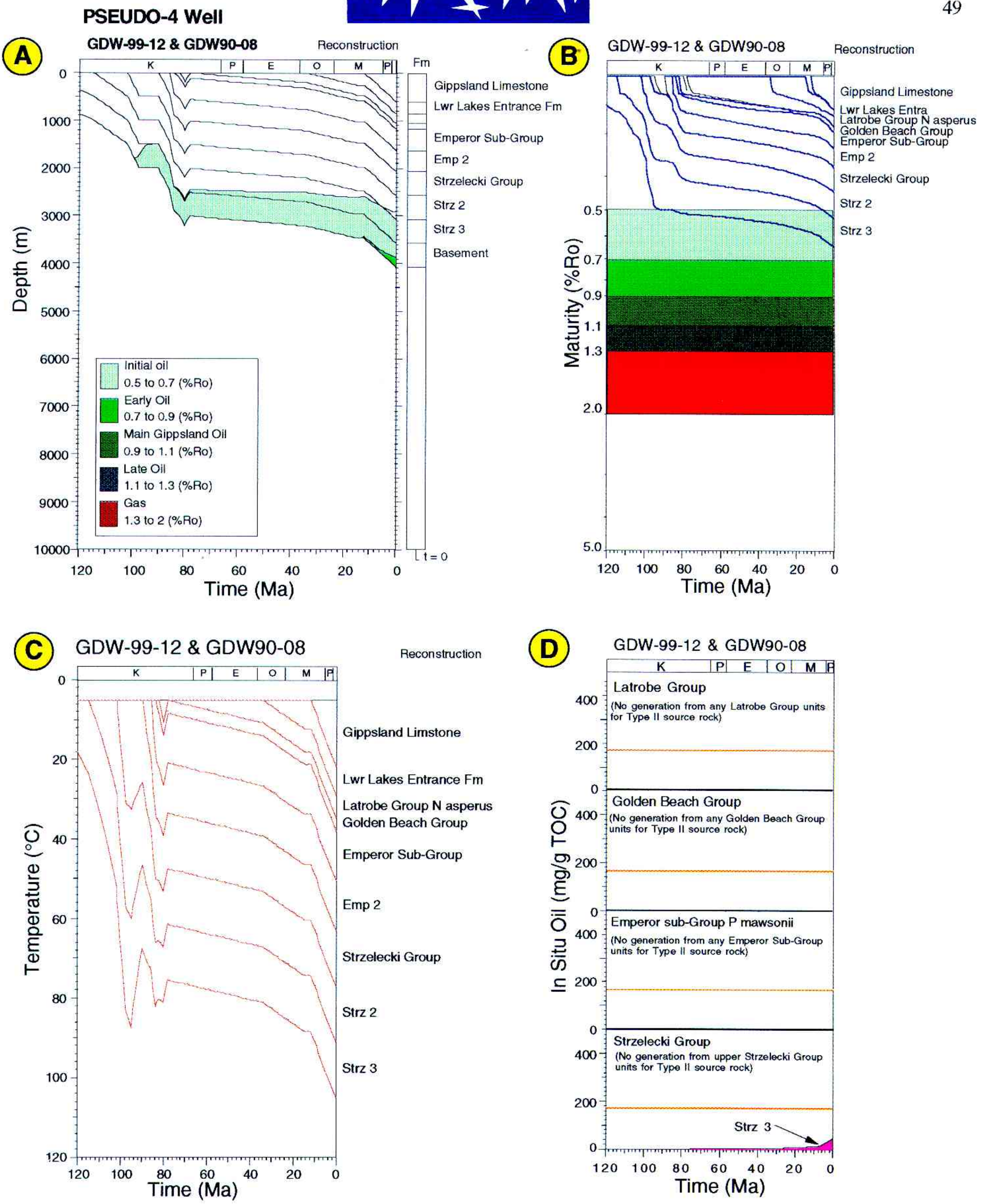


Figure 8.4: Pseudo-4 well, source rock maturation summary

A. Reconstructed burial history with vitrinite reflectance source rock maturation windows

B. Variation of vitrinite reflectance maturity with time predicted from the reconstructed thermal history shown in C.

C. Reconstructed thermal history based on the present-day geothermal conditions and the regional thermal history model discussed in the text.

D. In situ oil versus time for a Type II source rock derived from the reconstructed thermal history. The Strzelecki Group, Emperor sub-Group and Golden Beach Group have been divided arbitrarily into a number units of equal thickness (~ 400 to 600 m) in order to better illustrate the variation in timing of active hydrocarbon generation within these thick units. (The horizontal line at 175 mg/g TOC represents 50% oil generation from the assumed Type II source rock).

PSEUDO -5 Well

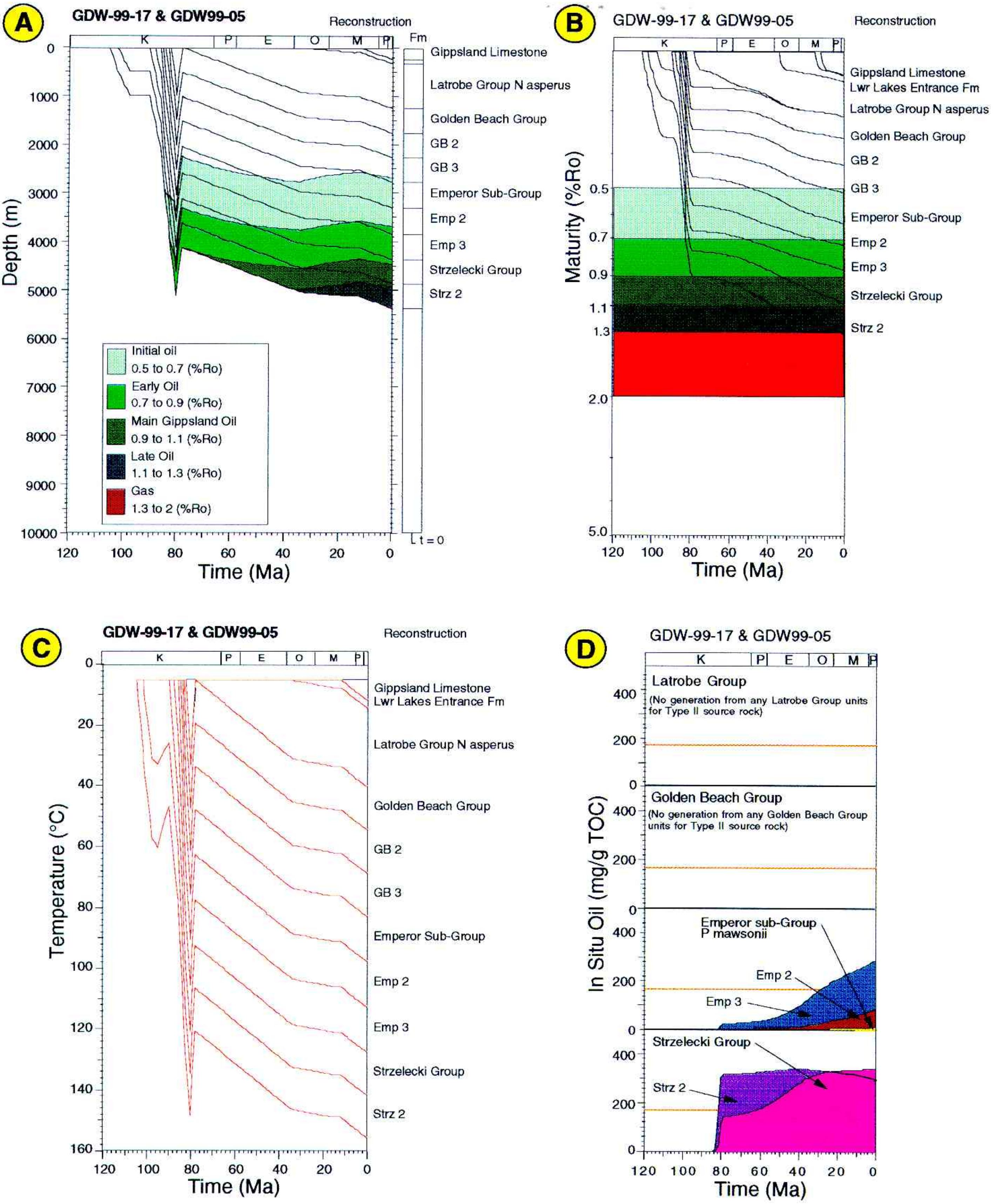


Figure 8.5: Pseudo-5 well, source rock maturation summary

A. Reconstructed burial history with vitrinite reflectance source rock maturation windows

B. Variation of vitrinite reflectance maturity with time predicted from the reconstructed thermal history shown in C.

C. Reconstructed thermal history based on the present-day geothermal conditions and the regional thermal history model discussed in the text.

D. In situ oil versus time for a Type II source rock derived from the reconstructed thermal history. The Strzelecki Group, Emperor sub-Group and Golden Beach Group have been divided arbitrarily into a number units of equal thickness (~ 400 to 600 m) in order to better illustrate the variation in timing of active hydrocarbon generation within these thick units. (The horizontal line at 175 mg/g TOC represents 50% oil generation from the assumed Type II source rock).

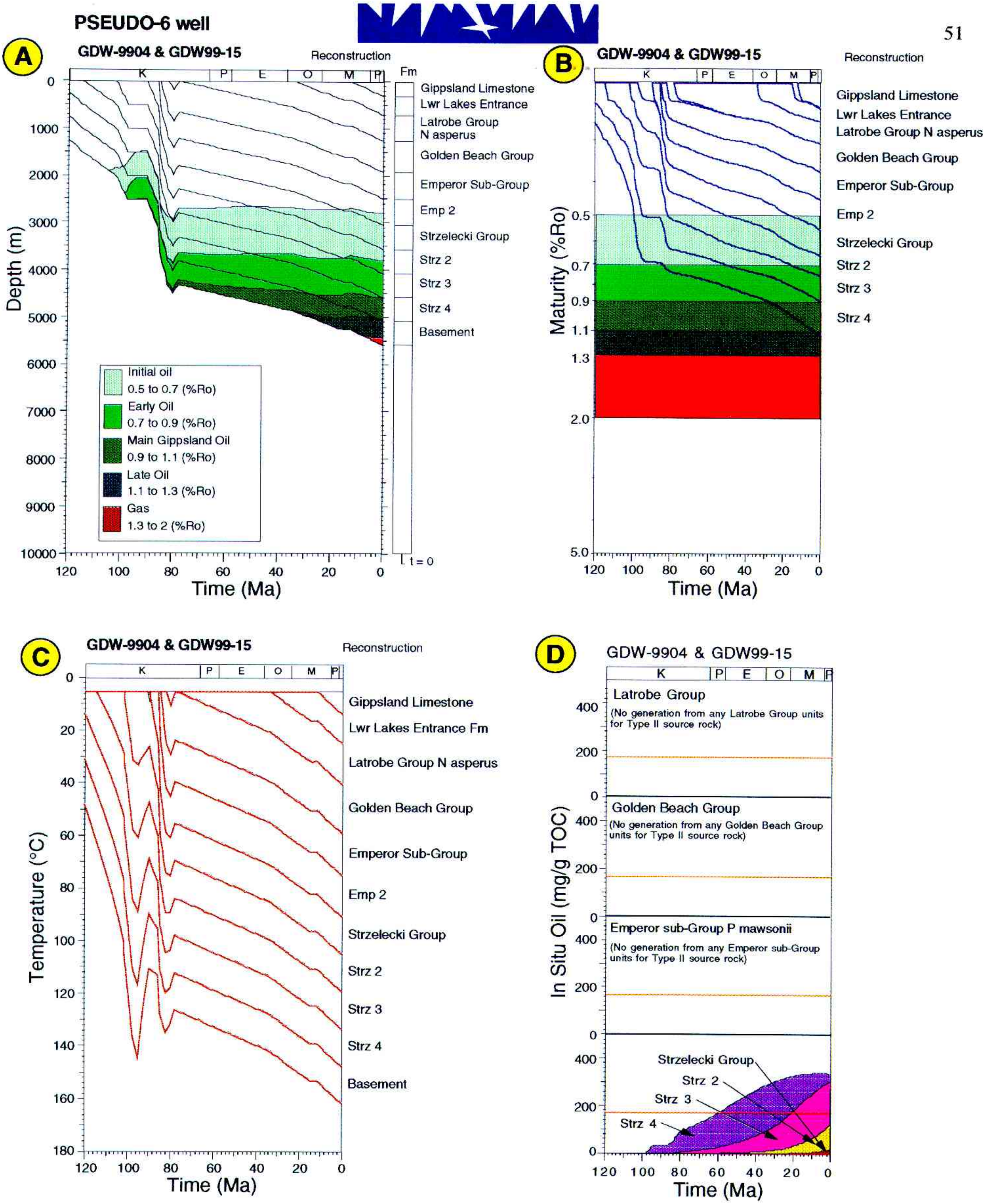


Figure 8.6: Pseudo-6 well, source rock maturation summary

A. Reconstructed burial history with vitrinite reflectance source rock maturation windows

B. Variation of vitrinite reflectance maturity with time predicted from the reconstructed thermal history shown in C.

C. Reconstructed thermal history based on the present-day geothermal conditions and the regional thermal history model discussed in the text.

D. In situ oil versus time for a Type II source rock derived from the reconstructed thermal history. The Strzelecki Group, Emperor sub-Group and Golden Beach Group have been divided arbitrarily into a number units of equal thickness (~ 400 to 600 m) in order to better illustrate the variation in timing of active hydrocarbon generation within these thick units. (The horizontal line at 175 mg/g TOC represents 50% oil generation from the assumed Type II source rock).

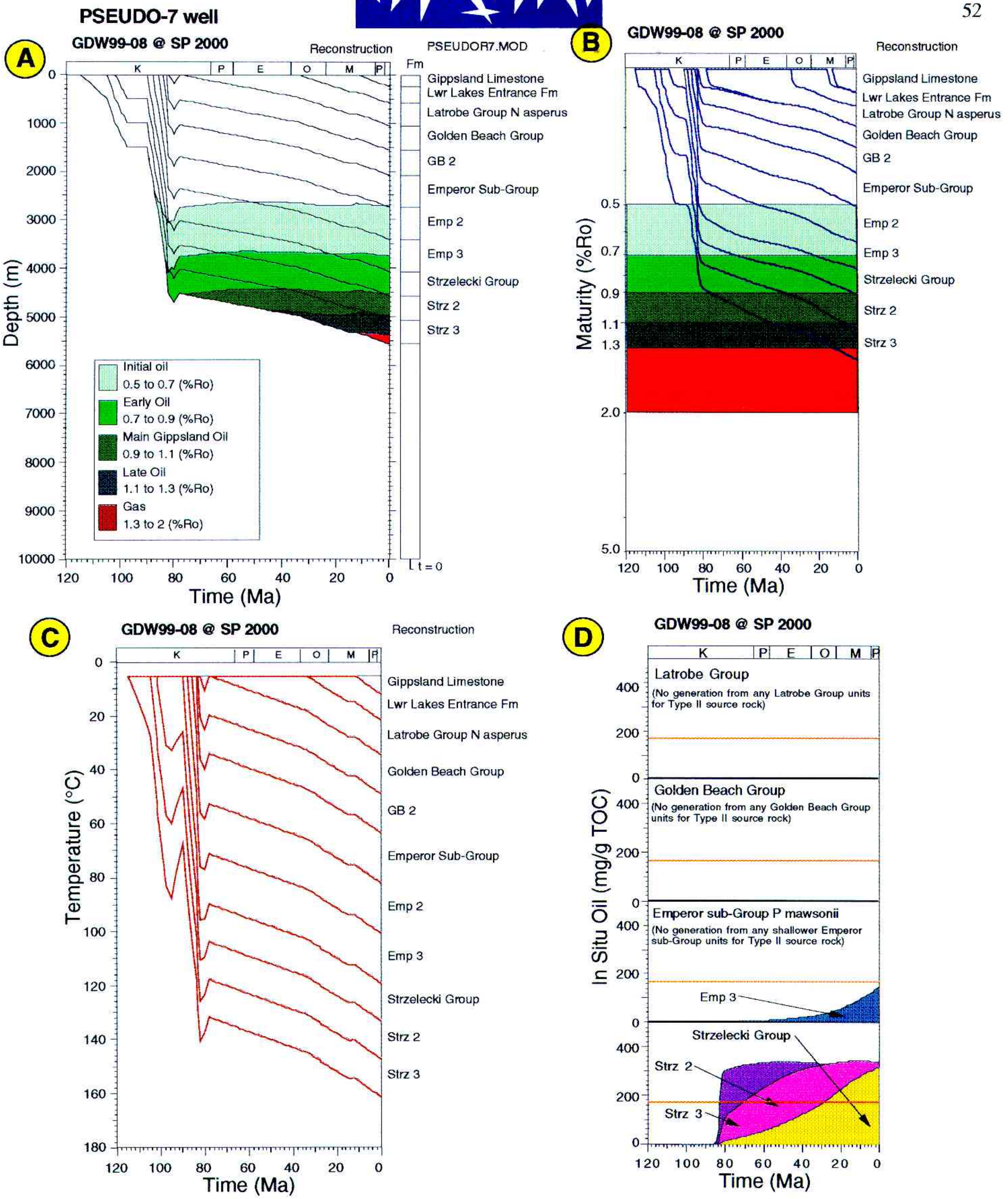


Figure 8.7: Pseudo-7 well, source rock maturation summary

A. Reconstructed burial history with vitrinite reflectance source rock maturation windows

B. Variation of vitrinite reflectance maturity with time predicted from the reconstructed thermal history shown in C.

C. Reconstructed thermal history based on the present-day geothermal conditions and the regional thermal history model discussed in the text.

D. In situ oil versus time for a Type II source rock derived from the reconstructed thermal history. The Strzelecki Group, Emperor sub-Group and Golden Beach Group have been divided arbitrarily into a number units of equal thickness (~ 400 to 600 m) in order to better illustrate the variation in timing of active hydrocarbon generation within these thick units. (The horizontal line at 175 mg/g TOC represents 50% oil generation from the assumed Type II source rock).

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APPENDIX A

Well Details and Geological Data

A.1 Stratigraphic details

Details of the preserved stratigraphy in each **Real well (Anemone-1A, Basker-1, Blackback-1, Hermes-1, Pisces-1, Shark-1 and Volador-1)** and in each of **seven Pseudo wells** are provided in Table A.1. The pseudo wells are located at:

1. Pseudo well-1: Intersection of G92A-3050 and GDW99-04
2. Pseudo well-2: Intersection of GDW99-02 and GDW99-17
3. Pseudo well-3: Intersection of G92A-3076 and GDW99-18
4. Pseudo well-4: Intersection of GDW99-12 and GDW99-08
5. Pseudo well-5: Intersection of GDW99-17 and GDW99-05
6. Pseudo well-6: Intersection of GDW99-04 and GDW99-15
7. Pseudo well-7: GDW99-08 at shot point 2000

The Real and Pseudo well locations are shown in Figure 1.1

A.2 Present temperatures

In the application of any technique involving estimation of paleotemperatures, it is critical to control the present temperature profile, since estimation of maximum paleotemperatures proceeds from assessing how much of the observed effect could be explained by the magnitude of present temperatures.

Raw BHT measurements in each well were obtained from the relevant well completion reports and were corrected using a simplified correction procedure adapted from that of Andrews-Speed et al. (1984). (Also see Oxburgh and Andrews-Speed, 1981.). In this procedure, the quoted BHT data are corrected by increasing the difference between the sea-bed temperature (assumed to be 10°C) and the uncorrected BHT by 20% for uncorrected temperatures below 66°C (150°F), and by 25% for uncorrected temperatures above 66°C (see Table A.1). Note that where more than one measurement is available at any one depth, the value with the shortest time since circulation was used.

Using the BHT values corrected in this way, linear present-day gradients have been established for each well using a sea-bed temperature of 10°C. Temperature data and present-day thermal gradients, which vary between ~25 and 37°C/km are summarised in Table A.1.

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Table A.1: Summary of stratigraphy - Gippsland Basin Deep Water Project (Geotrack Report #741)

	KB elevation (mAMSL)	Water Depth (m)	Stratigraphic Interval	Depth of Top TVD rKB (m)	Age of Top (Ma)
Anemone-1A					
	27	231	U. Gippsland Limestone	258	0
			L. Gippsland Limestone	1317	23
			Lakes Entrance Fm	2197	25
			Gurnard Fm	2581	40
			Unconformity	2677	45
			Latrobe Group L balmei	2677	55
			Latrobe Group T longus	2760	65
			Latrobe Group T lillei	3198	72
			Unconformity	3875	79
			Golden Beach Group N senectus	3875	81
			Golden Beach Group T apoxyexinus	4525	82
			TD	4775	86
			Unconformity	4801	86
			Emperor sub-Group	4801	88
			Unconformity	5215	90
			Strzelecki Group	5215	97.5
			Strz 2	5715	102
			Strz 3	6215	105
			Strz 4	6715	115
				7215	120

Table A.1: Continued

	KB elevation (mAMSL)	Water Depth (m)	Stratigraphic Interval	Depth of Top TVD rKB (m)	Age of Top (Ma)
Basker-1					
	25	162	Pliocene - Recent	187	0
			Gippsland Lst	1346	5
			Unconformity	1807	12
			L. Lakes Entrance Fm	1807	15
			Unconformity	2119.5	22
			Flounder Fm	2119.5	48
			Unconformity	2187	52
			Latrobe Group L balmei	2187	60
			Latrobe Group T longus	2503	65
			Latrobe Group T lillei	3191	72
			Unconformity	3800	78
			Golden Beach Group N senectus	3800	81
			TD	3991	82
			Unconformity	4190	82
			Emperor sub-Group	4190	87
			Emp 2	4803	88
			Emp 3	5416	89
			Unconformity	6030	90
			Strzelecki Group	6030	97.5
			Strz 2	6530	102
			Strz 3	7030	105
				7530	115

Table A.1: Continued

	KB elevation (mAMSL)	Water Depth (m)	Stratigraphic Interval	Depth of Top TVD rKB (m)	Age of Top (Ma)
Blackback-1					
	21	418	Gippsland Limestone	439	0
			Unconformity	2570	12
			L. Lakes Entrance Fm	2570	15
			Eocene Channel	2824	34
			Unconformity	2904	46
			Latrobe Group T longus	2904	65
			Latrobe Group T longus seismic marker	3543	69
			Latrobe Group T Lillei	4043	70
			TD	4043	70
			Unconformity	4204	78
			Golden Beach Group	4204	81
			Unconformity	5039	85
			Emperor sub-Group	5039	87
			EM 2	5676	88
			EM 3	6313	89
			Unconformity	6950	90
			Strzelecki Group	6950	97.5
			Strz 2	7450	102
			Strz 3	7950	105
				8450	115

Table A.1: Continued

	KB elevation (mAMSL)	Water Depth (m)	Stratigraphic Interval	Depth of Top TVD rKB (m)	Age of Top (Ma)
Hermes-1					
	23	85	Pliocene - Recent	108	0
			Gippsland Lst	307	5
			U. Lakes Entrance Fm	1878	12
			Unconformity	2162	13.5
			L. Lakes Entrance Fm	2162	15
			Unconformity	2475	22
			Oligocene Lakes Entrance Fm	2475	32
			Gurnard Fm	2502	34
			Unconformity	2508	36
			Flounder Fm	2508	45
			Unconformity	2544	48
			Latrobe Group L balemi	2544	60
			Latrobe Group T longus	2881	65
			Latrobe Group T lillei	3587	71
			TD	4565	79
			Unconformity	4648	79
			Golden Beach Group N senectus	4648	81
			GB 2	5212	82
			Unconformity	5776	84
			Emperor sub-Group	5776	86
			Emp 2	6405	87
			Emp 3	7034	88
			Unconformity	7663	90
			Strzelecki Group	7663	97.5
				8163	102

Table A.1: Continued

	KB elevation (mAMSL)	Water Depth (m)	Stratigraphic Interval	Depth of Top TVD rKB (m)	Age of Top (Ma)
Pisces-1					
	22	100	Gippsland Limestone	122	0
			Lakes Entrance Fm	1684.5	14
			Unconformity	1796.5	22
			Greensand	1796.5	30
			Unconformity	1808	33
			Gurnard Fm	1808	53
			Unconformity	1826.5	54
			Latrobe Group	1826.5	65
			Latrobe Group T lillei	1938	73
			Unconformity	2229	78
			Golden Beach Group	2229	81
			Golden Beach Group T apoxyexinus	2478	83
			TD	2558	84
			GB 3	3219	84
			GB 4	3960	85
			Unconformity	4700	86
			Basement	4700	400
				5200	450

Table A.1: Continued

	KB elevation (mAMSL)	Water Depth (m)	Stratigraphic Interval	Depth of Top TVD rKB (m)	Age of Top (Ma)
Shark-1					
	28.4	319.6	Gippsland Limestone	348	0
			Lakes Entrance Fm	1526	14
			Unconformity	1816	34
			Gurnard Fm	1816	53
			Unconformity	1854	54
			Flounder Fm	1854	63
			Unconformity	1915	64
			Latrobe Group T longus	1915	66
			Latrobe Group T lillei	2231	72
			Unconformity	2310	79
			Golden Beach Group N senectus	2310	81
			Emperor sub-Group	2471	82
			Emp 2	3080.4	85
			TD	3518	87
			Emp 3	3580.4	87
			Emp 4	4080.4	89
			Emp 5	4580.4	91
			Unconformity	5080.4	93
			Strzelecki Group	5080.4	97.5
				5580.4	102

Table A.1: Continued

	KB elevation (mAMSL)	Water Depth (m)	Stratigraphic Interval	Depth of Top TVD rKB (m)	Age of Top (Ma)
Volador-1					
	25.3	260	U. Gippsland Limestone	285	0
			Unconformity	1435	4
			L. Gippsland Limestone	1435	10
			Unconformity	2563	13
			U. Lakes Entrance Fm	2563	15
			Unconformity	2840	22
			L. Lakes Entrance Fm	2840	34
			Unconformity	2938	36.5
			Flounder Fm	2938	49
			Unconformity	3024	51
			Latrobe Group T longus	3024	66
			Latrobe Group T lillei	4022	73
			Unconformity	4420	79
			Golden Beach Group N senectus	4420	81
			TD	4611	82
			GB 2	4915	82
			GB 3	5410	83
			GB 4	5905	84
			Unconformity	6400	85
			Emperor sub-Group P. mawsonii	6400	87
			Emp 2	6875	88
			Unconformity	7350	90
			Strzelecki Group	7350	97.5
				7850	102

Table A.1: Continued

	KB elevation (mAMSL)	Water Depth (m)	Stratigraphic Interval	Depth of Top TVD rKB (m)	Age of Top (Ma)
Pseudo well 1					
	21	2347	Gippsland Limestone	2368	0
			Unconformity	2536	12
			L. Lakes Entrance Fm	2536	15
			Latrobe Group N asperus	3340	34
			Unconformity	4627	78
			Golden Beach Group	4627	82
			GB 2	5189	83
			GB 3	5750	84
			Emperor sub-Group	6311	85
			Emp 2	6860	86
			Emp 3	7409	87
			Emp 4	7958	88
			Emp 5	8507	89
			Unconformity	9056	90
			Strzelecki Group	9056	97.5
			Strz 2	9556	102
			Strz 3	10056	105
				10556	115
Pseudo well 2					
	21	2442	Gippsland Limestone	2463	0
			Unconformity	2583	12
			L. Lakes Entrance Fm	2583	15
			Latrobe Group N asperus	2973	34
			Unconformity	4231	78
			Golden Beach Group	4231	82
			GB 2	4823	83
			GB 3	5415	84
			Emperor sub-Group	6006	85
			Emp 2	6579.4	86
			Emp 3	7152.8	87
			Emp 4	7726.2	88
			Emp 5	8299.6	89
			Unconformity	8873	90
			Strzelecki Group	8873	97.5
			Strz 2	9373	102
			Strz 3	9873	105
				10373	115

Table A.1: Continued

	KB elevation (mAMSL)	Water Depth (m)	Stratigraphic Interval	Depth of Top TVD rKB (m)	Age of Top (Ma)
Pseudo well 3					
	21	2212	Gippsland Limestone	2233	0
			Unconformity	2548	12
			L. Lakes Entrance Fm	2548	15
			Latrobe Group N asperus	3673	34
			Unconformity	4135	78
			Golden Beach Group	4135	82
			GB 2	4574	83
			Emperor sub-Group	5013	84
			Emp 2	5474	86
			Emp 3	5935	88
			Unconformity	6397	90
			Strzelecki Group	6397	97.5
			Strz 2	6897	102
			Strz 3	7397	105
			Strz 4	7897	115
				8397	120
Pseudo well 4					
	21	2050	Gippsland Limestone	2071	0
			Unconformity	2671	12
			L. Lakes Entrance Fm	2671	15
			Latrobe Group N asperus	2926	34
			Unconformity	3129	78
			Golden Beach Group	3129	82
			Emperor sub-Group	3246	84
			Emp 2	3694.5	86
			Unconformity	4143	90
			Strzelecki Group	4143	97.5
			Strz 2	4641	102
			Strz 3	5141	115
			Basement	5641	135
				6141	450

Table A.1: Continued

	KB elevation (mAMSL)	Water Depth (m)	Stratigraphic Interval	Depth of Top TVD rKB (m)	Age of Top (Ma)
Pseudo well 5					
	21	2790	Gippsland Limestone	2811	0
			Unconformity	3049	12
			L. Lakes Entrance Fm	3049	15
			Latrobe Group N asperus	3139	34
			Unconformity	4064	78
			Golden Beach Group	4064	82
			GB 2	4571	83
			GB 3	5078	84
			Emperor sub-Group	5585	85
			Emp 2	6118	86
			Emp 3	6651	88
			Unconformity	7184	90
			Strzelecki Group	7184	97.5
			Strz 2	7684	102
				8184	105
Pseudo well 6					
	0	2685	Gippsland Limestone	2685	0
			Unconformity	3000	12
			L. Lakes Entrance Fm	3000	15
			Latrobe Group N asperus	3397	34
			Unconformity	3952	78
			Golden Beach Group	3952	82
			Emperor sub-Group	4615	85
			Emp 2	5180.5	86
			Unconformity	5746	90
			Strzelecki Group	5746	97.5
			Strz 2	6253	102
			Strz 3	6760	115
			Strz 4	7268	125
			Unconformity	7776	135
			Basement	7776	400
				8276	450

Table A.1: Continued

	KB elevation (mAMSL)	Water Depth (m)	Stratigraphic Interval	Depth of Top TVD rKB (m)	Age of Top (Ma)
Pseudo well 7					
	0	2672	Gippsland Limestone	2672	0
			Unconformity	2917	12
			L. Lakes Entrance Fm	2917	15
			Latrobe Group N asperus	3262	34
			Unconformity	3725	78
			Golden Beach Group	3725	82
			GB 2	4242	83
			Emperor sub-Group	4759	84
			Emp 2	5422	86
			Emp 3	6085	88
			Unconformity	6748	90
			Strzelecki Group	6748	97.5
			Strz 2	7248	102
			Strz 3	7748	105
				8248	115

All depths quoted are with respect to KB, except where otherwise stated.

Table A.2: Summary of temperature data - Gippsland Basin Deep Water Project (Geotrack Report #741)

KB elevation (mAMSL)	Water Depth (m)	Depth (ft)	BHT (°F)	BHT (°C)	T.S.C (hrs)	Depth (m)	Corrected BHT (°C)	Geothermal gradient (°C/km)
Anemone-1A								
27	231	3638	100.0	37.8	6.9	1109.0	43.3	25.0 **
		10003	144.0	62.2	9.25	3049.0	72.7	
		13520	212.0	100.0	13.3	4121.0	122.5	
		14731	230.0	110.0	14	4490.0	135.0	
		15577	258.0	125.6	11.2	4748.0	154.4	
Basker-1								
25	162	3337	107.6	42.0		1017.0	48.4	37.0
		9370	163.4	73.0		2856.0	88.8	
		10171	230.0	110.0		3100.0	135.0	
		10663	221.9	105.5		3250.0	129.4	
		13084	244.4	118.0		3988.0	145.0	
Blackback-1								
21	418	4140	113.0	45.0		1262.0	52.0	27.7
		9550	147.2	64.0		2910.9	74.8	
		10228	150.8	66.0		3117.4	80.0	
		11883	186.8	86.0		3621.8	105.0	
		13258	203.0	95.0		4041.0	116.3	
Hermes-1								
23	85	3638	119.8	48.8	4.7	1109.0	56.6	35.4
		8451	162.9	72.7	6.8	2576.0	88.4	
		12211	235.9	113.3	7	3722.0	139.1	
		14633	271.0	132.8	12.5	4460.0	163.5	
		14741	302.0	150.0	6.5	4493.0*		
		14957	273.9	134.4	12.75	4559.0	165.5	
Pisces-1								
22	100	8432	171.9	77.7	8	2570.0	94.6	34.6
		8435	187.9	86.6	18.5	2571.0*		
		8435	198.9	92.7	23	2571.0*		
Shark-1								
28.4	319.6	3950	104.0	40.0	5	1204.0	46.0	35.9
		7198	140.0	60.0	8.1	2194.0	70.0	
		11545	213.8	101.0	9.5	3519.0	123.8	
Volador-1								
25.3	260	14308	269.6	132.0	27	4361.0*		36.7
		14449	267.8	131.0	15	4404.0	161.3	
		15128	290.8	143.8	11.5	4611.0*		

Quoted BHT values have been corrected by increasing the difference between surface temperature and measured BHT by 20% for measured temperatures <150°F (<66°C) and by 25% for temperatures >150°F (>66°C). A surface temperature of 10°C has been assumed.
All depths quoted are with respect to KB, except where otherwise stated.
*Measurements not used in calculation of geothermal gradient.
**Revised lower from 28.9°C/km from BHT data, based on AFTA results.

Table A.3: Vitrinite reflectance sample details and results open file data - Gippsland Basin Deep Water Project (Geotrack Report #741)

Source number	Depth (m)	Sample type	Stratigraphic Subdivision	Stratigraphic age (Ma)	Present temperature *1 (°C)	VR (Range) %	N
Anemone-1A							
Amdel	2609	swc	Gurnard Fm	45-40	69	0.41	12
Amdel	2820	swc	Latrobe Group T longus	72-65	74	0.38	26
Amdel	2881	swc	Latrobe Group T longus	72-65	76	0.42	37
Amdel	2975	swc	Latrobe Group T longus	72-65	78	0.43	29
Amdel	3040	swc	Latrobe Group T longus	72-65	80	0.41	24
KK v9431	3070-3075	cuttings	Latrobe Group T longus	72-65	80	0.51 (0.44-0.63)	27
Amdel	3070	cuttings	Latrobe Group T longus	72-65	80	0.42	30
Amdel	3120	cuttings	Latrobe Group T longus	72-65	82	0.44	16
Amdel	3170	cuttings	Latrobe Group T longus	72-65	83	0.47	24
Amdel	3250	cuttings	Latrobe Group T lillei	79-72	85	0.44	30
Amdel	3300	cuttings	Latrobe Group T lillei	79-72	86	0.50	34
Amdel	3330	cuttings	Latrobe Group T lillei	79-72	87	0.47	8
KK v9432	3330-3335	cuttings	Latrobe Group T lillei	79-72	87	0.52 (0.44-0.62)	26
KK v9433	3355-3360	cuttings	Latrobe Group T lillei	79-72	87	0.47 (0.41-0.57)	29
Amdel	3360	cuttings	Latrobe Group T lillei	79-72	88	0.49	34
Amdel	3450	cuttings	Latrobe Group T lillei	79-72	90	0.53	2
Amdel	3510	cuttings	Latrobe Group T lillei	79-72	91	0.52	16
Amdel	3570	cuttings	Latrobe Group T lillei	79-72	93	0.55	14
Amdel	3610	cuttings	Latrobe Group T lillei	79-72	94	0.52	16
Amdel	3710	cuttings	Latrobe Group T lillei	79-72	96	0.58	4

Table A.3: Continued

Source number	Depth (m)	Sample type	Stratigraphic Subdivision	Stratigraphic age (Ma)	Present temperature *1 (°C)	VR (Range) %	N
Amdel	3810	cuttings	Latrobe Group T lillei	79-72	99	0.53	11
Amdel	3840	cuttings	Latrobe Group T lillei	79-72	100	0.50	12
Amdel	3980	cuttings	Golden Beach Group N senectus	82-81	103	0.54	16
Amdel	4040	cuttings	Golden Beach Group N senectus	82-81	105	0.58	12
Amdel	4159	core	Golden Beach Group N senectus	82-81	108	0.61	38
Amdel	4190	cuttings	Golden Beach Group N senectus	82-81	108	0.63	23
Amdel	4200	cuttings	Golden Beach Group N senectus	82-81	109	0.65	26
Amdel	4310	cuttings	Golden Beach Group N senectus	82-81	111	0.64	21
Amdel	4360	cuttings	Golden Beach Group N senectus	82-81	113	0.67	32
Amdel	4400	cuttings	Golden Beach Group N senectus	82-81	114	0.64	27
Amdel	4450	cuttings	Golden Beach Group N senectus	82-81	115	0.67	20
Amdel	4490	cuttings	Golden Beach Group N senectus	82-81	116	0.70	35
Amdel	4500	cuttings	Golden Beach Group N senectus	82-81	116	0.69	19
Amdel	4520	cuttings	Golden Beach Group N senectus	82-81	117	0.73	17
Amdel	4530	cuttings	Golden Beach Group T apoxyexinus	86-82	117	0.71	26

Table A.3: Continued

Source number	Depth (m)	Sample type	Stratigraphic Subdivision	Stratigraphic age (Ma)	Present temperature *1 (°C)	VR (Range) %	N
Basker-1							
KK	2830-2840		Latrobe Group T longus	72-65	108	0.52	
KK	2836		Latrobe Group T longus	72-65	108	0.54	
KK	2914		Latrobe Group T longus	72-65	111	0.56	
KK	2943		Latrobe Group T longus	72-65	112	0.54	
KK	2997		Latrobe Group T longus	72-65	114	0.59	
KK	3014		Latrobe Group T longus	72-65	115	0.61	
KK	3116		Latrobe Group T longus	72-65	118	0.66	
KK	3119		Latrobe Group T longus	72-65	118	0.60	
KK	3120		Latrobe Group T longus	72-65	119	0.69	
KK	3121		Latrobe Group T longus	72-65	119	0.52	
KK	3124		Latrobe Group T longus	72-65	119	0.62	
KK	3207		Latrobe Group T lillei	78-72	122	0.64	
KK	3315		Latrobe Group T lillei	78-72	126	0.62	
KK	3356		Latrobe Group T lillei	78-72	127	0.65	
KK	3862		Golden Beach Group N senectus	82-81	146	0.79	
KK	3864		Golden Beach Group N senectus	82-81	146	0.93	
KK	3947		Golden Beach Group N senectus	82-81	149	0.78	
KK	3980		Golden Beach Group N senectus	82-81	150	0.78	

Table A.3: Continued

Source number	Depth (m)	Sample type	Stratigraphic Subdivision	Stratigraphic age (Ma)	Present temperature *1 (°C)	VR (Range) %	N
Blackback-1							
KK 78255B	3185		Latrobe Group T longus	69-65	86	0.39	26
KK 78254X	3282		Latrobe Group T longus	69-65	89	0.46	26
KK 78254S	3331		Latrobe Group T longus	69-65	90	0.54	27
KK 78254L	3429		Latrobe Group T longus	69-65	93	0.55	27
KK 78254F	3784		Latrobe Group T longus seismic marker	70-69	103	0.57	28
KK 78254E	3796		Latrobe Group T longus seismic marker	70-69	103	0.57	27
KK 78255P	3887		Latrobe Group T longus seismic marker	70-69	106	0.52	30
KK 78255M	3931		Latrobe Group T longus seismic marker	70-69	107	0.55	27

Table A.3: Continued

Source number	Depth (m)	Sample type	Stratigraphic Subdivision	Stratigraphic age (Ma)	Present temperature *1 (°C)	VR (Range) %	N
Hermes-1							
Phillips	1950		U. Lakes Entrance Fm	13.5-12	75	0.42	
Phillips	2251		L. Lakes Entrance Fm	22-15	86	0.44	
KK x7903	2410	cuttings	L. Lakes Entrance Fm	22-15	91	0.35 (0.32-0.37)	5
KK x7904	2440	cuttings	L. Lakes Entrance Fm	22-22	93	0.39 (0.35-0.44)	5
KK x7905	2470	cuttings	L. Lakes Entrance Fm	22-22	94	0.36 (0.27-0.44)	6
KK x7906	2500	cuttings	Oligocene Lakes Entrance Fm	34-32	95	0.39 (0.29-0.46)	7
KK x7907	2530	cuttings	Flounder Fm	48-45	96	0.43 (0.38-0.46)	7
Phillips	2534		Flounder Fm	48-45	96	0.54	
KK x7908	2560	cuttings	Latrobe Group L balemi	65-60	97	0.37 (0.26-0.52)	14
Phillips	2580		Latrobe Group L balemi	65-60	98	0.53	
KK x7909	2590	cuttings	Latrobe Group L balemi	65-60	98	0.51 (0.38-0.56)	8
KK x7911	2650	cuttings	Latrobe Group L balemi	65-60	100	0.47 (0.41-0.53)	6
KK x7912	2680	cuttings	Latrobe Group L balemi	65-60	101	0.56 (0.54-0.60)	4
KK x7913	2710	cuttings	Latrobe Group L balemi	65-60	102	0.47 (0.41-0.63)	8
KK x7914	2750	cuttings	Latrobe Group L balemi	65-60	104	0.48 (0.38-0.59)	28
KK x7915	2780	cuttings	Latrobe Group L balemi	65-60	105	0.55 (0.49-0.60)	5
KK x7916	2810	cuttings	Latrobe Group L balemi	65-60	106	0.49 (0.41-0.60)	26
KK x7917	2840	cuttings	Latrobe Group L balemi	65-60	107	0.55 (0.46-0.62)	16
KK x7918	2870	cuttings	Latrobe Group L balemi	65-60	108	0.54 (0.47-0.63)	6
KK x7919	2900	cuttings	Latrobe Group T longus	71-65	109	0.55 (0.49-0.65)	5

Table A.3: Continued

Source number	Depth (m)	Sample type	Stratigraphic Subdivision	Stratigraphic age (Ma)	Present temperature *1 (°C)	VR (Range) %	N
KK x7920	2930	cuttings	Latrobe Group T longus	71-65	110	0.55 (0.42-0.64)	17
KK x7921	2960	cuttings	Latrobe Group T longus	71-65	111	0.55 (0.46-0.65)	26
KK x7922	2990	cuttings	Latrobe Group T longus	71-65	112	0.54 (0.47-0.68)	26
Phillips	3002		Latrobe Group T longus	71-65	112	0.54	
KK x7923	3020	cuttings	Latrobe Group T longus	71-65	113	0.56 (0.45-0.69)	20
KK x7924	3050	cuttings	Latrobe Group T longus	71-65	114	0.57 (0.49-0.71)	27
KK v9426	3065-3070	cuttings	Latrobe Group T longus	71-65	115	0.71 (0.55-0.87)	29
KK x7925	3080	cuttings	Latrobe Group T longus	71-65	115	0.56 (0.47-0.64)	28
KK x7926	3110	cuttings	Latrobe Group T longus	71-65	116	0.58 (0.49-0.70)	25
KK x7927	3140	cuttings	Latrobe Group T longus	71-65	117	0.59 (0.52-0.71)	27
KK x7928	3180	cuttings	Latrobe Group T longus	71-65	119	0.60 (0.52-0.71)	28
KK x7929	3210	cuttings	Latrobe Group T longus	71-65	120	0.59 (0.51-0.71)	28
Phillips	3231		Latrobe Group T longus	71-65	121	0.54	
KK x7930	3240	cuttings	Latrobe Group T longus	71-65	121	0.57 (0.49-0.69)	28
KK x7931	3270	cuttings	Latrobe Group T longus	71-65	122	0.60 (0.51-0.73)	27
KK x7932	3300	cuttings	Latrobe Group T longus	71-65	123	0.61 (0.51-0.72)	26
KK x7933	3330	cuttings	Latrobe Group T longus	71-65	124	0.58 (0.50-0.64)	27
KK x7934	3370	cuttings	Latrobe Group T longus	71-65	125	0.62 (0.53-0.73)	26
KK x7935	3400-3410	cuttings	Latrobe Group T longus	71-65	127	0.64 (0.50-0.74)	26
KK x7936	3430-3440	cuttings	Latrobe Group T longus	71-65	128	0.66 (0.56-0.77)	27
KK x7937	3470-3480	cuttings	Latrobe Group T longus	71-65	129	0.69 (0.58-0.79)	27

Table A.3: Continued

Source number	Depth (m)	Sample type	Stratigraphic Subdivision	Stratigraphic age (Ma)	Present temperature *1 (°C)	VR (Range) %	N
KK v9427	3490-3495	cuttings	Latrobe Group T longus	71-65	130	0.87 (0.72-0.98)	27
KK x7938	3500-3510	cuttings	Latrobe Group T longus	71-65	130	0.66 (0.58-0.79)	28
KK x7939	3530-3540	cuttings	Latrobe Group T longus	71-65	131	0.68 (0.59-0.75)	26
KK x7940	3560-3570	cuttings	Latrobe Group T longus	71-65	132	0.67 (0.59-0.78)	28
KK x7941	3590-3600	cuttings	Latrobe Group T lillei	79-71	133	0.72 (0.60-0.85)	27
Phillips	3599		Latrobe Group T lillei	79-71	134	0.59	
KK x7942	3620-3630	cuttings	Latrobe Group T lillei	79-71	135	0.70 (0.59-0.82)	28
KK x7943	3650-3660	cuttings	Latrobe Group T lillei	79-71	136	0.78 (0.60-0.88)	27
KK x7944	3680-3690	cuttings	Latrobe Group T lillei	79-71	137	0.77 (0.65-0.88)	30
KK x7945	3710	cuttings	Latrobe Group T lillei	79-71	138	0.75 (0.65-0.84)	27
KK x7946	3740	cuttings	Latrobe Group T lillei	79-71	139	0.79 (0.72-0.95)	26
KK x7947	3760-3770	cuttings	Latrobe Group T lillei	79-71	139	0.79 (0.70-0.93)	27
Phillips	3800		Latrobe Group T lillei	79-71	141	0.62	
KK x7948	3800	cuttings	Latrobe Group T lillei	79-71	141	0.82 (0.74-0.94)	27
KK x7949	3840	cuttings	Latrobe Group T lillei	79-71	142	0.79 (0.63-0.89)	26
KK x7950	3850-3860	cuttings	Latrobe Group T lillei	79-71	143	0.78 (0.68-0.90)	27
KK x7951	3880	cuttings	Latrobe Group T lillei	79-71	144	0.81 (0.67-0.94)	27
KK v9428	3900-3905	cuttings	Latrobe Group T lillei	79-71	144	0.94 (0.79-1.03)	29
KK x7952	3910	cuttings	Latrobe Group T lillei	79-71	145	0.81 (0.68-0.94)	27
KK x7953	3930-3940	cuttings	Latrobe Group T lillei	79-71	145	0.82 (0.68-0.98)	27
KK x7954	3970-3980	cuttings	Latrobe Group T lillei	79-71	147	0.82 (0.69-0.92)	27

Table A.3: Continued

Source number	Depth (m)	Sample type	Stratigraphic Subdivision	Stratigraphic age (Ma)	Present temperature *1 (°C)	VR (Range) %	N
Phillips	4000		Latrobe Group T lillei	79-71	148	0.68	
KK x7955	4000-4010	cuttings	Latrobe Group T lillei	79-71	148	0.83 (0.74-0.92)	27
KK x7956	4030-4040	cuttings	Latrobe Group T lillei	79-71	149	0.83 (0.75-0.93)	27
KK x7957	4060-4070	cuttings	Latrobe Group T lillei	79-71	150	0.87 (0.72-0.96)	25
KK x7958	4080-4090	cuttings	Latrobe Group T lillei	79-71	151	0.84 (0.70-0.97)	25
KK x7959	4120-4130	cuttings	Latrobe Group T lillei	79-71	152	0.76 (0.63-0.97)	25
KK x7960	4140-4150	cuttings	Latrobe Group T lillei	79-71	153	0.84 (0.73-0.97)	28
KK x7961	4170-4180	cuttings	Latrobe Group T lillei	79-71	154	0.84 (0.73-0.98)	29
KK x7962	4190-4200	cuttings	Latrobe Group T lillei	79-71	155	0.87 (0.73-1.01)	28
Phillips	4197		Latrobe Group T lillei	79-71	155	0.72	
KK x7963	4230-4240	cuttings	Latrobe Group T lillei	79-71	156	0.82 (0.72-0.98)	28
KK x7964	4270-4280	cuttings	Latrobe Group T lillei	79-71	158	0.89 (0.80-0.99)	28
KK v9429	4285-4290	cuttings	Latrobe Group T lillei	79-71	158	0.92 (0.73-1.10)	26
KK x7965	4290-4300	cuttings	Latrobe Group T lillei	79-71	158	0.90 (0.82-1.00)	28
KK x7966	4320-4330	cuttings	Latrobe Group T lillei	79-71	159	0.90 (0.75-1.02)	28
KK x7967	4350-4360	cuttings	Latrobe Group T lillei	79-71	160	0.92 (0.82-1.00)	28
KK x7968	4390-4400	cuttings	Latrobe Group T lillei	79-71	162	0.89 (0.80-1.00)	27
Phillips	4398		Latrobe Group T lillei	79-71	162	0.74	
KK x7969	4400-4410	cuttings	Latrobe Group T lillei	79-71	162	0.90 (0.75-0.98)	22
KK x7970	4440-4450	cuttings	Latrobe Group T lillei	79-71	164	0.92 (0.81-1.08)	22
KK x7971	4470-4480	cuttings	Latrobe Group T lillei	79-71	165	0.90 (0.81-0.99)	26

Table A.3: Continued

Source number	Depth (m)	Sample type	Stratigraphic Subdivision	Stratigraphic age (Ma)	Present temperature *1 (°C)	VR (Range) %	N
KK x7972	4500-4510	cuttings	Latrobe Group T lillei	79-71	166	0.90 (0.81-0.99)	28
KK x7973	4520-4530	cuttings	Latrobe Group T lillei	79-71	166	0.96 (0.81-1.10)	27
KK v9430	4540-4545	cuttings	Latrobe Group T lillei	79-71	167	0.91 (0.79-1.16)	12
KK x7974	4560-4565	cuttings	Latrobe Group T lillei	79-71	168	0.97 (0.84-1.08)	29

Table A.3: Continued

Source number	Depth (m)	Sample type	Stratigraphic Subdivision	Stratigraphic age (Ma)	Present temperature *1 (°C)	VR (Range) %	N
Pisces-1							
KK 15725	1075	swc	Gippsland Limestone	14-0	43	0.34	1
KK 15726	1199	swc	Gippsland Limestone	14-0	47	0.26 (0.21-0.34)	3
KK 15727	1352	swc	Gippsland Limestone	14-0	53	0.21 (0.19-0.22)	3
KK 15728	1490	swc	Gippsland Limestone	14-0	57	0.30 (0.25-0.33)	5
KK 15729	1514	swc	Gippsland Limestone	14-0	58	0.31 (0.30-0.32)	4
KK 15730	1590	swc	Gippsland Limestone	14-0	61	0.27 (0.25-0.29)	3
KK 15731	1669	swc	Gippsland Limestone	14-0	64	0.36 (0.26-0.47)	4
KK 15733	1834	swc	Latrobe Group	73-65	69	0.33 (0.24-0.44)	10
KK 15734	1906	swc	Latrobe Group	73-65	72	0.33 (0.21-0.48)	4
KK 15735	1927	swc	Latrobe Group	73-65	72	0.32 (0.23-0.42)	7
KK 15736	1936	swc	Latrobe Group	73-65	73	0.33 (0.19-0.47)	6
KK 15737	1940	swc	Latrobe Group T lillei	78-73	73	0.41 (0.22-0.57)	12
KK 15738	2069	swc	Latrobe Group T lillei	78-73	77	0.46 (0.30-0.58)	7
KK 15739	2157	swc	Latrobe Group T lillei	78-73	80	0.51 (0.43-0.56)	12
KK 15741	2285	swc	Golden Beach Group	83-81	85	0.49 (0.39-0.56)	7
KK 15742	2357	swc	Golden Beach Group	83-81	87	0.48 (0.28-0.60)	21
KK 15743	2377	swc	Golden Beach Group	83-81	88	0.50 (0.25-0.66)	20
KK 15744	2429	swc	Golden Beach Group	83-81	90	0.42 (0.30-0.64)	11
KK 15745	2442	swc	Golden Beach Group	83-81	90	0.47 (0.26-0.60)	9
KK 15746	2463	swc	Golden Beach Group T apoxyexinus	84-83	91	0.51 (0.34-0.63)	21

Table A.3: Continued

Source number	Depth (m)	Sample type	Stratigraphic Subdivision	Stratigraphic age (Ma)	Present temperature *1 (°C)	VR (Range) %	N
KK 15747	2505	swc	Golden Beach Group T apoxyexinus	84-83	92	0.56 (0.40-0.70)	20
KK 15748	2513	swc	Golden Beach Group T apoxyexinus	84-83	93	0.50 (0.33-0.65)	10
KK 15750	2531	swc	Golden Beach Group T apoxyexinus	84-83	93	0.55 (0.46-0.65)	3
KK 15751	2535	swc	Golden Beach Group T apoxyexinus	84-83	93	0.54 (0.34-0.68)	25
KK 15752	2546	swc	Golden Beach Group T apoxyexinus	84-83	94	0.60	1

Table A.3: Continued

Source number	Depth (m)	Sample type	Stratigraphic Subdivision	Stratigraphic age (Ma)	Present temperature *1 (°C)	VR (Range) %	N
Shark-1							
KK v1849	1937	swc	Latrobe Group T longus	72-66	67	0.42 (0.29-0.61)	28
KK v1850	1983	swc	Latrobe Group T longus	72-66	69	0.39 (0.31-0.51)	28
KK v1851	2026	swc	Latrobe Group T longus	72-66	70	0.38 (0.29-0.52)	29
KK v1852	2065	swc	Latrobe Group T longus	72-66	72	0.42 (0.33-0.49)	27
KK v1853	2105	swc	Latrobe Group T longus	72-66	73	0.47 (0.38-0.61)	28
KK v1854	2150	swc	Latrobe Group T longus	72-66	75	0.44 (0.31-0.56)	27
KK v2029	2456	swc	Golden Beach Group N senectus	82-81	86	0.63 (0.50-0.73)	27
KK v2030	2490	swc	Emperor sub-Group	85-82	87	0.86 (0.61-0.93)	25
KK v2031	2528	swc	Emperor sub-Group	85-82	88	0.50 (0.43-0.56)	23
KK v2032	2573	swc	Emperor sub-Group	85-82	90	0.58 (0.48-0.78)	27
KK v2033	2640	swc	Emperor sub-Group	85-82	92	0.60 (0.45-0.73)	27
KK v2034	2707	swc	Emperor sub-Group	85-82	95	0.61 (0.54-0.68)	26
KK v2035	2757	swc	Emperor sub-Group	85-82	96	0.64 (0.54-0.72)	26
KK v2036	2794	swc	Emperor sub-Group	85-82	98	0.64 (0.55-0.83)	28
KK v2037	2868	swc	Emperor sub-Group	85-82	100	0.60 (0.51-0.68)	26
KK v2038	2900	swc	Emperor sub-Group	85-82	102	0.53 (0.39-0.65)	27
KK v2039	3065	swc	Emperor sub-Group	85-82	108	0.61 (0.47-0.67)	19
KK v2040	3226	swc	Emp 2	87-85	113	0.56 (0.43-0.73)	28
KK v2041	3290	swc	Emp 2	87-85	116	0.65 (0.46-0.84)	17
KK v2042	3355	swc	Emp 2	87-85	118	0.79 (0.69-0.90)	26

Table A.3: Continued

Source number	Depth (m)	Sample type	Stratigraphic Subdivision	Stratigraphic age (Ma)	Present temperature *1 (°C)	VR (Range) %	N
KK v2043	3430	swc	Emp 2	87-85	121	0.73 (0.58-0.89)	24
KK v2044	3490	swc	Emp 2	87-85	123	0.76 (0.60-0.93)	27
KK v2045	3510	swc	Emp 2	87-85	124	0.76 (0.62-0.95)	26

Table A.3: Continued

Source number	Depth (m)	Sample type	Stratigraphic Subdivision	Stratigraphic age (Ma)	Present temperature *1 (°C)	VR (Range) %	N
Volador-1							
Analabs	3550		Latrobe Group T longus	73-66	130	0.61 (0.50-0.68)	
Analabs	3645		Latrobe Group T longus	73-66	133	0.71 (0.60-0.80)	
Analabs	3674		Latrobe Group T longus	73-66	134	0.72 (0.66-0.86)	
Analabs	3692		Latrobe Group T longus	73-66	135	0.82 (0.63-0.93)	
Analabs	3799		Latrobe Group T longus	73-66	139	0.75 (0.66-0.89)	
Analabs	3820		Latrobe Group T longus	73-66	140	0.76 (0.67-0.88)	
Analabs	3920		Latrobe Group T longus	73-66	143	0.85 (0.75-0.93)	
Analabs	3950		Latrobe Group T longus	73-66	145	0.94 (0.75-1.05)	
Analabs	4039		Latrobe Group T lillei	79-73	148	0.89 (0.82-0.96)	
Analabs	4152		Latrobe Group T lillei	79-73	152	0.85 (0.72-0.95)	
Analabs	4170		Latrobe Group T lillei	79-73	153	0.88 (0.68-1.03)	
Analabs	4191		Latrobe Group T lillei	79-73	153	0.89 (0.75-1.01)	
Analabs	4218		Latrobe Group T lillei	79-73	154	0.85 (0.72-0.98)	
Analabs	4264		Latrobe Group T lillei	79-73	156	0.83 (0.70-0.94)	
Analabs	4372		Latrobe Group T lillei	79-73	160	0.88 (0.75-0.99)	
Analabs	4526		Golden Beach Group N senectus	82-81	166	0.90 (0.81-0.98)	
Analabs	4536		Golden Beach Group N senectus	82-81	166	0.89 (0.77-1.02)	
Analabs	4554		Golden Beach Group N senectus	82-81	167	0.89 (0.74-1.01)	

Note: Some samples may contain both vitrinite and inertinite. Only vitrinite data is shown.

*1 See Appendix A for discussion of present temperature data.