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SUBSURFACE BIOSTRATIGRAPHY IN THE CASTERTON-DONODONG AREA

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with appendix by. Dr. B. McGowran (University of Adelaide)

Unpublished report 1964/76

INTRODUCTION

Recent drilling by Planet Oil Co. N.L. has necessitated an investigation of the foraminiferal biostratigraphy of 42 bores drilled within the Casterton-Dorodong area by the Victorian Mines Department, South Australian Mines Department and Planet Oil Co.

This study was greatly assisted by Mr. P.R. Kenley who freely discussed his intimate knowledge of the geology of this region. The Planet geologist, Mr. G. Brown, provided the author with information, samples and much discussion. It should be noted that Mr. Kenley and Mr. Brown are of conflicting views, making this study a stimulating one. However, the author's results can hardly be regarded as a third opinion as they depend very much on the degree of interpretation. The author wishes to thank Dr. B. McGowran of the University of Adelaide for his original work on the Heathfield Well, Core No. 1, and for the checking of many of the author's determinations of Paleocene species.

THE SCOPE

The bores studied are clustered into two areas (see fig. 1) to the south west (the Dorodong area) and to the west (the Casterton Area) of Casterton. Bores examined in these two areas are listed in Appendix I & II with biostratigraphic detail for each bore.

As shown by Kenley (1962), marine faunas are present in three rock units; the Knight Group, the Glenelg Group and the Whalers Bluff Formation (listed in ascending order). The time was not available to conduct a detailed examination of all of the 42 drilled sections, so three particular aspects were selected for study. These aspects were:-

(1) The age and lateral extent of the marine faunas within the Knight Group.

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(ii) The biostratigraphic units, in terms of Carter's (1958) Faunal Units, at the base of the Glenelg Group in each section.

(iii) The apparent age and depositional environment of the Whalers Bluff Formation.

THE BIOSTRATIGRAPHY

(i) of the Knight Group: Kenley (1951 & 1954) has described and discussed the Knight Group in outcrop, with particular reference to the outcropping basal unit, the Bahgallah Formation. Molluscan evidence, given by Kenley (l.c.) clearly demonstrates that the Bahgallah Formation is the time correlate of the Pebble Point Formation on the western flank of the Otway Ranges. The Pebble Point Formation, on molluscan evidence, was regarded as being of Paleocene to lower Eocene age, but recently McGowran (in press) has been able to effect a more precise age on the foraminiferal faunas, and to show that the Pebble Point Formation is of middle Paleocene age. McGowran (l.c.) also shows that the Pebble Point fauna is fairly distinct from the upper Paleocene fauna of the higher Rivernook Member. The author is now able to demonstrate that there are two Paleocene faunas above the Rivernook fauna in the La Trobe No. 1 bore (at Princetown) and is certain that the Pebble Point fauna is distinct from the Rivernook fauna in the La Trobe and other subsurface sections. The author records that the Pebble Point fauna extends some 150 feet into the Dilwyn Clay in La Trobe. The Dilwyn Clay is a unit of silts, sandy silts and sands above the Pebble Point Formation and the glauconitic sands of the Rivernook Member is within the Dilwyn Clay. Therefore the Dilwyn Clay is the rock correlate of the Dartmoor Formation in Dartmoor-Casterton area.

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As yet good foraminiferal faunas have not been isolated from the Bagallah Formation in outcrop, but core No. 1, from Planet Heathfield No. 1 Well, lithologically resembled the Bagallah Formation and contained a Pebble Point fauna as reported by McGowran (Appendix III, this report). The outcropping basal silts of the Dartmoor Formation have not revealed calcareous foraminifera, but do contain arenaceous Haplophragmoides faunas (syn. Cyclammina) of species which represent Taylor's (in press) Paleocene Haplophragmoides assemblages.

In subsurface section rich Paleocene faunas have been found in some samples of Knight Group sediments; ex. Kanawinka No. 4, Drajurk No. 1, Planet Tullich Structure Holes No. 4, 7 and 14, as well as in Heathfield No. 1. In no sample are species present which are indicative only of the Rivernook or higher faunas and some species present are exclusive to the Pebble Point fauna. Such species include Baggatella sp. nov. McGowran, Citharina plumoides, C. sp. 1 McGowran, Dentalina insula and Cibicides whitei. Also present are Anomalinoides westraliensis, Nodosaria latejugata and the "ehrenbergi morphotype" of Globorotalia chapmani, common in the Pebble Point fauna but very rare in the Rivernook. It should be noted that the genus Citharina does not occur in sediment younger than Paleocene and that the planktonic species G. chapmani is restricted to the Paleocene (McGowran, in press).

The above faunas occur in both glauconitic sands and silts, but faunas are absent in the medium grained sands higher in the Knight Group sections. Apart from core No. 1 in Heathfield No. 1, Mr. Kenley (pers. comm.) states that it is difficult to positively identify the Bahgallah Formation in subsurface sections. The author agrees with this and has found Pebble Point faunas in sediment more typical of the basal Dartmoor Formation than of the Bahgallah Formation.

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(ii) of the basal Glenelg Group: In the Dorodong area drilled sections, Kenley (1962) describes the basal member of the Glenelg Group as consisting of calcareous and sideritic sands and micaceous siltstones. These sediments were examined and particular notice was taken of the first foraminiferal sample above the Knight Group. These lowest samples in the Glenelg Group showed faunal variation from bore to bore, in terms of Carter's (1958) faunal units. The specific criteria are listed below, and it should be noted that some of the criteria differ from Carter's as the result of several published works and adjustments made by the author. The faunas are as follows:-

(a) Faunal Unit 4 (basal Janjukian): planktonic fauna- Globigerina linaperta, G. ampliapertura (both ampliapertura and euapertura morphotypes), Globorotalia testarugosa and Chiloguembelina cubensis (syn. Guembelina rugosa).
benthonic fauna - includes several species of Anglogenerina and Uvigerina and Bolivinopsis sp. (non. B. crespinae which is now shown to be Spirobolivina emmendorferi).

This fauna is a transitional one between the upper Eocene and the typical Janjukian faunas. The persistance of G. linaperta, G. ampliapertura (sensu stricto) and C. cubensis is a characteristic criterion of Faunal Unit 4.

(b) Faunal Unit 5 (Janjukian): planktonic fauna - Globigerina ampliapertura (euapertura morphotype), Globorotalia extans, and G. opima opima.
benthonic fauna - fairly nondescript but containing Victoriella conoidea and a rich arenaceous fauna.

(c) Faunal Unit 6 (lower Longfordian): planktonic fauna - Globigerina apertura, G. ciperoensis, G. woodi and Globigerinoides triloba immatura.
benthonic fauna - nondescript but Victoriella conoidea absent.

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The initial appearance of G. ciperoensis and G. woodi is indicative of Faunal Unit 6. Carter (l.c.) uses the first appearance of G. triloba as marking the base of Faunal Unit 7, but the "immatura morphotype" occurs in small numbers below the base of Faunal Unit 7. Certainly the appearance of Globigerinoides triloba is indicative of the Longfordian.

From Appendix I and II it can be seen that the biostratigraphic unit at the base of the Glenelg Group varies from bore to bore. This variation ranges from Faunal Unit 4 to 6 or possibly 7. In any one line of bores, this variation is gradual. In the tabulation below, the southern line of Dorodong bores are arranged in section from south west to north east.

Faunal Unit 4	Faunal Unit 5	Faunal Unit 6
Kanawinka	Kanawinka	Dergholm
Bore 4 : 5 : 3.	Bore 7 : 1.	Bore 1 : 3.

The two end samples of this series are distinct faunas. Kanawinka 4 containing remnants of upper Eocene planktonic fauna is certainly distinct from Dergholm 3 which contains the first appearance of the typically lower Miocene planktonic faunas. The faunal changes between these two end sections are gradual.

A similar series can be shown in the parallel northern line of Dorodong bores, though Faunal Unit 6 is not present in any basal Glenelg Group sample.

Yet another series can be shown in a section of Planet Tullich Structure holes. But this line of section is perpendicular to the two Dorodong lines. In the tabulation below a line of Tullich structure holes are arranged in section from north west to south east.

Faunal Unit 4	Faunal Unit 6	Faunal Unit 5
Planet Structure Holes		
5 : 14.	9*.	16 : 18.

* Faunal Unit 5 may be present but thin development when compared with holes 16 & 18.

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The basal member of the Glenelg Group is lithologically similar in all bores, yet there are biostratigraphic differences. For the southern line of Dorodong drilling, the cited evidence clearly suggests that the basal member of the Glenelg Group is a diachronously transgressive unit, gradually overlapping onto a sloping or faulted surface. The northern line of Dorodong drilling shows the same feature during a shorter time range. The situation in the Tullich Structure hole line may appear anomalous, when compared to the other two lines, as hole 9 contains younger sediment than do holes of either side. However, hole 9 was probably in a higher structural position during the transgression of the basal member of the Glenelg Group.

A similar diachronous transgression from Faunal Unit 4 to 6 has been described from the flanks of the Baragwanath Anticline (Gippsland Basin) by Hocking & Taylor (1964).

(iii) of the Whalers Bluff Formation: These sediments contain rich foraminiferal faunas including Ammonia beccarii, Elphidium pseudonodosum, E. advenum imperatrix, Flintina intermedia, Nonion victoriense, Cancris phillipinensis, Valvulineria kalimnensis and Globigerinoides conglobata. These species are shown by Carter (1964) and Parr (1939) to be typical of the Kaliminan (lower Pliocene) Jemmys Point Formation of the Gippsland Basin and by Parr (l.c.) of the Kaliminan of Grange Burn (near Hamilton). Similar faunas, no younger than Kaliminan, are listed by Ludbrook (1961) from the Loxton Sands and Bookpurnong Beds of the South Australian part of the Murray and Otway basins. Kenley (1962) suggests that the Whalers Bluff Formation in the Dorodong area is of lower Pleistocene age. Crespin (1963)has described similar species from the Maretimo Member of the Whalers Bluff Formation at Portland. She assigns these faunas a upper Pliocene age.

Thus the age of the Whalers Bluff Formation in this area is in dispute. One must consider that the faunas indicate a shallow water, embayment (or gulf) facies. An almost identical biofacies is shown by Bandy (1964) to exist today in the shallow protected

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waters of the Gulf of Batabano, Cuba. In southern Australia, these conditions could well have existed in different areas at different times from the upper Miocene to the lower Pleistocene. However, the author considers the fauna to be typical of the Kaliminan and designates it the "Kalminan facies" fauna.

THE AREAL DISTRIBUTION OF BIOSTRATIGRAPHIC UNITS

The distribution of the biostratigraphic units will be discussed with relationship to the Kanawinka Fault (Kenley 1962). Fig. 1 shows the biostratigraphic units present in each section examined.

In no section examined was fauna found that was older than middle Paleocene. The report of Upper Cretaceous sediment in Planet Heathfield No. 1 Well cannot be confirmed.

(i) Paleocene: Only definite middle Paleocene faunas were found. In most cases these are to the south or in the immediate vicinity of the Kanawinka Fault. However 170 feet (approx.) of marine middle Paleocene is reported on the northern side of the fault, in Planet Tullich Structure hole 14.

It would appear that in middle Paleocene times, true marine conditions did not reach the northern line of Dorodong bores. A Paleocene Haplophragmoides assemblage is recorded in Kanawinka 12A, but the presence of these euryhaline arenaceous species in the absence of calcareous species suggests a marginal marine, low salinity environment as is discussed by Taylor (in press).

Evidently the marine Paleocene transgressed over the Kanawinka fault in the Casterton area, but not in southern line of Dorodong bores although there is a thin development in Kanawinka Bore 3 (just over the fault). The marine transgression did not reach the northern line of Dorodong bores which contain marginal marine sediments, and Mr. W. Harris (palynologist, South Australian Mines Dept. - pers. comm.) has not reported any marine forms in the Paleocene sediments on the South Australian part of the Otway Basin.

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In many sections, above the marine Paleocene, there is an interval of sands and silty sands which are barren of fauna. This interval is up to 200 feet thick and is upper Paleocene to Eocene in age. Kenley (1962) has commented that this sediment has been eroded. This is particicularly so in the vicinity of the fault, where sections (ex. Tullich Structure Hole 7) pass directly into marine Paleocene without intersecting the non marine Paleocene.

(ii) Janjukian and Longfordian: The distribution of the biostratigraphic units within these stages have already been discussed in respect to the basal sediments of the Glenelg Group. It has been concluded that diachronous transgressive sedimentation took place. In the case of the Dorodong drilling, this transgression was perpendicular to the Kanawinka Fault (sensu Kenley, 1962), with younger sediments gradually overlapping on the upthrow side. But in the case of the Tullich structure drilling, it is seen that this transgression also took place parallel to the fault with the full transgressive sequence of the upthrow side (ex. Tullich Structure Holes 5, 14, 9, 16 & 18).

Drilling in the Casterton area shows that most of the Glenelg Group sediments have been eroded from the downthrow side of the fault. A similar situation is clearly shown by Kenley (l.c.) for the Dorodong area.

(iii) "Kaliminan facies" faunas: Kenley (l.c.) has already shown that the distribution of these sediments is influenced by the fault and they do not extend north (upthrow) of the topographic expression of the fault.

The age of these sediments are difficult to assess, though the Kaliminan aspect can not be dismissed. It is noted that Ludbrook (1964, fig.36 - 6 & 7) shows similar faunas just across the South Australian border.

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CONCLUSIONS

Three Tertiary marine transgressions are shown in the Casterton-Dorodong area. These are in the middle Paleocene, Janjukian to Longfordian stages and Kalimnan or younger stage. The distribution of these transgressions is not identical in any of the three cases. Each transgression was onto a sloping surface (topographic and/or structural expression), erosion occurred between each transgression and the nature of the surface altered before the next transgression.

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APPENDIX I.

DORODONG AREA

(refer unpublished report by Kenley, 1962/59)

(i) South line of bores. Discussed in order west - east.

KANAWINKA NO. 4

? - 122 feet - Janjukian - Faunal Unit 5 faunas rich in arenaceous species.

122 - 137 feet - Basal Janjukian - Faunal Unit 4 faunas with few planktonic species though Globorotalia testarugosa and Chiloguembelina cubensis present.

137 - 319 feet - N.F.F.

319 - 324 feet - Poor Paleocene fauna.

347 - 355 feet - Good middle Paleocene (Pebble Point) fauna, including Citharina plumoides and Modosaria latejugata.

KANAWINKA No. 5

(N.B. Following results in agreement with Carter's appendix to unpublished report 1962/59)

? - 140 feet - Janjukian - Faunal Unit 5.

140 - 155 feet - Basal Janjukian - Faunal Unit 4.

155 - 324 feet - N.F.F.

324 - 340 feet - Poor Paleocene fauna.

KANAWINKA No. 3

? - 132 feet - Janjukian - Faunal Unit 5.

132 - 150 feet - Basal Janjukian - Faunal Unit 4. Planktonic fauna includes Globigerina ampliapertura, Globorotalia testarugosa and Chiloguembelina cubensis

170 - 175 feet - Sparse middle Paleocene fauna which includes Citharina sp. 1 McGowran a diagnostic Pebble Point species.

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KANAWINKA No. 7

90 - 133 feet - Basal Longfordian - Faunal Unit 6. Good planktonic fauna including Globigerina woodi and G. ciperoensis.

133 - 192 feet - Janjukian - Faunal Unit 5. Good planktonic fauna including Globigerina euapertura, Globorotalia opima opima and G. extans.

192 - 212 feet - N.F.F.

KANAWINKA No. 1

? - 217 feet - Janjukian - Faunal Unit 5. Victoriella conoidea and planktonic species including Globigerina euapertura and Globorotalia extans.

217 - 231 feet - N.F.F.

DERGHOLM No. 1

218 - 249 feet - Basal Longfordian - Faunal Unit 6. Good planktonic fauna including Globigerina apertura, G. woodi, G. ciperoensis, Globigerinoides triloba immatura.

249 - T.D. - N.F.F.

DERGHOLM No. 3

115 - 129 feet - Basal Longfordian - Faunal Unit 6. Good Planktonic fauna as for Dergholm No. 1

129 - T.D. N.F.F.

(ii) North line of bores. Discussed in order west - east.

KANAWINKA No. 18

? - 260 feet - Basal Janjukian - Faunal Unit 4.

260 - T.D. - N.F.F.

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KANAWINKA No. 13

204 - 234 feet - Basal Janjukian - Faunal Unit 4. Good Planktonic fauna including Globigerina ampliapertura, G.linaperta and Chiloguembelina cubensis.

234 - T.D. - N.F.F.

KANAWINKA No. 12A

? - 180 feet - Janjukian - Faunal Unit 5.

180 - 220 feet - Basal Janjukian - Faunal Unit 4.

220 - 258 feet - N.F.F.

258 - 278 feet - Paleocene Haplophragmoides fauna consisting of H. complanata, H. paupera and H. rotundata Absence of calcareous fauna in fresh sediment strongly indicates marginal marine environment.

KANAWINKA No. 15

? - 296 feet - Basalt Longfordian - Faunal Unit 6. Planktonic fauna includes Globigerina ciperoensis and G. woodi.

296 - 324 feet - Janjukian - Faunal Unit 5. Suspect high in unit as G. woodi is still present associated with Globorotalia extans and G. opima opima.

324 - T.D. - N.F.F.

KANAWINKA No. 17

291 - 316 feet - Janjukian. Faunal Unit 5.

316 - T.D. - N.F.F.

APPENDIX II CASTERTON AREA

PLANET HEATHFIELD NO. 1 -

80 - 120 feet - "Kaliminan facies" foraminifera.

120 - 690 feet - N.F.F. Probably Eocene to upper Paleocene

690 - 950 feet - Marine Paleocene - probably middle Paleocene (Pebble Point fauna)

960 - 975 feet (Core No. 1) - Marine middle Paleocene (Pebble Point fauna - see McGowran's appendix to this report).

975 - T.D. No first appearances of species below 975 feet. Definitely no sign of Upper Cretaceous marine.

SOUTH AUSTRALIAN MINES DEPT. DRAJURK No. 1 -

100 ft. (approx.) - "Kaliminan facies" foraminifera.

430 - feet - Marine Paleocene faunas - probably middle Paleocene. Dr. A.N. Carter examined this material and recognised it as "Kings Park fauna" which is now regarded as Paleocene.

PLANET TULLICH No. 1 -

Cutting samples only - highly contaminated by rich "Kaliminan facies" faunas which first appear at 90 feet.

Marine Paleocene is probably present at 250 feet.

PLANET TULLICH STRUCTURE HOLE NO. 1

Sludge samples only in all structure holes.

In this hole the samples are heavily contaminated from 90 feet.

90 - 110 feet - "Kaliminan facies" fauna.

400- 500 feet - Some Paleocene foraminifera and other fauna.

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PLANET TULLICH STRUCTURE HOLE NO. 2 -

90 - 120 feet - "Kaliminan facies" faunas

120 - 430 feet - heavy contamination from above

430 - 590 feet - " " " " together with some Paleocene.

PLANET TULLICH STRUCTURE HOLE No. 3

Hole abandoned at 115 feet. "Kaliminan facies" faunas at 90 feet.

PLANET TULLICH STRUCTURE HOLE No. 4

90 feet - very thin development of "Kaliminan facies" faunas.

90 - 150 feet - Apparently marine Paleocene though contaminated from above.

150- 220 feet - Marine middle Paleocene (Pebble Point fauna).

PLANET TULLICH STRUCTURE HOLE No. 5

20 - 60 feet - Excellent Janjukian fauna. Sample at 40 - 50 feet contains Faunal Unit 4(Basal Janjukian).

60 - T.D. - Very heavy contamination from above. Both non-marine and marine Paleocene are probably present.

PLANET TULLICH STRUCTURE HOLE No. 6

90 - 110 feet - "Kaliminan facies" faunas.

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PLANET TULLICH STRUCTURE HOLE No. 7

90 feet - very thin development of "Kaliminan facies" fauna.

100 - 240 feet - Marine middle Paleocene (Pebble Point fauna). Presence of Baggatella sp.nov at 120 feet is significant.

PLANET TULLICH STRUCTURE HOLE No. 8

90 - 120 feet - "Kaliminan facies faunas"

120 - T.D. - Heavy contamination from above - probable marine Paleocene below 220 feet.

PLANET TULLICH STRUCTURE HOLE No. 9

30 - 120 feet - Longfordian. Faunal Unit 7 definitely present at top of section.

120- 150 feet - Heavy contamination from above. Faunal Unit 5 may be present at base. It is suggested that there is little or no Janjukian in this section.

PLANET STRUCTURE HOLES Nos. 10 - 13.

No marine Tertiary in any of these sections.

PLANET STRUCTURE HOLE no. 14

20 - 100 feet - Basal Longfordian (Faunal Unit 6), but mainly Janjukian (Faunal Unit 5).

100 - 120 feet- Lower Janjukian (Faunal Unit 4).

120 - 300 feet -Heavy contamination from above - probably non marine Paleocene.

300 - 470 feet -Marine middle Paleocene (glauconitic). Characteristic species include Citharina ~~the~~plumoides.

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PLANET STRUCTURE HOLE No. 15

No marine Tertiary sediments in section. Interval 60 - 130 feet could be non-marine Eocene or Paleocene.

PLANET STRUCTURE HOLE No. 16

10 - 60 feet - Upper Janjukian (Faunal Unit 5). No development of Longfordina.

60 -100 feet - Heavy contamination from above - no sign of lower Janjukian faunas.

PLANET STRUCTURE HOLE No. 17

100 - 160 feet - "Kaliminan facies" faunas.

160 - 350 feet - Heavy contamination from above. Probably non-marine Eocene and Paleocene.

350 - 500 feet - Contamination but some Paleocene species.

PLANET STRUCTURE HOLE No. 18

10 - 60 feet - Upper Janjukian (Faunal Unit 5) faunas.

APPENDIX III

REPORT ON FORAMINIFERA IN SAMPLE FROM HEATHFIELD NO. 1

by Dr. B. McGowran, University of Adelaide

Sample: Heathfield No. 1 (Planet), Core 1, 960-975 ft.
A dark green, friable, gritty, glauconitic sediment with numerous shelly fossil fragments.

Fauna:

+ Quinqueloculina sp.
* Polymorphina sp.
Tobolia cf. veronica Dain
Dentalina sp.
+ Lenticulina sp.
Robulus reussi Haque
Angulogerina sp. nov.
* Globocassidulina sp.
Bolivinoides oedumi (Brotzen)
* Baggatella sp. nov.
Hoeglundina scalaris (Franke)
Ceratobulimina westraliensis Parr
Alabamina westraliensis (Parr)
+ Conorbina? sp.
* Conorbina sp. of McGowran, MS.
* Gyroidinoides sp. of McGowran, MS.
* Pseudovalvulineria sp. nov.
Anomalinoides praespissiformis (Cushman & Bermudez)
* Anomalinoides aff. nobilis Brotzen
* Karreria pseudoconvexa (Parr)
Cibicides sp. 1 of McGowran, MS.
Cibicides umbonifer Parr

Most of these 22 species are represented by one or two specimens only. The dominant forms are C. umbonifer, Anomalinoides sp. nov., and Robulus reussi.

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Also present: ostracodes, gastropods, shark teeth, and a relatively abundant, calcareous microfossil with pustulose surface, whose affinities have not yet been recognized. Several fossils are infilled with glauconite.

Correlation

This fauna has been compared with two recently studied faunas from the Wangerrip Group in the Pebble Point Coastal sequence (McGowran, 1965). Species present in the Pebble Point Formation, but not the Rivernook Member of the overlying Dilwyn Clay, are marked (*) in the above list. On the other hand, no exclusively Rivernook species are present. Apart from three (+), each represented by a single specimen, the other species are common to both Wangerrip Group faunas. Enough specimens have been recovered to further the resemblance to the Pebble Point fauna, in which the three dominant species noted above are also dominant. Also, the lack of planktonics compares with the Pebble Point (3% specimens) in contrast to the Rivernook (37%). C. umbonifer is present in the Rivernook, but not dominant or with the flattened, small variants found here and in the Pebble Point fauna. Finally, the Pebble Point aspect is supported by the enigmatic, pustulose form (whose biostratigraphic value in the Victorian Paleocene may become considerable with more study), as well as the lithology and preservation.

Conclusion

Heathfield No. 1, Core 1 from 960-975 ft., is correlated with the Pebble Point Formation. Thus it is dated as Middle Paleocene in age. This correlation supports the previous correlation of the nearby, outcropping Bahgallah Formation with the Pebble Point on the basis of its molluscan fauna. This is the first record of the Pebble Point Formation fauna from the subsurface of Western Victoria.