Gippsland Basin Cretaceous Biostratigraphy Project

Percy Strong

Confidential

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Part A: Provisional Foram Report

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CONTENTS

1. PURPOSE

This Institute of Geological & Nuclear Sciences (GNS) study was undertaken in collaboration with Esso Australia to assess similarities between the Gippsland and Taranaki Basins, and the extent to which New Zealand biostratigraphic knowledge could be applied in a trans-Tasman setting. Six Gippsland Basin wells, providing a paleo-onshore to offshore transect, were designated by Esso Australia for study of a part of their upper Cretaceous sequence. The wells chosen were Anemone-1, 1A, Angler-1, Archer-1, Blackback-1, East Pilchard-1 and Tuna-4.

The main achievements of work to date are:

1. This study is the first investigation of foraminiferal faunas from Cretaceous sections of these wells. However, Cenozoic foraminifers have been previously recovered from Anemone-1 and Angler-1 and mounted on assemblage slides. Caved Cenozoic foraminifera were also noted from the other studied wells.
2. The potential utility of foraminifera for age/environment and correlation assessments in future drillholes was evaluated.
3. Foraminiferal biostratigraphy has, at best, only very modest potential in wells examined in this study, but foraminifera may have some utility in paleoenvironmental interpretation. Overall utility is likely to improve in the more offshore sections of the basin, south of Anemone and nearby wells.
4. The project served as showcase for GNS capabilities and products.
5. Establishing relationships with staff at Esso Australia, Victoria Department of Primary Industries, and other individuals and organisations.

2. MATERIALS AND METHODS

A suite of 128 samples of washed/dried cuttings from selected upper Cretaceous intervals within the Anemone-1/1A, Angler-1, Archer-1, Blackback-1, East Pilchard-1 and Tuna-4 offshore petroleum wells was collected at the Victoria DPI Core Store,Werribee, and at Esso Australia headquarters in downtown Melbourne. Sample depths were pre-selected at GNS, using logs and well biostratigraphic reports provided by Esso Australia. This collecting programme was followed closely, as available time did not permit on-site inspection of material for sample selection. However, where cuttings were stored in transparent plastic bags, some minor depth adjustments were made. The amount of cuttings taken was limited by us to no more than one-half of the material available, and sample weights consequently ranged from c. 6 g to c. 85 g.

All bulk samples were examined individually at GNS, Lower Hutt, and 65 of them, considered from their lithology to be the most likely to be fossiliferous, were selected for further work. These samples were then processed using standard GNS techniques, and wet-

sieved on a 75-micron screen. Residue >75 microns was retained for examination, finer material comprising the silt-clay fraction was lost during processing.

Because this project is intended to be a feasibility test for foraminiferal well servicing in Gippsland Basin drillholes, sample examination was done to "well biostratigraphy" commercial standards. From our experience, examination to this level will generally produce useful results, if they are to be had at all, and within a reasonable time span. Before examination, residue is sieved into >500 micron, >212 micron and <212 (pan) fractions. The entire >500 micron fraction usually is scanned for large specimens. The >212 micron fraction, which typically contains most adult foraminiferal specimens is split by the cone-and-quarter method (fast, sufficiently accurate), to provide enough representative sample for c. 2 standard picking trays. Pan fraction was scanned for c. 1-2 minutes for small specimens. Normally, this procedure can easily stay abreast of 20 m samples when the ROP is c. 6-10 m/hr.

3. FORAMINIFERAL RESULTS

The main finding of this study is that foraminifera are of very limited biostratigraphic, but some paleoenvironmental, utility, in three of the chosen wells. Their value could increase for drilling farther south however. Foraminifera are sparse to common in 16 of the 65 samples examined, with all productive samples coming from marine shales/siltstones in the southernmost wells, Anemone-1/1A, Angler-1, and Archer-1. Only one significant calcareous fauna was recovered, with other assemblages consisting mainly or wholly of agglutinated taxa. Table 1 lists the foraminiferal taxa recorded during this study.

Haplophragmoides is the most common foraminifer seen, and appears to be represented by at least 6 species. The genus is taxonomically difficult, as its typically non-descript morphology and apparently considerable intra-specific variability is complicated by variable deformation individuals during burial. However, there are exceptions, and a *Haplophragmoides* species, tentatively referred to *H.wilgunyaensis,* is distinctive enough that its highest and lowest occurrences could provide readily recognisable bioevents. This species was originally described by Crespin (1963, Australian Min. Res. Geol. Geophys. Bull 66) from the Lower Cretaceous of western Queensland, and is distinguished by its incised sutures and high number of chambers.

Calcareous foraminifera, which tend to have more biostratigraphic utility, had significant representation in only one sample, from Anemone-1, and rare occurrences in a couple of others. It is considered that their general absence is due to unfavourable paleoenvironments, rather than to post-depositional dissolution. Calcareous faunas could become more prominent seaward of Anemone.

Foraminiferal occurrences were confined to shales and siltstones. Coarser sandstones were unfailingly barren of foraminifers and after a number of these were examined initially, further processing of this lithology was considered to be without merit. These sandstones constituted a substantial part of the lithofacies associations penetrated by the 6 drillholes, resulting in a very discontinuous foraminiferal record in the three wells where fossils occurred.

	Anemone -1	Anemone-1A									Angler-1				Archer-1	
PALYNOLOGICAL ZONE	lr T lilliei	lr Nothofagidites senectus					Tricolporites apoxyexinus				lr Tricolporites lilliei				lr N senectus	lr N senectus
DEPTH	3730	4170	4195	4320	4350	4375	4410	4475	4500	4520	4050	4110	4140	4170	3930	4050
SPECIES																
Astacolus							X									
Gavelinella? sp.	X															
Haplophragmoides sp. 1		X	X												X	
Haplophragmoides sp. 2		X	X													
Haplophragmoides sp. 3								X								
Haplophragmoides sp. 4								X				X		X	X	
Haplophragmoides sp. 5									X			X				
Haplophragmoides, small, disk		X			X											
Haplophragmoides cf. *wilgunyaensis*			X				X	X	X	X		X	X		X	
Haplophragmoides spp.		X	X	X				X	X	X	X		X		X	X
Lenticulina sp.							X	X								
Marginulinopsis cf. *collinsi*							X									
Melonis sp.								cv								
Nodosarids, various						X										
Praebulimina sp.													cv			
Psammosphaera sp.					?		X	X	X	X	X				X	
Pyrulinoides sp.						X										
Saccammina sp.			X			X	X								X	
Trochammina cf. *inflata*		X	X													
Trochammina sp.						?	?								X	
Echinoderm plates		X				X										
Inoceramus prisms						X										
Ostracods		X														
cv = probably caved																

From what was observed, foraminiferal biostratigraphy potentially could provide worthwhile results if drilling continued to move offshore, southward of Anemone, Angler, and Archer. Presumably, continuously fossiliferous section would increase with increasingly fine terrigenous sediment, and biostratigraphically significant taxa, commonly shelf or slope-dwellers, would become more common and persistent.

Well-by-well results are provided in the following sections. The three numbers separated by forward slashes indicate total samples taken for the well, the number prepared for study, and the number with foraminifera.

3.1 Anemone-1/1A (See Table 1 & 2)

Samples collected/prepared/fossiliferous: 45/22/10

Comments

General:
Table 1 lists foraminifera recorded in Anemone-1/1A, and Table 2 provides sample examination information.

Colour indices for agglutinated foraminifers are in the 5 to 7 range, indicating fully mature sediments but also moderately obscuring morphological details of the individual specimens.

Age:
Although the overall fauna has a Cretaceous character, no age-diagnostic species were recorded in the well.

Paleoenvironment:
Nine of the 10 faunas recovered consist entirely of agglutinated foraminifers, or are strongly dominated by them. *Haplophragmoides, Saccammina* and *Trochammina,* in that order, are most commonly encountered, with the first of these characteristically overwhelmingly dominant. Diversity is typically low, suggesting restricted conditions, probably subnormal salinity. A lagoonal to marine marsh setting is inferred, implying that barrier beaches may have lain farther to the south.

The tenth sample, from 4410 m, contains a substantial proportion of calcareous foraminifers, mostly Lagenids. No planktics were found. This fauna suggests a normal marine, (mid?) shelf environment, with neritic surface waters fully sheltered from oceanic circulation.

In sequence stratigraphic terms, the 4410 m sample reflects the maximum transgression at the sit (within the studied interval) and a marine highstand.

Table 2. Anemone-1/1A: foram samples (9/22/45)

Anemone-1					
DEPTH	**WEIGHT**	**RESIDUE**	**FORAMS**	**NOTES ON RESIDUE**	**BIOSTRAT**
3500	23.24	18.59	No	Snd, med to crse, angular; zst, dark grey; coal chips.	Mid T. lilliei
3535	19.97			Not processed	
3565	17.37			Not processed	
3600	17.20	9.00	No	Snd, med to crse, angular; zst, dark grey; coal chips, rare glauconite.	Lower T. lilliei
3635	27.33			Not processed	
3660	14.78			Not processed	
3690	39.53			Not processed	
3730	28.02	23.22	Yes	Snd, med to crse, angular; zst, dark grey; coal chips, pyrite, rare glauconite. Single pyritised probable foram, in place?	
3755	30.48			Not processed	
3780	25.74			Not processed	
3815	19.43			Not processed	
3835	35.84			Not processed	
3865	11.54	8.28	No	Snd, med to crse, angular; zst, brn, mica-ceous; coal chips, pyrite, occ'l glauconite.	
3890	17.23			Not processed	
3915	25.43			Not processed	
3950	19.14	10.65	No	Snd, med to v crse, ang; zst, brn, micaceous. Pyrite, rare glauc. Caved Cenozoic forams.	Upper N. senectus
3985	29.68	24.22	No	Snd, v crse to med, ang; zst, grey, occ'l glauc	
Anemone-1A					
3865	16.82	10.50	No	Snd, crse to med, ang to few subang; common zst, drk grey,	Lower T. lilliei
3900	49.45			Not processed	
3915	24.95			Not processed	
3950	22.62	14.56	No	Snd, v crse to med, ang; zst, dark grey, carb; rare glauc,coal chips	Upper N. senectus
3985	36.72	27.06		Snd, v crse to med, ang, few subang; zst, dark grey; pyrite	
4010	25.74	17.68	No	Snd, v crse to med, ang; zst, dark grey & brn; pyrite, coal chips	
4055	35.18			Not processed	
4080	26.60	22.25	No	Snd, v crse to med, ang; zst, minor, dark grey & tan; pyrite	
4115	39.12	32.49	No	Snd, v crse to med, ang; zst, dark grey & tan; pyrite, biotite, occ'l glauc. Rare, caved Ceno-zoic forams.	
4145	33.30			Not processed	
4170	6.06	1.60	Yes	Zst, grey; minor snd, med grain, ang. Few poorly preserved aggl forams, ostracods, echinoderm fragments	Lower N. senectus
4195	12.08	3.78	Yes	Zst, grey; minor snd, med grain, ang. Few poorly preserved aggl forams, echinoderm fragments	
4225	38.35	30.33	No	Snd, med to v crse; zst dark grey; pyrite	

Anemone-1					
DEPTH	**WEIGHT**	**RESIDUE**	**FORAMS**	**NOTES ON RESIDUE**	**BIOSTRAT**
4290	23.26	15.27	No	Snd, f grain, slightly calc, silty; zst dark grey; pyrite, rare glauc	
DEPTH	**WEIGHT**	**RESIDUE**	**FORAMS**	**NOTES ON RESIDUE**	**BIOSTRAT**
4320	29.43	14.55	Yes	Sst, f to med grain, calc.; zst, drk grey, non calc; pyrite. Very few poorly preserved aggl forams & rare caved Cenozoic forams.	
4350	14.07	5.37	Yes	Zst, drk grey; biotite, pyrite. Rare, poor aggl forams	
4375	22.32	8.98	Yes	Zst, drk grey, hard; pyrite. Rare forams, *Inoceramus* prisms.	
4410	52.15	18.82	Yes	Zst, drk grey, hard; pyrite, tr glauc. Few calc & aggl forams, *Inoceramus* prisms.	Tricolpites apoxyex.
4440	unsampled?			Pre-selected for sampling, but no sample taken	
4475	43.87	15.16	Yes	Zst, drk grey, hard; pyrite, tr glauc. Few aggl forams.	
4500	42.12	16.97	Yes	Zst, drk grey, hard; pyrite, tr glauc. Few aggl forams.	
4520	30.75	13.30	Yes	Zst, drk grey, hard; pyrite, tr glauc. Few aggl forams.	
4560	22.81			Not processed	
4625	25.73			Not processed	
4675	28.10			Not processed	
4710	24.26			Not processed	
4740	18.88			Not processed	
4770	21.2			Not processed	
TOTAL SAMPLES			45		
SAMPLES EXAMINED			22		

3.2 Angler-1 (See Tables 1 & 3)

Samples collected/prepared/fossiliferous: 12/12/4

Comments

General:
Although samples were examined from both the *Tricocolpites lilliei* and *Nothofagidites senectus* Palynozones, only those from the *T. lilliei* Zone yielded foraminifera.

Age:
No age-diagnostic species were recovered.

Paleoenvironment:
With the exception of a single, probably caved, calcareous specimen at 4140 m, only agglutinated taxa were recovered. Foraminifera were sparse, except in the 4170 m sample, where they were moderately common. The low diversity, *Haplophragmoides*-dominated assemblages are suggestive of brackish water environments, perhaps lagoon or salt marsh, within the coastal complex.

Table 3. Angler-1: foram samples (4/12/12)

DEPTH	WEIGHT	RESIDUE	FORAMS	NOTES ON RESIDUE	BIOSTRAT
4050	46.31	10.14	Yes	Zst, grey, hard, rare glauc; minor sst, crse, ang; pyrite, coal chips. 1 foram recovered.	T. lilliei (I. koroj)
4080	35.84	11.57	No	Zst, grey, hard, rare carb chips; minor sst, med to crse, ang; pyrite, coal chips glauc.	
4110	46.58	12.50	Yes	Zst, grey-brn, hard, rare glauc; snd, vfg to fg, ang; coal chips, pyrite. Mod common forams; ostracods, echinoderm frags.	
4140	56.59	13.75	Yes	Zst, grey, carb chips; snd, crse, ang; pyrite, rare glauc. Sparse forams.	
4170	29.63	6.91	Yes	Zst to vfg sst, grey, carb chips; snd, med to crse, ang; mudstn, reddish, glauc. One foram found.	
4200	37.66	13.48	No	Zst, grey to brownish; sand, vfg, grey; coal chips, pyrite, rare glauc. Caved Cenozoic forams.	Upper N. senectus (I. koroj)
4240	63.86	55.98	No	Snd, med to crse, ang; sst, f to med grn, silty, ang; zst, grey & brn; pyrite, rare glauc	
4265	48.92	41.30	No	Snd, crse to med, ang; sst, fg, subang, poorly sorted; zst, grey; coal chips, pyrite.	
4275	84.43	69.38	No	Snd, crse to med, ang; sst, fg, subang, poorly sorted, some w/flaser? bedding; zst, grey; coal chips, pyrite.	
4290	58.75	45.26	No	Snd, crse to med, ang; sst, fg, subang, poorly sorted; zst, grey; coal chips, pyrite.	
4320	42.88	23.98	No	Snd, med to crse, ang; sst, f grn, silty, ang, calc; zst, grey; mudstn, salmon; pyrite.	
4330	55.30	20.17	No	Zst, grey; sst, white, fg to vfg, ang; snd, med to v crse, ang; pyrite	
TOTAL SAMPLES			12		
SAMPLES EXAMINED			12		

3.3 Archer-1 (See Tables 1 & 4)

Samples collected/prepared/fossiliferous: 24/9/2

Comments

General:
Sample processing had become much more selective by the time Archer was done, as it had become apparent that the sandier sediments were consistently non-productive. Consequently, only a few samples, mainly darker-coloured and finer-grained, were given further study.

Age:
No age-diagnostic species were encountered.

Paleoenvironment:
Foraminifera were moderately common at 3930 m, and rare at 4050 m Only agglutinated taxa were recovered, and again they suggest brackish water lagoonal or salt marsh settings.

Table 4. Archer-1: foram samples

DEPTH	WEIGHT	RESIDUE	FORAMS	BIOSTRAT	NOTES ON RESIDUE
3320	20.23	2.40	No	Lower T lilliei	Zst, brn, sndy; pyrite, glauc. Caved Cenozoic forams common.
3350	33.51				Not processed
3380	38.68	3.23	No		Zst, brn, finely sndy; pyrite, glauc. Caved Cenozoic forams.
3400	40.06				Not processed
3430	42.31				Not processed
3460	42.93	36.74	No		Zst, brn-grey, v calc. Caved Cenozoic (Miocene?) forams.
3500	40.84				Not processed
3530	65.50	25.29	No		Mostly snd, v crse to med, ang to subang; minor zst, grey. Caved Cenozoic forams.
3555	52.04				Not processed
3595	73.91			Upper N senectus	Not processed
3625	57.48				Not processed
3655	77.13	61.98	No		Mostly snd, v crse to med, ang to subang; minor zst, grey. Caved Cenozoic forams.
3680	65.58				Not processed
3705	56.73				Not processed
3730	41.23	34.49	No		Sst, v crse to med, ang; zst, brn; coal chips
3755	38.12				Not processed
3820	60.08	40.23	No		Sst, v crse to med, ang; zst, brn, carb; coal chips
3855	38.49				Not processed
3890	47.45			Lower N senectus	Not processed
3930	50.76	2.25	Yes		Mudstn, drk grey; zst, lt tan; minor snd, crse, ang; rare glauc. Aggl forams mod common.
3965	60.65				Not processed
4000	38.16				Not processed
4030	35.15				Not processed
4050	42.21	14.56	Yes		Zst, grey, hard. Rare aggl forams.
TOTAL SAMPLES			24		
SAMPLES EXAMINED			9		

3.4 Blackback-1 (See Table 5)

Samples collected/prepared/fossiliferous: 27/10/0

Comments

General:
Although the finest-grained mainly were selected for processing, none were productive. It is likely that there was only very minor marine influence at the site during the Cretaceous.

Table 5. Blackback-1: foram samples (0/10/27)

DEPTH	WEIGHT	RESIDUE	FORAMS	NOTES ON RESIDUE	BIOSTRAT
3510	27.96			Not processed	Lower F. longus
3525	22.42	9.42	No	Zst, brn, mic; minor snd, qtz, ang; coal chips common, pyrite	
3535	39.72			Not processed	
3570	22.39	10.14	No	Zst, brn, mic, carb; minor qtz snd, ang; coal chips, pyrite, glauc??	
3615	26.39	13.06	No	Sst, flds, crse, ang; minor zst, brn, mic; coal chips	
3645	58.38			Not processed	
3680	37.76	25.36	No	Sst, flds, crse, ang; minor zst, brn, mic; coal chips, glauc (in place?)	
3710	37.03			Not processed	
3765	44.16			Not processed	
3800	32.04			Not processed	
3865	48.08	42.64	No	Sst, grey, fg, calc, silty, pyrite; minor snd, crse; minor zst, brn; coal chips, rare glauc	
3905	33.66			Not processed	
3935	44.80			Not processed	
3965	25.80	20.84	No	snd, med to crse; minor zst, brn; coal chips, rare glauc. Caved Cenozoic forams.	
4000	32.65			Not processed	
4060	36.21			Not processed	
4095	33.73			Not processed	
4110	23.65	15.30	No		
4140	21.58	8.89	No		
4170	28.20			Not processed	
4225	35.89	35.04	No		Probable Lower F. longus
4270	20.06			Not processed	
4315	32.29			Not processed	
4340	37.84			Not processed	
4365	22.20			Not processed	
4380	21.98			Not processed	
4390	17.71	12.92	No		
TOTAL SAMPLES			27		
SAMPLES EXAMINED			10		

3.5 East Pilchard-1 (See Table 6)

Samples collected/prepared/fossiliferous: 17/12/0

Comments

General:
Although the section contained several siltstone intervals, which were extensively processed, none of the samples was productive. It is likely that there was only very minor marine influence at the site during the Cretaceous.

Table 6. East Pilchard-1: foram samples (0/12/17)

DEPTH	WEIGHT	RESIDUE	FORAMS	NOTES ON RESIDUES	BIOSTRAT
2525	24.93	11.86	No	Mafic Igneous fragments; snd, med to crse; zst, tan; pyrite. Caved Cenozoic forams.	?Lower T lilliei
2560	29.97			Not processed	
2595	33.34	11.55	No	Zst, grey, carb; sst, ylo-white, silty; pyrite. Caved Cenozoic forams.	
2635	37.85			Not processed	
2660	23.38	5.57	No	Zst, tan, sndy; zst, grey, carb; sst, med to crse, ang; pyrite.	
2695	50.24	33.35	No	Snd, med to crse, ang, rare subang; sst, fg, ang, silty; zst, grey; pyrite, coal chips grey chert.	N senectus
2735	51.54	9.61	No	Zst, grey & tan, carb; coal chips, pyrite	
2810	44.57			Not processed	T. apoxyex
2855	66.11	16.99	No	Zst, dark grey, hard, sndy; sst, ylo-brn, f to med grn, carb; snd, crse, ang; pyrite, coal chips.	Lower T. apoxyex. & ?P mawsoni
2905	45.82	32.05	No	Snd, med to v crse, ang; sst, fg, ang, silty, carb; zst, grey; pyrite, coal chips.	
2935	51.41	23.07	No	Snd, med to v crse, ang; sst, fg, ang, silty, carb; zst, grey; pyrite, coal chips. Caved Cenozoic forams.	
2985	39.44	11.82	No	Snd, med to v crse, ang; sst, fine to med, silty; zst, grey, carb.	
3010	48.71	22.92	No	Zst, grey, non-calc; minor snd, ang; v rare glauc, poss in place. Most marine-looking residue seen in sample suite.	
3050	56.35			Not processed	
3070	74.64	34.62	No	Zst, grey, carb; sst, f to med grn, white, silty; snd, med to crse grn, ang, rare rounded.	
3090	54.77			Not processed	
3125	84.38	68.04	No	Snd, v crse to med, ang; minor sst, fg, silty, ang, carb; minor zst grey; coal chips.	
TOTAL SAMPLES			17		
SAMPLES EXAMINED			12		

3.6 Tuna-4 (See Table 7)

Samples collected/prepared/fossiliferous: 3/3/0

Comments

General:
Tuna-4 is the most northerly well examined in this study, and the site presumably was closest to the paleoshoreline. Very few cuttings samples were available. There was good sidewall core coverage for the well, but it was deemed poor use of scarce material to attempt to recover foraminifers from the small sidewall samples. Further, results from other drillholes strongly suggested that this effort would be unsuccessful.

Table 7. Tuna-4: foram samples (0/3/3)*

DEPTH	WEIGHT	TYPE	RESIDUE	FORAMS	BIOSTRAT	COMMENT ON RESIDUES
2850	unsampled*	SWC			T lilliei	No sample taken
2965	unsampled	SWC				No sample taken
3025	unsampled	SWC				No sample taken
3045	unsampled	SWC				No sample taken
3100	unsampled	SWC			N senectus	No sample taken
3150	unsampled	SWC				No sample taken
3215	19.03	CTGS	15.44	No		Snd, v crse to med, ang, few subang to subround; sst, med to crse, silty; zst, grey; coal chips.
3265	34.57	CTGS	22.24	No		Zst, grey & brn; sst, f to med, silty; snd, crse, ang; coal chips, grey chert. 1 grain glauc seen.
3275	unsampled	SWC				No sample taken
3310	32.54	CTGS	20.89	No		Sst, ylo-brn, f to med, ang, silty; zst, grey; snd, crse, ang.
*Unsampled levels available only as SWCs						
TOTAL SAMPLES			3			
SAMPLES PROCESSED			3			

4. RECOMMENDATIONS

Foraminifera:
Work reported herein strongly suggests that Upper Cretaceous foraminifera are unlikely to be recovered at all from Gippsland Basin wells drilled north of Anemone-Angler-Archer, and foraminiferal studies in such wells is therefore not recommended. Although foraminifers make only a modest contribution to the biostratigraphic and paleoenvironmental interpretation of these three wells, increased marine influence is likely to the south (and also east). It is recommended that any well drilled in these areas include at least reconnaissance-level foraminiferal work.