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MICROPALAEONTOLOGY AND STRATIGRAPHY OF ROUGH RANGE SOUTH no. 1 BORE, CARNARVON BASIN, WESTERN AUSTRALIA

by

Irene Crespin and D.J.Belford.

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INTRODUCTION

West Australian Petroleum Pty. Ltd. recently submitted an excellent suite of cores from Rough Range No. 1 Bore for micropalaeontological examination. The collection included 33 cores, the first core, No. 3 being taken at 656-664 feet and the last core, No. 70, at 2756-2762 feet. Coring was almost continuous throughout the Tertiary with the result that new information on the stratigraphical sequence of the Tertiary in the Carnarvon Basin has been obtained. The discovery, for the first time, of certain genera and species of foraminifera between the depths of 855 feet and 883 feet (Cores Nos. 4 and 7) indicate that beds referable the lower part of "e" stage (Upper Oligocene) are present in subsurface sections in the Carnarvon Basin. Furthermore, genera and species in beds from 935 feet down to 1001 feet (Cores Nos. 8, 9, 10, 11) suggests that beds referable to "c" stage (Lower Oligocene) are present, some of these forms being found only in Tertiary deposits in the Indo-Pacific region north of the Carnarvon Basin.

SUMMARY OF STRATIGRAPHICAL SEQUENCE

The following table summarizes the results obtained from examination of the samples from Rough Range South No.1 Bore. A complete description of each of these divisions is given below:

Period	Stage	Core Nos.	Depth in feet	Lithology and faunal Characteristics
Tertiary	"h" (Pliocene)	3	656-665	Hard white limestone with small foraminifera
	"e1-2" (Upper Oligocene)	4,7	855-883	Grey limestone and sandy limestone with *Eulepidina*
	"c" (Lower Oligocene)	8-11	935-1001	Grey sandy limestone with new genus aff. *Lacazina*
	"a-b" (Middle to Upper Eocene)	12-15	1065-1140	Limestone with abundant dolomite, also bryozoa and larger foraminifera.
		16-49	1140-2220	Glauconitic sandy limestone; larger forams scarce, small species common.
	Campanian	50,52, 53,54	2240-2362	Grey glauconitic calcarenite with *Inoceramus*.

Period	Stage	Core No.	Depth in feet	Lithology and faunal characteristics.
Upper Cretaceous	Lower Turonian	61	2500-2502	Greenish calcareous siltstone with foraminifera.
[illegible]	Cenomanian	70	2756-2768	Dark grey pyritic siltstone with arenaceous foraminifera.

DETAILED DESCRIPTION OF CORES WITH STRATIGRAPHICAL AND FAUNAL NOTES

Pliocene

The first core, No. 3, taken at 656-664 feet, was a hard limestone containing a few poorly preserved foraminifera. The following species were recognised:

Eponides sp.
Rotorbinella cycloclypeus (Howchin and Parr)
Streblus beccarii (Linne)
Triloculina tricarinta d'Orb.

This assemblage is found in rocks ranging from Pliocene to Recent. The species Rotorbinella cycloclypeus was described by Howchin and Parr from the Pliocene of the Adelaide basin.

Lower part of "e" stage

Cores Nos. 4 and 7 taken at 855-860 feet and 874-883 feet respectively, consist of grey limestone to sandy limestone, containing numerous foraminifera, including many tests of Lepidocyclina of the subgenera Nephrolepidina and Eulepidina. The species recognised are as follows:

Austrotrillina howchini (Schlumberger)
Amphistegina bikiniensis Todd and Post
Elphidium sp. nov.
Cymbalopora sp. nov.
Genus aff. Cymbalopora
Gypsina sp. nov.
Gypsina globulus Reuss
Heterostegina borneensis Van der Vlerk
Lepidocyclina (Eulepidina) planata Oppenorth
Lepidocyclina (Eulepidina) sp. nov.
Lepidocyclina (Nephrolepidina) parva Oppenorth
L.(N.) sumatrensis (Brady) var. inornata Provale
L.(N.) borneensis Provale
L.(N.) angulosa Provale
L.verrucosa Scheffen
L.verbeeki Newton and Holland
L.(N.) spp.
Neoalveolina pygmaea (Hanzawa)
Rotalia tectoria Todd and Post
Spiroloculina sp.
Triloculina tricarinata d'Orb.
Operculina cf. victoriensis Chapman and Parr.

This assemblage has not previously been found in Australian Tertiary deposits.

Austrotrillina howchini has not been found previously in "e" stage beds in the Carnarvon Basin although it has been recorded from "e" stage localities in the Indo-Pacific region. Cole (1955) has recorded it from "e" stage beds at the depth of 1954-1965 feet in the deep hole 2B on Bikini Atoll. The species Amphistegina bikiniensis and Rotalia tectoria described

from Deep Hole 2B on Bikini Atoll, between the depths of 1797 and 2400 feet, are recorded for the first time from the Australian Tertiaries. Heterostegina borneensis and Neoalveolina pygmaea are well known lower "e" stage forms in Indo-Pacific assemblages. Gypsina sp. nov. is a form frequently referred to by workers on Indo-Pacific by faunas (Bursch, 1949; Cole, 1955) as G.vesicularis described by Brady from recent deposits. It shows little resemblance with that species. It is closely allied to Gypsina howchini described by Chapman from the Miocene of Victoria but the arrangement of the median chambers is different. Vertical sections are identical with those given under G.vesicularis by Bursch (1949) from the Kei Islands in the Mollucca Group. A new species of Cymbalopora occurs in Core 7 at 874-880 feet together with a form closely allied to Cymbalopora.

Lepidocyclinae of the subgenera Nephrolepidina and Eulepidina are common in Cores 4 and 7 and the assemblage is typical of the lower part of the "e" stage. The species of the subgenus Nephrolepidina L.(N.) angulosa, L.(N.) borneensis, L.(N.) parva, L.(N.) sumatrensis var. inornata, L.(N.) verrucosa and L.(N.) verbeeki) range from "e" stage to the lower part of "f" stage. Only two species of the subgenus Eulepidina L.(E.) planata, L.(E.) sp. nov. have been recognised. L.(E.) planata is characteristic of lower "e" stage assemblages. The features of L.(E.) sp. nov. are the smallness of the test and the huge proloculum in relation to the size of the test. There seems little doubt that the above assemblage of species represents the lower part of "e" stage.

"c" Stage (Lower Oligocene)

Cores Nos. 8, 9, 10 and 11 taken at 935-950 feet, 950-955 feet, 955-975 feet and 981-1001 feet respectively are most probably referable to "c" stage. The lithology is grey limestone, almost a coquinite, in which many of the tests of the foraminifera are encrusted with a thin coating of calcite, giving a marked lithological change from that in the overlying grey limestone of cores Nos. 4 and 7. There is also a distinct change in the microfauna, with a complete absence of Lepidocyclinae. The following species were recognised:

Asterigerina marshallana Todd and Post
Elphidium sp. nov.
Eorupertia sp.
Gypsina sp. nov.
Heterostegina sp. nov.
Operculina cf. victoriensis Chapman and Parr
Operculina sp. nov.
New genus aff. Lacazina

The above assemblage has not been met with previously in the Western Australian Tertiary deposits and it is suggested that it represents "c" stage. It contains forms new to Australian Tertiary microfaunas.

Asterigerina marshallana was described by Todd and Post (1955) from Deep Hole 2B on Bikini Atoll, where it occurs from 1600 feet down to 2500 feet. The species is common in Core 7 at 950-955 feet in the present bore. The new species of Gypsina has been commented upon above. It is very common in Core No. 11 at 981-1001 feet.

The most striking form is a new genus which occurs in some abundance especially in Core No. 9 at 950-955 feet and which has affinities with the Cretaceous genus Lacazina. The present form belongs to the group of trematophore foraminifera.

It is identical generically with a form described as "Lacazina" wichmani by Schlumberger (1894) from the Eocene of the north-west coast of New Guinea and with a similar form recorded by Crespin (1938) from the Eocene beds of the Chimbu Area, New Guinea. Another form described as "Lacazina" reicheli by Bursch (1947) from the Kei Islands, Mollucca Group off South-western New Guinea also belongs to this new genus. The present form from Rough Range South No. 1 Bore shows close relationship with "L". reicheli. Bursch gave the range of that species as from "b" to "c" (Upper Eocene to Lower Oligocene). This new genus is under investigation. As no species are present to suggest an Eocene age for these beds in the Rough Range South No. 1 Bore, on present evidence it is concluded that they belong to "c" stage (Lower Oligocene).

Eocene

Deposits of Eocene age extend from 1065 feet down to 2220 feet. Two distinct lithologies are present, each containing a characteristic foraminiferal assemblage.

(a) Cores Nos. 12, 13, 14 and 15, taken at 1065-1083 feet, 1083-1103 feet, 1103-1121 feet and 1121-1140 feet respectively, show a marked lithological change from the beds immediately overlying. The sediments consist of dolomitic limestone containing abundant rhomb-shaped crystals of dolomite, bryozoa and both larger and smaller foraminifera of Eocene age. A little glauconite is present in Core No. 15.

The following species of foraminifera have been recognised:

Alabamina westraliensis Parr
Asterocyclina sp.
Aktinocyclina aster Woodring
Heterostegina ocalana Cushman
Heterostegina sp. nov.
Discocyclina sp.
Crespinella sp. nov.
Eponides toulmini Brotzen
Gyroidina scrobiculata Finlay
Globigerina linaperta Finlay

The well known Upper Eocene species Aktinocyclina aster is represented by many small tests but Asterocyclina and Discocyclina are rare. Tests of Heterostegina ocalana are numerous and there are many tests of a smooth species of the genus which are apparently new. Tests of Crespinella sp. nov. are numerous. This new species is widely distributed in the Upper Eocene beds of the Carnarvon Basin as well as in Eocene deposits in Southern Australia (Crespin 1956). Globigerina linaperta and Gyroidina scrobiculata have been described by Finlay from the Eocene of New Zealand and Eponides toulmini by Brotzen from the Palaeocene of Sweden. However, it is widely distributed in the Eocene of Australia and America. Alabamina westraliensis was described by Parr (1938) from the King's Park Bore, Perth. These bryozoal and foraminiferal limestones are most probably the equivalent of the Giralia Calcarenite of the Carnarvon Basin.

(b) Glauconitic sandy limestone and silty limestone is represented in Cores Nos. 16 (1140-1160 feet), 17 (1170-1175 feet), 22 (1260-1270 feet), 26 (1333-1343 feet), 27 (1356-1366 feet), 28 (1366-1372 feet), 29 (1372-1392 feet), 31 (1412-1433 feet), 35 (1462-1470 feet), 39 (1688-1698 feet), 40 (1888-1890 feet), 42 (1975-1980 feet), 45 (2090-2100 feet), 46 (2120-2125 feet), 47 (2150-2155 feet), 48 (2180-2185 feet) and 49 (2215-2220 feet).

Larger foraminifera are scarce but many Eocene species have been recognised amongst the smaller forms. The species recognised are as follows:

Aktinocyclina aster Woodring
Angulogerina subangularis Parr
Anomalina perthensis Parr
Bolivinopsis crespinae Parr
Bolivinopsis cubensis (Cushman and Bermudez)
Cibicides pseudoconvexus Parr
Cibicides perlucida Nuttall
Cibicides sp. nov.
Crespinella sp. nov.
Eponides toulmini Brotzen
Epistomina eocenica (Cushman and Hanna)
Flabellinella sp.
Globorotalia cocoaensis (Cushman)
Globorotalia (Turborotalia) centralis (Cushman and Bermudez)
Globigerina primitiva (Finlay)
Globigerina mexicana (Cushman)
Globigerina spp.
Globigerinella micra (Cole)
Gyroidina depressa (Alth)
Gyroidina scrobiculata (Finlay)
Gaudryina (Pseudogaudryina) jacksonensis (Cushman)
Lagena perthensis Parr
Listerella cf. communis (d'Orb)
Massilina torquayensis (Chapman)
Notorotalia stachei (Finlay)
Planorbulina macphersoni (Finlay)
Pullenia eocenica (Cushman and Seigfus)
Spiroplectammina mississippiensis (Cushman)
Stomatorbina torrei (Cushman and Bermudez)
Textulariella sp. 1
Vaginulinopsis echinatus (Thalmann)
Vaginulinopsis gippslandicus (Chapman and Crespin)
Verneuilina cf. villarensis (Cushman and Bermudez)

Bolivinopsis cubensis and Globorotalia (Turborotalia) centralis were described from the Middle to Upper Eocene of Cuba. B.cubensis was recorded from Rough Range No. 1 Bore at 900-910 feet and at 950-960 feet.

Well known and widely distributed Eocene species are given in this list. Massilina torquayensis and Vaginulinopsis gippslandicus are typical of the Janjukian deposits of south-eastern Australia. Several species were described by Parr from the Upper Eocene of the King's Park Bore, Perth. Other species such as Notorotalia stachei and Planorbulina macphersoni are characteristic of the Eocene of New Zealand.

With the absence of typical Lower Eocene species of Globorotalia, the beds from 1140 feet down to 2220 feet are regarded as Middle to Upper Eocene in age and most probably the equivalent of the Giralia Calcarenite.

Upper Cretaceous

Deposits of Upper Cretaceous age extend from 2240 feet down to 2768 feet. Three distinct lithological units are present, each containing a characteristic foraminiferal assemblage.

1. Cores Nos. 50 (2240-2245 feet), 52 (2300-2305 feet), 54 (2355-2363 feet) consist of grey glauconitic calcarenite with abundant Inoceramus prisms. The beds contain an assemblage of foraminiferal species similar to that found in the Korojon Calcarenite. They are as follows:

Ammodiscus cretaceus (Reuss)
Anomalina velascoensis (Cushman)
Bolivina incrassata (Reuss)
Bolivinoides decorata (Jones) australis (Edgell)
Bolivinitella planata (Cushman)
Cibicides excavata Brotzen
Dorothia bulletta (Carsey)
Dorothia pupa (Reuss)
Dentalinopsis sp. nov.
Frondicularia tueria (Finlay)
Globotruncana arca (Cushman)
Globotruncana ventricosa White
Globotruncana sp. nov.
Globorotalites conicus (Carsey)
Gavellinella cf. pseudopapillosa (Carsey)
Gaudryina sp.
Guembelina globulosa (Ehrenberg)
Heterostomella austiniana (Cushman)
Marssonella oxycona (Reuss)
Planulina taylorensis (Carsey)
Planulina voltziana (d'Orb)
Robulus spp.
Spiroplectammina laevis (Roemer) var.cretosa (Cushman)

Bolivina incrassata, Globotruncana arca and Planulina voltziana are typical Upper Senonian forms, the general assemblage indicating a Campanian age for the beds.

2. No core was available between No. 54 and No. 61, which showed a marked lithological change from the overlying beds. Core 61 was taken at 2500-2502 feet and consisted of greenish calcareous siltstone, resembling the Upper Gearle Siltstone. The following foraminifera were recognised:

Anomalinoides sp. nov.
Bigenerina compressiuscula (Chapman)
Clavulinoides cf. trilaterus (Cushman)
Globigerina cretacea (d'Orb.)
Globigerinella aspera (Ehrenberg)
Globotruncana lapparenti (Brotzen) tricarinata (Quereau)
Globotruncana (Praeglobotruncana) stephani/(Gandolfi)
Guembelina globulosa (Ehrenberg) /stephani
Hastigerinella cf. subcretacea (Tappan)
Marssonella oxycona (Reuss)
Quadrimorphina allomorphinoides (Reuss)
Stensioina sp. nov.
Valvulineria sp. nov.

Globotruncana (Praeglobotruncana) stephani stephani ranges from Upper Cenomanian to Lower Turonian, whereas G.lapparenti tricarinata is not known below Turonian. The assemblage, G.lapparenti tricarinata, Hastigerinella cf. subcretacea was previously recorded from Core No. 1 (1530-1548 feet) in Rough Range Bore No. 8 from the Gearle Siltstone (Belford, 1955). Clavulinoides cf. trilatera and Bigenerina compressiuscula, Anomalinoides sp. nov. and Stensioina sp. nov. have been previously known only from outcrops of the Gin Gin Chalk and Toolonga Calcilutite, in beds of Santonian age.

3. Core No. 70 at 2756-2762 feet shows another change in lithology. The rock is a dark grey pyritic siltstone in which only arenaceous foraminifera are present. It probably represents the Lower Gearle Siltstone and is Cenomanian in age. The species recognised are as follows:

Ammobaculites fisheri (Crespin)
Bigenerina wintoni (Cushman and Alexander)
Hyperammina sp.
Spiroplectammina sp.
Trochamminoides coronus (Loeblich and Tappan)

PRINCIPAL RESULTS

Important results of the examination of samples from Rough Range South No. 1 Bore, are:

1. Distinct lithological changes occur between cores Nos. 7 and 8; between Nos. 11 and 12, with the appearance of abundant dolomite; between Nos. 15 and 16, where glauconitic sandy limestone appears and extends down to core No. 49; core No. 50 is represented by grey calcarenite with abundant Inoceramus; core No. 61, a greenish calcareous siltstone and core No. 70 by dark grey pyritic siltstone.

2. Lower Miocene beds were probably present between the depths of 665 feet and 855 feet.

3. Lower "e" stage beds are identified for the first time in subsurface sections in Western Australia.

4. "c" stage (Lower Oligocene) beds are also identified for the first time in Western Australia, with genera not previously recorded from the Australian Tertiary deposits.

5. Some species of smaller foraminifera found in the Tertiary beds in bores on Bikini Atoll and one of a genus showing affinities with Lacazina, found in faunas from the Molucca Group and Central Highlands of New Guinea are present.

6. The thickness of Middle to Upper Eocene beds is much greater than in any other bore so far examined in the Carnarvon basin.

7. Definite Palaeocene (lowest Tertiary) and uppermost Cretaceous (Maestrichtian) beds are apparently absent. There is an interval of only 20 feet between cores No. 49 (lower Tertiary) and No. 50 (Upper Cretaceous, Campanian) so that if Palaeocene and Maestrichtian beds do occur, they are very thin.

8. It is not possible to make faunal correlations between the Tertiary beds in this bore and those in other bores drilled on the Rough Range Structure, because this one contains so many new faunal assemblages. This suggests very strongly that more detailed sampling of the Tertiary section in bores in this area is highly desirable.

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