WELL COMPLETION REPORT

ANEMONE-1,1A

BASIC DATA

A P P E N D I X 1

MICROPALAEONTOLOGY

MICROPALAEONTOLOGICAL REPORT

ON THE PETROFINA ET AL.

ANEMONE NO.1 WELL

GIPPSLAND BASIN.

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1. INTRODUCTION

Twenty sidewall cores between the depths 1130m to 2615m from Anemone-1 were submitted by Petrofina Exploration Australia S.A. for micropalaeontological age dating and environmental interpretation.

The interval 1130 to 2210m as seen in these cores consists of Pliocene and Miocene limestones and marls of outer shelf and upper bathyal facies. The deepest sample at 2210m is high in the early Miocene. A 200m sample gap intervenes between this and the next sample at 2408m, which is of Latest Oligocene age. The facies in this and the next sample, at 2539m, is similar to that of the Miocene above. Between 2555m and 2579m, three samples consist of bioclastic limestone, in part silty and recrystallised, which contains a poorly preserved fauna identified as Zone I-1, of Late Oligocene age. Some features of the fauna suggest the possibility of slumping or mass transport to explain the genesis of this limestone. This unit overlies an interval with a glauconitic matrix. A sidewall core at 2585m in this unit yielded foraminifera. Extremely rare specimens suggest that the age is either Early Oligocene or Eocene, but the foraminiferal evidence in this sample is very poor. Two samples in a glauconitic sandstone beneath this were barren of foraminifera.

The sequence appears to differ from that seen in the Angler-1 well. Marine faunas of Middle Eocene age were not definitely identified in Anemone-1. All that can be said of the sample at 2585m is that it lies somewhere between Middle Eocene and Early Oligocene in age, based on the range of two species. Whereas in Angler-1 Early Oligocene carbonates of zone J were identified above the marine Gurnard Formation, in

Anemone-1, zone J (usually seen in the basal Lakes Entrance Formation) was not seen in the carbonate samples submitted. The oldest carbonate sample is the Late Oligocene (Zone I-1) sample at 2579m. As much of the Late Oligocene and Early Miocene in Angler was masked by caving in the ditch cuttings, comparisons of that part of the sequence are not possible. The sequence above 1802m in Anemone-1 appears to be similar to the deep-water mid-Miocene to Late Pliocene interval seen in Angler-1.

The foraminiferal zonation used in this report is the zonal scheme developed for the temperate water faunas of the Gippsland Basin by D.J.Taylor (1966, 1983a, 1983b and unpublished data).

2. LIST OF SAMPLES STUDIED.

All samples are sidewall cores. Depths are in metres below rotary table.

1130m	2105
1194	2210
1262	2408
1312.5	2539
1323.5	2555
1356.5	2566
1402.5	2579
1504	2585
1704	2601.5
1802	2615

3. NATURE AND AGE SIGNIFICANCE OF THE FORAMINIFERAL ASSEMBLAGES.

At 1130m : Zone A-3 : Late Pliocene.

The sidewall core contains a moderately diverse foraminiferal fauna consisting mostly of small planktonic specimens. Globorotalia inflata is moderately abundant, as is G. scitula scitula. The age is defined by the presence of Globorotalia inflata, G. tosaensis tosaensis and G. cf. puncticulata, in the absence of the Pleistocene indicator, G. truncatulinoides. The assemblage can be approximately correlated with zone N21 of the tropical zonation. The virtual absence of Globigerinoides and Orbulina may suggest cold temperate water temperatures at this time. The benthic assemblage consists of genera such as Cassidulina, Cibicides, Astrononion, Anomalinoides, Bolivina and Euuvigerina, suggesting deep outer shelf water depths. Bathyal indicators appear to be lacking.

At 1194m : Zone A-4 : late Early Pliocene to Mid Pliocene.

This sample contains an abundant, well-preserved planktonic-dominated fauna. The assemblage is dominated by Globorotalia cf. inflata, with some specimens very close to G. inflata s.s., and many specimens grading into G. crassaformis ronda. Globorotalia conoidea is also very common. Globigerina spp. consist of very small specimens; Globigerinoides spp. are extremely rare. Based on the age ranges of Globorotalia cf. inflata and G. crassaformis, the age is no older than zone A-4 (Taylor, unpublished data). The evolutionary appearance of the G. inflata group

marks the base of Taylor's zone A, low in the Pliocene. Based on the ranges given by Jenkins (1986) for the ages of G. conomiozea and G. miozea conoidea, the age would not be younger than Early Pliocene. The benthonic assemblage is sparse but diverse. The most common species are Vulvulina pennatula and Planulina cf. wuellerstorfi, pointing to bathyal water depths in excess of 500m.

At 1262m : Zone B-1 : Earliest Pliocene to Latest Miocene.

The sample contains an abundant planktonic dominated assemblage, dominated by Globorotalia miozea conoidea, Turborotalia acostaensis and small globigerinids. There is a total absence of the Globorotalia inflata group, indicating an age older than zone A. The occurrence of both Globorotalia conomiozea and G. miotumida miotumida together is inconsistent with distributions reported in Taylor's unpublished 1981 zonation framework chart. However, subsequently Taylor recorded both species together in Helios-1 at 645m, in a sample which he dated as zone B-1 (Taylor, 1983a). Benthonic specimens are moderately common in this sample. The presence of species such as Karreriella bradyi, Osangularia bengalensis and Vulvulina pennatula suggests upper bathyal water depths.

1312.5m - 1402.5m : Zone B-2 : Late Miocene.

Four sidewall cores in this interval contain variable, planktonic-dominated assemblages. All contain Globorotalia miotumida miotumida, whereas G. conomiozea is present only as two "cf." occurrences. This suggests an age in B-2 rather than B-1. This age assignment is confirmed by the occurrence of

Globorotalia lenguaensis at 1323.5m and 1356.5m. The lowest three samples contain Turborotalia acostaensis acostaensis, indicating an age no older than B-2. Some reworking from Zone E is indicated by the presence of Praeorbulina glomerosa, and probably also by the persistent occurrences of Globorotalia miozea miozea (from Zone D and older). Variations in planktonic assemblages in this interval are marked. The highest sidewall core at 1312.5m is dominated by large specimens of Globorotalia miozea conoidea. The next sample at 1323.5m is dominated by small Turborotalia, principally T. continuosa and T. cf. siakensis. The sample at 1356.5m is dominated by small Globorotalia scitula and small Turborotalia spp. The deepest sample at 1402.5m is also dominated by these two forms, with Orbulina becoming more common in this sample. The presence of Turborotalia mayeri in this deepest sample suggests an age near the boundary with zone C. Taylor equates the extinction of this species with the top of zone C. The variations in the abundance of the principal planktonic species can be interpreted as indicating the influence of differing water masses, or current systems, through the Late Miocene.

The benthonic assemblage in these sample is very sparse, with no one species or group dominant. Sphaeroidina bulloides is conspicuous because of the large size of the specimens. The species has a wide depth occurrence in Gippsland, from 100m to greater than 2000m (Taylor, unpublished data). Martinotiella communis and Karreriella bradyi are present as occasional specimens, suggesting upper slope water depths. The remainder of the benthos consists of Cassidulina spp., Cibicides spp., Gyroidina sp., Anomalinoides spp., Notorotalia and Siphouvigerina,

suggesting either deep shelf depths, or that the benthic assemblage has been transported from those depths into deeper water.

At 1504m : probably Zone C : Middle Miocene.

The presence of Globorotalia miozea miozea in this sample was initially thought to indicate an age in zone D-1, at which level this species becomes extinct. However, further work has shown the presence of rare specimens of G. miozea miozea much higher in the sequence, and these occurrences are now interpreted as reworking. This sample contains the deepest occurrence of G. miotumida miotumida s.s. It also contains G. lenguaensis, reported by Bolli and Saunders (1986) to range no older than N14. Based on the occurrence of the latter two species, and the presence of Turborotalia cf. acostaensis, the sample is thought to be of zone C age, at the top of the Middle Miocene. The presence of Hoeglundina elegans and Cyclammina sp. suggests a bathyal environment.

1704 - ?1802m : Zone D-1 : Middle Miocene.

Both samples consist of a silty limestone or calcisiltite, indurated and with poorly preserved assemblages, often pyrite-filled. The presence of Globorotalia peripheroacuta, G. peripheroronda, G. zealandica and Orbulina spp. in the higher sample indicates a definite D-1 age determination. The lower sample still contains G. peripheroacuta, suggesting the same age, but Orbulina is virtually absent (one specimen of O. suturalis was found), which is anomalous. No specimens of Praeorbulina were found. This suggests possible shape sorting of the assemblage, as Orbulina (and its ancestor, Praeorbulina) are

normally abundant at this level above the Orbulina datum. (See also discussion on next sample below). The benthos of both samples is sparse. Cassidulina plus uvigerinids are moderately common in the higher sample. Karreriella bradyi and Vulvulina pennatula in the deeper sample, plus Cassidulina and lagenids suggest an upper bathyal depth. Although the environment is not well defined by these two samples, the presence of Cassidulina neocarinata and the possibility of shape sorting of the planktonic component both suggest that this poorly preserved interval may represent canyon fill sediments, emplaced by mass transport.

At 2105m : Zone E-2 - Latest Early Miocene.

The foraminiferal assemblage in this sample is abundant and diverse, in contrast to the samples just discussed. The planktonic component is dominated by the genus Globigerinoides. G. sicanus and Praeorbulina glomerosa are moderately common. Together these species indicate Taylor's zone E-2, a zone immediately prior to the Orbulina datum, and thus equivalent to tropical zone N8. Other conspicuous planktonic species present include Globorotalia miozea miozea, G. praescitula and G. menardii. The benthonic assemblage is diverse, and includes many small Lagena and Fissurina spp. Osangularia bengalensis is conspicuous; Cibicides spp. are almost absent. The depositional environment is interpreted as probably upper bathyal.

Taylor, in common with other authors such as Bolli and Saunders (1986), places the Middle / Early Miocene boundary at 15.0 million years before present, between tropical zones N8 and N9. However, some authors (eg. Haq et al., 1987) place the boundary at 16.2 m.y., thus including Zone N8 in the Middle Miocene. In such

usage, zone E-2 would also be called "Middle Miocene". This illustrates the problem of using European stage subdivisions when the usage applied to these terms has not always been uniform. Correlation in Gippsland by use of the local zone names eliminates one source of ambiguity.

At 2210m : Zone F : Early Miocene.

The indicator species for the base of zone F, Globigerinoides sicanus (=bisphericus), was not found in this sample. However, other species present include G. transitorius, G. miozea miozea and G. praescitula. The latter two species, which are common in this sample, have base ranges in zone F in Selene-1 (Taylor, 1983b). Also present is Globorotalia zealandica, which has the upper part of its range within the equivalent of zone F (Jenkins, 1971). Zone F can be correlated approximately with the upper part of Zone N7 of the tropical zonation. The environment of deposition is questionably interpreted as upper bathyal, although some species may well have been derived from shelf depths.

At 2408m : Zone H-2 : Latest Oligocene.

The age of this sample is based primarily on the base range of Globigerina woodi woodi, which is abundant here. Globigerinoides spp. are virtually absent - only two somewhat questionable specimens being found after detailed searching. The presence of Globigerina euapertura and Turborotalia opima opima initially suggested correlation with Taylor's zone I-1, in spite of the presence of G. woodi. However, J. Rexilius (pers. comm.) indicates that T. opima opima is unreliable as an indicator species in Gippsland; and

the species has long been recorded from the Early Miocene of Western Australia (Apthorpe, unpublished data). Jenkins (1986) records G. euapertura as overlapping the range of G. woodi. On this basis the provisional dating of the sample as I-1 has been changed to zone H-2. Taylor correlated this zone with basal zone N4, in the latest Oligocene.

The benthonic assemblage contains an unusual number of large Ammobaculites cf. agglutinans and other agglutinated species. On the basis of the presence of Vulvulina pennatula, Karreriella bradyi and abundance of lagenids and Brizalina, the sample is considered to have been deposited in upper bathyal depths.

2539m - 2579m : Zone I-1 : Late Oligocene.

The uppermost sample in this interval contains an abundant planktonic assemblage dominated by very small Globigerina and Turborotalia spp., mostly specifically indeterminable. Species suggestive of the age are extremely rare. The presence of Globoquadrina dehiscens establishes that the age is no older than zone I-1 (Taylor, unpublished data), and the absence of Globigerina woodi s.s. indicates that it is no younger than this. (Specimens identified as G. cf. woodi occur rarely in this and other samples below). Turborotalia opima opima is intermittently present, becoming more common in the two lowest samples. Turborotalia extans occurs in three of the four samples. Its overlap with Globoquadrina dehiscens seems to contradict its range as suggested by Taylor, who would confine it to zone I-2 and older. No other indications of I-2 species were seen.

The benthonic assemblage of all four sidewall cores contains many species in common, but their abundances

vary from sample to sample. The sample at 2539m contains a sparse benthos, which includes Hoeglundina elegans, Karreriella bradyi, Martinotiella communis and Vulvulina pennatula. These species are considered to indicate upper bathyal water depths. The sample at 2555m is a limestone, much of the washed residue consisting of broken foraminifera with relatively few specimens identifyable. The sparse benthos is dominated by small specimens of Cibicides, Fullenia and Globocassidulina - essentially a shelf assemblage. Some of the planktonic specimens are deformed, possibly due to mass transport before the chambers were diagenetically infilled with calcite. These two observations suggest that the sediment may have been emplaced by slumping of material from the (outer) shelf. The sample at 2566m contains a large amount of residue greater than 70 microns size. Much of the sample consists of quartz silt and broken biogenic grains; foraminifera are relatively sparse, poorly preserved and frequently indeterminable. Bone chips and teeth are more common than usual. The presence of a few bathyal foraminifera (Cyclammina sp., Karreriella bradyi, Vulvulina pennatula) continues to suggest bathyal depths of deposition. Sediment influx from shallow depths is strongly suggested. The deepest carbonate sample, at 2579m, contains an abundant but recrystallised foraminiferal assemblage. The low diversity benthonic part of the assemblage is dominated by Cibicides spp., suggesting a shelf origin for some of the fauna. However, rare specimens of Cyclammina sp. and Vulvulina pennatula continue to suggest bathyal depths of deposition, so that some of the sediment may well have been transported downslope. The sample contains chips of Latrobe Group claystones and

sandstones, which are interpreted to be the result of drilling contamination (because of the variety of different rock types present), rather than indicating reworking.

At 2585m : possibly zone J ??? : ?possibly Early Oligocene ???

This sample consists of coarse quartz grains and rare glauconite pellets in a large amount of matrix of hard, dark green glauconite. Embedded in the matrix are rare foraminifera, predominantly planktonic. Virtually all specimens are broken or have their walls partly dissolved away. Although many of the specimens can be identified as Globigerina sp. (or Subbotina sp.) on the basis of the internal glauconite molds which remain, most diagnostic features of specimens have been destroyed. Very rare specimens, mostly thick-walled, form an exception to this statement, but the age indications are somewhat contradictory. One whole specimen of Globorotalia testarugosa was recovered. The species is reported only from the Oligocene by Jenkins (1971). Globigerina cf. angiporoides occurs as a single, damaged specimen. The range of G. angiporoides is Middle Eocene to Early Oligocene. Planorotalites cf. renzi is identified as a single, partially dissolved small specimen. If the specimen is, in fact, P. renzi, it would indicate a Middle Eocene age for the sample. There is thus no clear indication of the age from the foraminiferal assemblage, due mostly to the extremely bad preservation. The benthonic assemblage is similarly affected; the most common identified form was the robust Globocassidulina subglobosa. Cibicides spp. and ?Haplophragmoides sp. comprise most of the other

identified forms. There is too little evidence to suggest a water depth. The environment was either a marine shelf, or a marginal marine area into which marine fauna was carried. The former interpretation is tentatively preferred.

2601.5 - 2615m : age indeterminable : virtually barren.

The higher sample is a greensand, consisting of a large amount of brownish altered glauconite pellets, and rare quartz. Rare fish teeth and bone fragments suggest a marine origin, but only one fragmentary foraminiferid was found. The sample at 2615m is a glauconitic quartz sand in which no foraminifera were found. No age can be suggested for either sample.

4. REFERENCES.

Bolli, H.M. and Saunders, J.B. (1986): Oligocene to Holocene low latitude planktic foraminifera. p155-262 in Bolli, H.M., Saunders, J.B. and Perch-Nielsen, K. (eds), Plankton Stratigraphy : Cambridge University Press.

Haq, B.U., Hardenbol, J. and Vail, P.R. (1987): Chronology of fluctuating sea levels since the Triassic : Science, v.235, p.1156-1166.

Jenkins, D.G. (1971) : New Zealand Cenozoic Planktonic Foraminifera. New Zealand Geological Survey, Paleontological Bulletin 42.

Jenkins, D.G. (1986) : Southern mid-latitude Paleocene

to Holocene planktic foraminifera. p.263-282 in Bolli, H.M., Saunders, J.B. and Perch-Nielsen, K. (eds), Plankton Stratigraphy : Cambridge University Press.

Taylor, D.J. (1966) : Esso Gippsland Shelf No.1 : the Mid-Tertiary foraminiferal sequence. Commonwealth of Australia, Bureau of Mineral Resources, Geology and Geophysics. Publications Petroleum Search Subsidy Acts Australia, no. 76, p.31-46.

Taylor, D.J. (1983a) : Stratigraphy of the foraminiferal sequence in Helios #1, Gippsland Basin. Appendix 6 in Helios-1 well completion report. Phillips Australian Oil Company, unpublished report.

Taylor, D.J. (1983b) : Stratigraphy of the foraminiferal sequence in Selene #1, Gippsland Basin. Appendix No.7 in Selene-1 well completion report. Phillips Australian Oil Company, unpublished report.

TABLE 1. SUMMARY OF MICROPALAEONTOLOGICAL AGE DETERMINATIONS, ANEMONE-1.

DEPTH (M)	ZONE	AGE	ENVIRONMENT
At 1130	A-3	Late Pliocene	Deep outer shelf
At 1194	A-4	late Early Pliocene to mid-Pliocene	Bathyal
At 1262	B-1	Earliest Pliocene to latest Miocene	Upper bathyal
1312.5-1402.5	B-2	Late Miocene	Outer shelf to upper bathyal.
At 1504	probably C	Middle Miocene	Upper bathyal
1704-?1802	D-1	Middle Miocene	Upper bathyal - possibly canyon fill
At 2105	E-2	latest Early Miocene	Probably upper bathyal
At 2210	F	Early Miocene	Probably upper bathyal
At 2408	H-2	Latest Oligocene	Upper bathyal
2539-2579	I-1	Late Oligocene	Upper bathyal, possibly + slumping
At 2585	J???(-N?)	???Early Oligocene (to possibly Eocene)	indet.(see text)
2601.5-2615	-	indeterminable (virtually barren)	