Gippsland Basin Cretaceous Biostratigraphy Project – Part B: Provisional Dinoflagellate Report

Graeme J. Wilson

Confidential

Client Report 2005/165

November 2005

Institute of
GEOLOGICAL
& NUCLEAR
SCIENCES
Limited

Gippsland Basin Cretaceous Biostratigraphy Project

Part B: Provisional Dinoflagellate Report

Graeme J. Wilson

Prepared for

ESSO AUSTRALIA PTY LTD

CONFIDENTIAL

Institute of Geological & Nuclear Sciences client report 2005/165
Project Number: 54080010

November 2005

Gracefield Research Centre, 69 Gracefield Road, P O Box 30368, Lower Hutt, New Zealand, Telephone: +64-4-570 1444, Facsimile: +64-4-570 4600

A Crown Research Institute

COMMERCIAL – IN – CONFIDENCE

This report has been prepared by the Institute of Geological & Nuclear Sciences Limited exclusively for and under contract to Esso Australia Pty Ltd. Unless otherwise agreed in writing, all liability of the Institute to any other party other than Esso Australia Pty Ltd in respect of the report is expressly excluded.

The basis of this contract is that any and all work done on samples and slides viewed, taken or borrowed shall be properly documented and reported to the Petroleum Development Unit (DPI), Government of Victoria, and made available to the public.

CONTENTS

KEYWORDS

Gippsland Basin; Anemone-1/1A; Latrobe Group; Cretaceous; dinoflagellates.

INTRODUCTION

This report attempts to correlate previous biostratigraphic assessments of the economically important Upper Cretaceous Latrobe Group in the Gippsland Basin (Morgan 1989; Partridge 1999, 2003) with the New Zealand Stage and dinoflagellate zonal scheme (Cooper 2004; Figure1). Several of the original palynological slides (on loan from DPI, Melbourne) were re-examined by the writer in order that a consistent taxonomic list could be obtained.

Petrofina Anemone-1/1A well, in the southern part of the basin, was selected for dinoflagellate assessment since it has a significantly greater marine aspect (and therefore more dinoflagellates) than other wells located particularly in northern parts of the basin, for which spore-pollen biostratigraphy is more useful (see Woollands & Wong 2001; Figure 2). The well tested gas in the Golden Beach Subgroup (lower part of the Latrobe Group).

The New Zealand Upper Cretaceous dinoflagellate zonal scheme was originally developed by Wilson (1984) using analyses of surface sections principally in the eastern basins of both North Island and South Island; the latest revision of this scheme is published in Cooper (2004). Effective application of this zonation to petroleum exploration wells in the Taranaki Basin is probably best demonstrated by Beggs et al. (1992) who recognized an earlier Late Cretaceous "Sequence K2" (Rakopi Formation) and a later Late Cretaceous "Sequence K1" (North Cape Formation). Outcrop sections of the Upper Cretaceous Pakawau Group, originally considered non-marine, occur in northwest Nelson and have been shown to contain marine dinoflagellates, principally in the North Cape Formation (Wizevitch et al. 1992).

ANEMONE-1/1A WELL: DINOFLAGELLATE BIOSTRATIGRAPHY

2728.5 m (swc)
Dinoflagellates are relatively abundant and include *Isabelidinium cingulatum* in association with *Eisenackia* cf. *crassitabulata*. This represents the lower to middle part of the Paleocene *Palaeocystodinium golzowense* Zone in terms of the New Zealand zonation. The interval was correlated with the Australian *Eisenackia crassitabulata* dinoflagellate Zone and the lower part of the *Lygistepollenites balmei* spore/pollen Zone by Morgan (1989). At this level the indicated environment is offshore marine.

2750 m (swc)
Indeterminate. Very little organic matter present including a few scattered pollen grains.

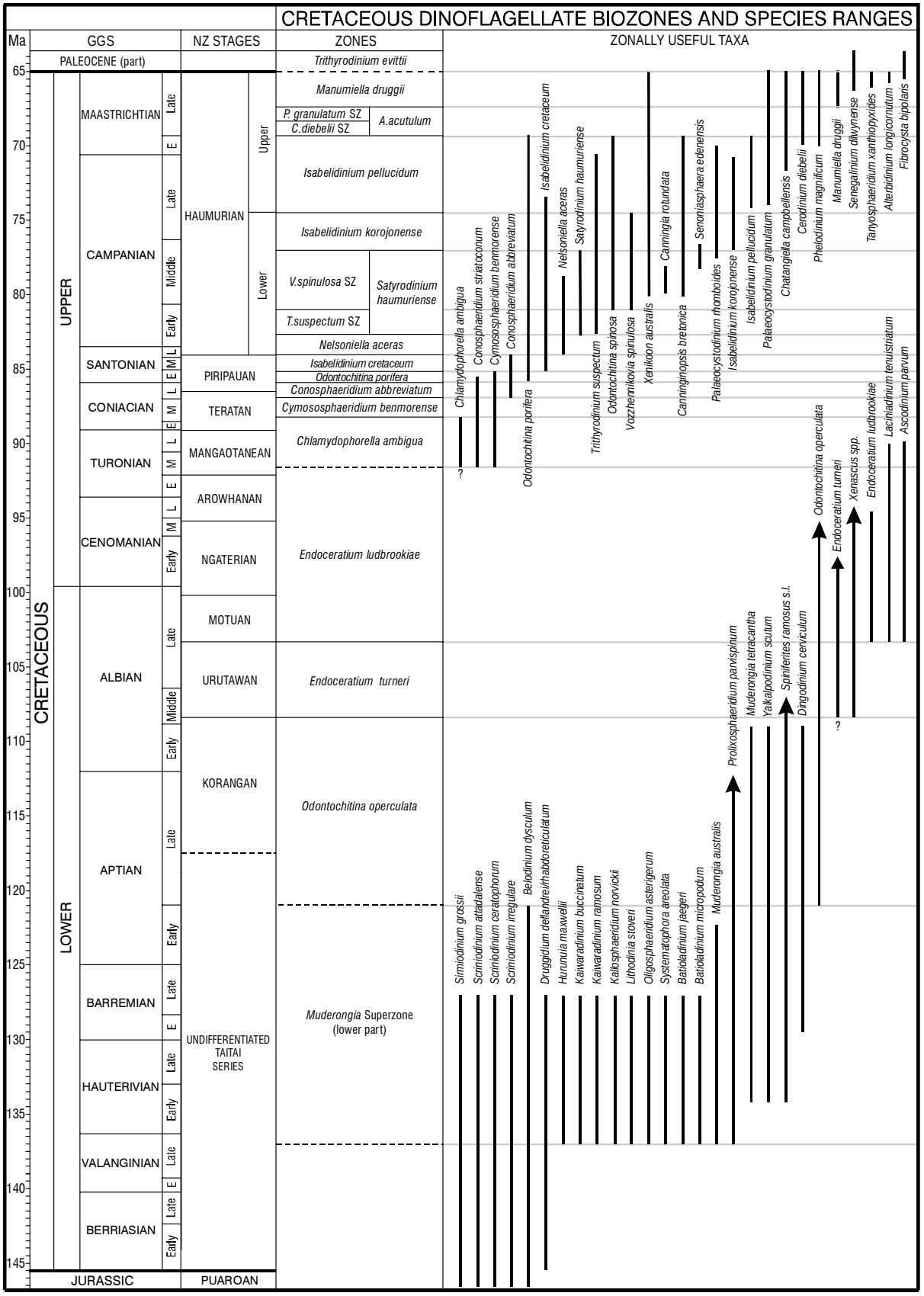

Figure 1. Stratigraphic ranges of the biostratigraphically most useful Cretaceous dinoflagellates, after Wilson (1984a); Schiøler and Wilson (1998); Roncaglia *et al.* (1999); Crampton *et al*. (2000, 2001, 2004); Schiøler et al. (2001), Cooper (2004).

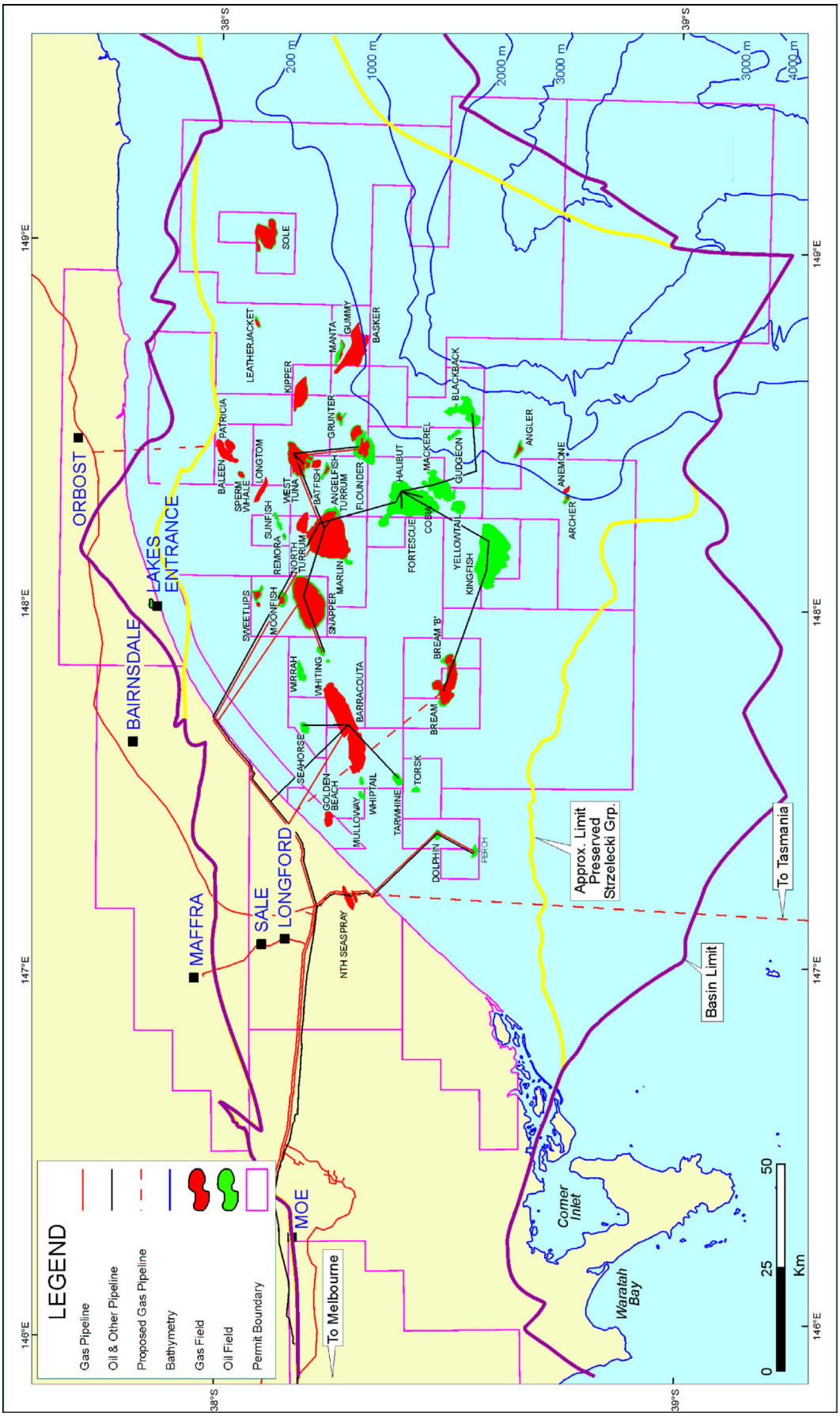

Figure 2. Oil and gas fields, Gippsland Basin (Woollands & Wong, 2001).

2762 m (swc), 2809.5 m (swc), 2816 m (swc)
Dinoflagellates are rare and include *Manumiella druggii*, indicating uppermost Cretaceous *M. druggii* Zone. This interval was correlated with the middle to upper *Forcipites longus* spore/pollen Zone by Morgan (1989) using the palynological zonal scheme documented by Helby et al. (1987). Environment is nearshore marine in the upper part and brackish in the lower part.

The Cretaceous/Tertiary boundary clearly lies between 2728.5 m and 2762 m and there is no clear evidence of the early Paleocene *Trithyrodinium evittii* Zone, indicating a possible hiatus.

2820 m (swc), 2825 m (swc), 2838 m (swc)
Dinoflagellates are extremely rare but appear to indicate *M. druggii* Zone, based on the presence of *M. druggii* or closely related forms. This interval was correlated with the lower to middle *F. longus* spore/pollen Zone by Morgan (1989). Environment brackish.

2850 m (swc), 2863 m (swc), 2958 m (swc), 3036 m (swc), 3063 m (swc)
Dinoflagellates are absent from this interval, which is considered non-marine. The interval was correlated with the lower *F. longus* spore/pollen Zone by Morgan (1989).

3075 m (ctgs)
Dinoflagellates occur in this sample, but are very pale and are likely to be caved.

3340 m (ctgs), 3450 m (ctgs)
Dinoflagellates are absent and the interval is considered non-marine. This interval was correlated with the middle to upper *Tricolporites lilliei* spore/pollen zone by Morgan (1989).

3575 m (ctgs), 3660 m (ctgs), 3875 m (ctgs)
Moderately rich dinoflagellates are present, including *Isabelidinium pellucidum*, and apparently belong to the New Zealand *I. pellucidum* Zone. Some evidence of caving is suggested and it is possible that the lower part could be older. This interval was correlated with the lower *T. lilliei* spore-pollen Zone by Morgan (1989). The depositional environment is nearshore marine or brackish.

3960 m (ctgs)
Rare dinoflagellates including *I. pellucidum*, indicating apparent *I. pellucidum* Zone. The interval was placed in the upper *Nothofagidites senectus* spore/pollen Zone by Morgan (1989). Environment marginal marine.

4159 m (core catcher)
A relatively rich dinoflagellate assemblage includes *Satyrodinium haumuriense* and is indicative of the lower Haumurian *S. haumuriense* Zone. Other taxa include *Xenikoon* sp., *Nelsoniella* sp., *Chatangiella* cf. *victoriensis* and *Odontochitina* cf. *porifera.* The interval was correlated with the lower *N. senectus* spore/pollen Zone by Morgan (1989). Environment nearshore marine.

4375 m (ctgs), 4400 m (ctgs), 4620 m (ctgs), 4775 m (ctgs; TD)
All samples yielded moderate dinoflagellate assemblages and, in New Zealand terms, appear to be of earliest Haumurian to Piripauan age, no older than *Odontochitina porifera* Zone, on account of the association of *O. porifera*, *Cyclonephelium* cf. *compactum* and relatively abundant *Chatangiella* cf. *victoriensis.* The interval was correlated with the *Nelsoniella aceras* to *Odontochitina porifera* Australian dinoflagellate zones and the lower *N. senectus* to *Tricolpites apoxyexinus* spore/pollen Zone by Morgan (1989). A nearshore to offshore marine environment is indicated. As noted by Morgan, the lowest part of the sequence (4620 m and 4775 m) contains brown palynomorph specimens indicating maturity for hydrocarbons, whereas palynomorphs from the sequence above indicate only marginal maturity or, above 3570 m, immaturity for hydrocarbons.

DISCUSSION

The above summary indicates that the Upper Cretaceous mainly marine section in Anemone-1/1A has a thickness of over 2000 m, from c.2762 m to TD at 4775 m, and ranges from the uppermost Haumurian *Manumiella druggii* Zone down to the *Odontochitina porifera* Zone of Piripauan age, in terms of the New Zealand stage and dinoflagellate zonal schemes. This represents a latest Maastrichtian to Santonian interval according to the latest version of the New Zealand timescale (Cooper 2004) and demonstrates that the New Zealand stages and dinoflagellate zones, all based on well-dated surface outcrops, can be applied to the subsurface Gippsland Basin sequences.

A dinoflagellate species list, with age interpretations, is given in Table 1.

Unlike most other wells in the Gippsland Basin, particularly in the northern part, open marine or marginal marine deposition appears to have been predominant in Anemone-1/1A, apart from the obvious substantial non-marine interval between 2850 m and 3400 m. A figure showing the full interpreted depositional environment for the well is provided by Woollands & Wong (2001, p.101; Figure 3).

Although a close correlation with the New Zealand dinoflagellate zonal scheme has been achieved, a major gap is present in the Late Haumurian where there is no indication of the *Alterbidinium acutulum* Zone. It seems most likely that this period of time is represented in the Gippsland Basin by the substantial non-marine interval discussed above, which has been correlated with the greater part of the *T. lilliei* and *F. longus* spore/pollen zones.

Relatively few New Zealand oil exploration wells in the Taranaki basin have a significantly thick marine Upper Cretaceous section comparable with Anemone-1/1A. The most complete sections appear to be in Ariki-1, Tane-1 and Wainui-1, where the *M. druggii* to at least the *I. pellucidum* Zones (including *A. acutulum*) are represented and the thickness of the Upper Cretaceous (Mata Series) is up to 500 m (Beggs et al.1992). An apparently more complete marine Cretaceous/Tertiary transition interval, including the basal Paleocene *Trithyrodinium*

evittii Zone, is present in the New Zealand wells, compared with Anemone-1/1A (Beggs et al. 1992).

Outcrops of the North Cape Formation (upper part of the Pakawau Group) in northwest Nelson have yielded dinoflagellates which are indicative of the *M. druggii* and *A. acutulum* Zones (Wizevitch et al. 1992) and confirm a marine depositional environment for at least part of the formation in this area.

Table 1. Anemone-1/1A Well, Gippsland Basin – Dinoflagellate Species List

DEPTH (m)	2728.5	2750	2762	2809.5	2816	2820	2825	2838	2850	2863	2958	3036	3063	3075	3340	3450	3575	3660	3875	3960	4159	4375	4400	4620	4775
TYPE	SWC 24	SWC 23	SWC 22	SWC 18	SWC 17	SWC 16	SWC 15	SWC 14	SWC 13	SWC 11	SWC 6	SWC 2	SWC 1	ctgs	ctgs	ctgs	ctgs	ctgs	ctgs	ctgs	core	ctgs	ctgs	ctgs	ctgs
AGE	PALEOC.	nd	CRET.	CRET.	CRET.	CRET.	nd	CRET.	nd	nd	nd	nd	nd	nd	nd	nd	CRET.	CRET.	CRET.	CRET	CRET.	CRET.	CRET.	CRET.	CRET.
ZONE	P.gol.	nd	M.dr	M.dr	M.dr	M.dr	nd	M.dr	nd	nd	nd	nd	nd	nd	nd	nd	l.pe	lpe	lpe	lpe	Sha	?Opo	?Opo	?Opo	?Opo
SPECIES																									
														cvgs?											
Areoligera spp.	x																								
Spiniferites ramosus	x																								
Chlamydophorella sp.	x																								
Fibrocysta cf. bipolaris	x																								
Glaphyrocysta retiintexta	x																								
Spinidinium densispinatum	x																								
Senegalinium dilwynense	x																								
Isabelidinium cingulatum	x																								
Palaocystodinium golzowense	x																								
Eisenackia cf. crassitabulata	x		x																						
Manumiella conorata			x																						
Manumiella druggii			x	x	x			x																	
Manumiella seelandica			x																						
Impagidinium sp.			x																						
Pyxidinopsis spp.			x																x						
Hystrichosphaeridium sp.				x																					
Impagidinium sp.					x																				
Manumiella sp.					x																				
Batiacasphaera spp.					x														x		x	x	x	x	
Senegalinium sp.					x																				
Manumiella cf. druggii						x																			
Operculodinium sp.							x							x											
Spiniferites sp.														x								x			
Glaphyrocysta sp.														x											
Cribroperidinium spp.														x							x				
Alterbidinium cf. longicornutum																	x								
Chatangiella spp																	x								
Isabelidinium pellucidum																	x	x		x					
Odontochitina spinosa																	x								x
Alterbidinium cf. acutulum																	x								
Oligosphaeridium cf. complex																	x				x	x	x		x
Odontochitina porifera																	x					x	x		
Cleistosphaeridium sp.																	x								
Isabelidinium marshallii																		x					x		
Isabelidinium spp.																		x					x		x
?Xenikoon sp.																		x			x	x	x		
Hystrichodinium spp.																			x				x		
Isabelidinium cf. pellucidum																			x						
Circulodinium cf. distinctum																			x		x				x
Odontochitina cf. porifera																					x				
Alterbidinium spp.																					x		x		
Chatangiella cf. victoriensis																					x	x	x	x	x
Satyrodinium cf. haumuriense																					x				
Nelsoniella spp.																					x				
Trithyrodinium cf. suspectum																						x			
Odontochitina operculata																						x	x	x	
Isabelidinium cooksoniae																						x		x	
Cyclonephelium cf. compactum																						x	x	x	
Dinogymnium spp.																							x		
Amphidiadema spp.																							x		
Vozzhennikovia cf.spinulosa																								x	
Xenascus cf. ceratioides																									x

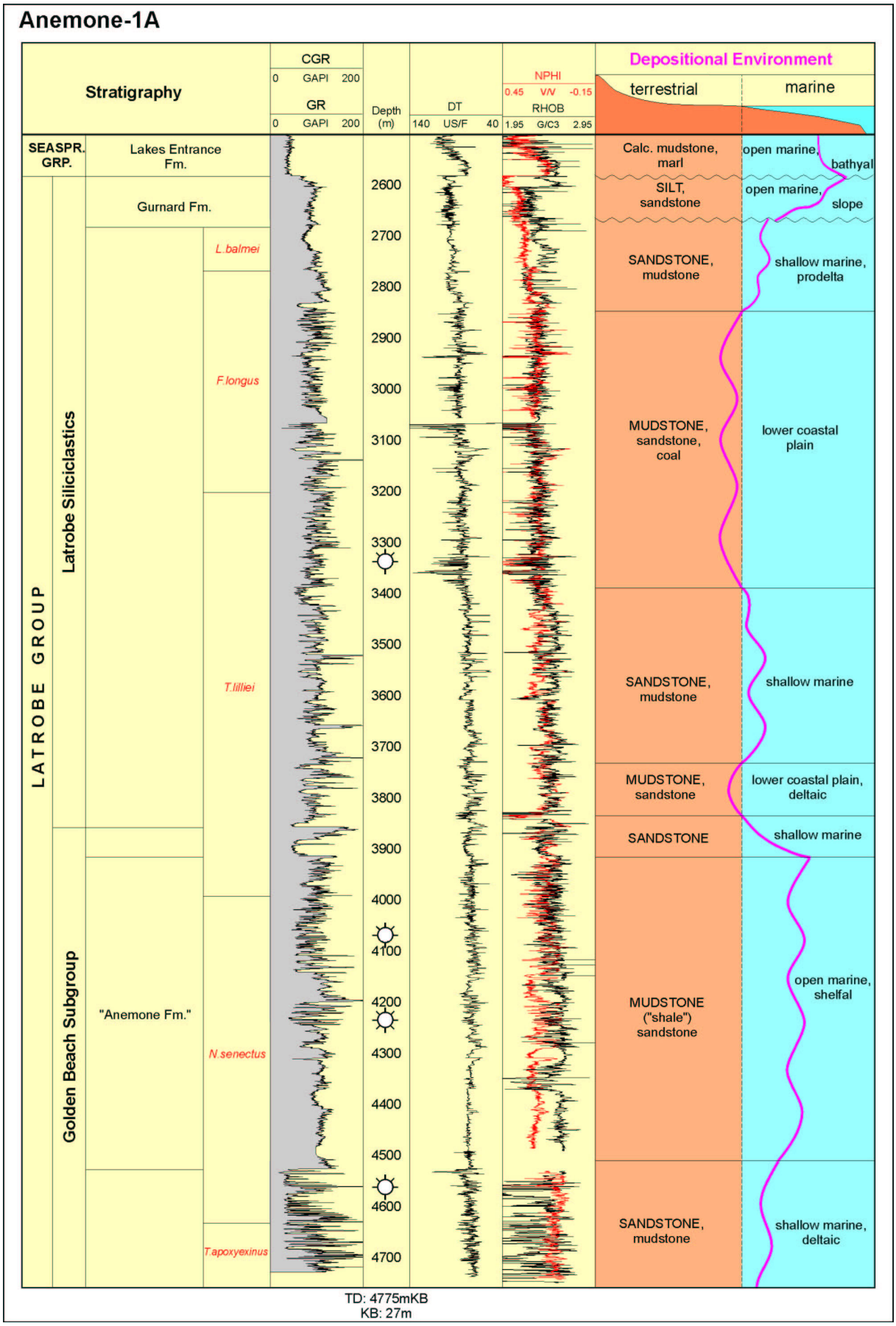

Figure 3. Anemone 1/1A Well, Gippsland Basin, shoing inferred depositional environment (Woollands & Wong, 2001)

REFERENCES

Beggs, J.M., Wilson, G.J., Raine, J.I., Pocknall, D.T. 1992. Biostratigraphic review of Cretaceous and Early Cenozoic section in Taranaki Basin exploration wells. *DSIR Geology and Geophysics Contract Report 1992/38*. 182 p.

Cooper, R.A. (Ed.) 2004. The New Zealand Geological Timescale. Institute of Geological & Nuclear Sciences Monograph 22. 284 p.

Helby, R., Morgan, R., Partridge, A.D. 1987. A palynological zonation of the Australian Mesozoic. *Memoir of the Association of Australasian Palaeontologists 4*: 1-94.

Morgan, R. 1989. Palynology and geological implications Petrofina Anemone-1 Gippsland Basin, Australia. Well Completion Report – Appendix 7.

Partridge, A.D. 1999. Late Cretaceous to Tertiary geological evolution of the Gippsland Basin, Victoria. PhD thesis, La Trobe University, Bundoora, Victoria, unpublished, 439 p.

Partridge, A.D. 2003. A guide to the stratigraphy of the Latrobe Group, Gippsland Basin. Biostrata Report 2003/3.

Wilson, G.J. 1984. New Zealand Late Jurassic to Eocene dinoflagellate biostratigraphy – a summary. *Newsletters on Stratigraphy 13*: 104-117.

Wizevitch, M.C., Thrasher, G.P., Bussell, M.R., Wilson, G.J., Collen, J.D. 1992. Evidence for marine deposition in the Late Cretaceous Pakawau Group, northwest Nelson. *New Zealand Journal of Geology and Geophysics 35*: 363-369.

Woollands, M.A. & Wong, D. (Eds) 2001. Petroleum Atlas of Victoria, Australia. *The State of Victoria, Department of Natural Resources and Environment, 2001*