STRATIGRAPHY AND MICROPALAEONTOLOGY OF CAPE RANGE BORE NO.I., CARNARVON BASIN, WESTERN AUSTRALIA

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Contents

I. Introduction

Sixty-two cores and numerous cuttings from Cape Range Bore No.1, were submitted by West Australian Petroleum Pty. Limited for micropalaeontological examination. The first core submitted was Core No.1 from 500 to 513 feet, the second one Core No.5 from 3,302 to 3,311 feet and the last, Core No.66 from 8,000 to 8,019 feet. Cuttings were taken from about every ten feet, the first sample coming from the depth of 23 to 33 feet and the last from 6,897 to 6,900 feet. The cores, Core No.20 (3,552 to 3,570 feet) to Core 66 (8,000 to 8,019 feet) were very hard, and preparation for examination was difficult. However, all residues yielded a fairly rich foraminiferal fauna. Information given in interim reports on cores is incorporated here.

2. Stratigraphical Subdivisions and probable formational equivalents in the Carnarvon Basin

The stratigraphical subdivisions, with limiting depths and probable formational equivalents in the Carnarvon Basin, are set out below. Several of the boundaries have had to be based on microfaunal assemblages in the cuttings and consequently are approximate only. The first appearance of zonal species in the downward sequence of the samples has been regarded as significant.

Stratigraphical Subdivisions	Limiting Depths (feet)	Thickness (feet)	Probable formational equivalents
Lower Miocene ("E"Stage)	23 - 570	647	Mandu Calcarenite
Upper to Middle Eocene	570 - 870	300	Giralia Calcarenite
Palaeocene	870 - 1,180	310	Wadera-Pirie Calcarenite
Upper Cretaceous (Maestrichtian to Campanian)	1,180 - 1,365	185	Miria Marl-Korojon Calcarenite
Lower Cretaceous	1,365 - 6,966	5,301	
Albian	1,365 - 1,680	515	Windalia Radiolarite
Aptian	1,680 - 3,475	1,795	Muderong Shale
?Aptian	3,475 - 3,570	95	Birdrong Formation
Neocomian	3,570 - 6,966 (Core 64)	3,396	
?Jurassic	8,000 - 8,019		

3. Detailed Discussion of Stratigraphical Subdivisions with remarks on the Microfaunal Assemblages

A. Lower Miocene ("e" Stage)

Cream to grey calcarenite was present from 23 feet down to 570 feet. Only one core (Core No.1 at 500-518 feet) was submitted for examination, but cuttings were available from every ten feet of drilling. The foraminiferal assemblage is regarded as Lower Miocene ("e" stage) in age and is similar to that found in the sediments at the type locality for the Mandu Calcarenite in Badjirrajirra Creek, Cape Range (Condon, Perry, Johnstone and Crespin, 1953). A list of species recognised is geven below. The majority of species are typical of Miocene deposits throughout the Indo-Pacific region. Species not previously recognised in the Cape Range area are marked "x".

Angulogerina australe (Heron-Allen and Earland)
Anomalinella rostrata (Brady)
Bolivina fastigia Cushman
Bolivina scalprata Schwager var. retiformis Cushman
Bolivinella australis Cushman
Carpenteria rotaliformis Chapman and Crespin
Cibicides victoriensis Chapman, Parr and Collins
Cycloclypeus eidae Tan
Discorbis tuberculata (W.&.B.) var. australiensis Chapman, Parr & Collins
Lepidocyclina (Eulepidina) badjirraensis Crespin
Operculina victoriensis Chapman and Parr
Osangularia bengalensis (Schwager)
x Palmula sp.nov.
x Planulinella cf. escornebovensis (Sigal)
Reussella decorata (Heron-Allen and Earland)
Reussella ensiformis (Chapman)
Uvigerina sumatrensis LeRoy

B. Upper to Middle Eocene

No cores were submitted to give some control for the determination of the upper and lower limits of the Eocene deposits in the Cape Range Bore No.1. However, the foraminiferal species in the cuttings indicate that Eocene sediments lie between the depths of 570 feet and 870 feet. The sediments are almost wholly calcarenites. Fragments of flint are present from 760 feet to 780 feet; the cuttings at 840-850 feet consisted almost entirely of cleavage fragments of calcite.

The first evidence of Eocene foraminifera in the cuttings was at 570 feet, when a few tests of Globigerina finlayi were found; from that depth down to 870 feet species of Eocene foraminifera described from Western Australia and south-eastern Australia and from overseas are common. Victoriella plecte, described from Victoria, was found at 610-620 feet and small tests of Discocyclina were present at 760-870 feet.

The planktonic species identified were Globigerina triloculinoides, G.finlayi, G.mexicana, G.ouachitaensis, G.taroubaensis and Globigerinella micra with the characteristic Middle Eocene Globorotalia crassata at 860-870 feet.

Probably the most important discovery was that of several tests of Hantkenina (Applinella) cf.dumblei at 850-860 feet and at 860-870 feet. This species is characteristoc of the Middle Eocene of Trinidad (Bronnimann, 1950) and of the Middle East (Grimsdale,1951). This is the first record of the genus Hantkenina in the Eocene deposits of Western Australia.

It is difficult to divide the Upper and Middle Eocene deposits in this bore but the Middle Eocene zonal species Globorotalia crassata and Hantkenina (Applinella) cf.dumbeli) were not met with until the sample at 850-860 feet and the latter form was not seen below 870 feet.

An interesting assemblage of arenaceous and calcareous species was found in these beds. It consisted of numerous tests of species of Cyclammina and Chilostomella also Glomospira charoides, Ammolagena clavata, large tests of Ammodiscus parri and Bathysiphon angleseaensis. The majority of these species were found in the deepest portion of Bengworden South No.1 Bore, (Holland's Landing), East Gippsland, Victoria and are characteristic of the Navet Formation (Middle Eocene) in Trinidad (Cushman and Renz, 1948).

The following species, described from the Eocene or characteristic of Eocene assemblages, have been recognised:

Ammodiscus parri Crespin
Angulogerina subangularis Parr
Bathysiphon angleseaensis Crespin
Bolivinopsis crespinae Parr
Bulimina pupula Stache
Bulimina truncana Gumbel
Chilostomella cylindroides Reuss
Chilostomella cf.czezcki Reuss
Cibicides umbonifer Parr
Cibicides sp.1
Cibicides sp.2
Cyclammina incisa Stache
Cyclammina rotundata Chapman and Crespin
Discocyclina sp.
Fissurina terrilli (Parr)
Globigerina finlayi Bronnimann
Globigerina cf.danvillensis Howe and Wallace
Globigerina ouachitaensis Howe and Wallace
Globigerina mexicana Cushman
Globigerina triloculinoides Plummer
Globigerina taroubaensis Bronnimann
Globigerinella micra (Cole)
Globorotalia chapmani Parr
Globorotalia crassata Cushman
Glomospira charoides (Parker and Jones)
Guembelina venezuelana Nuttall var.rugosa Parr
Hantkenina (Applinella) cf. dumbelei Weinzierl & Applin
Lagena perthensis Parr
Pseudoglandulina clarkei Parr
Robulus limbosus (Reuss)var.hockleyensis Cushman
Siphonodosaria cocoaensis (Cushman)
Spiroplectammina mississippiensis (Cushman)
Vulvulina advena Cushman
Vulvulina jarvisi Cushman

This list of Eocene species is by no means complete as well preserved species were found in cuttings from lower beds referred to the Palaeocene and Upper Cretaceous.

C. Palaeocene

The limiting depths of deposits of Palaeocene age in Cape Range No.1 Bore, may be from 870 feet down to 1,180 feet. Evidence for these depths is supported by the examination of a core taken at the depth of 1,300 to 1,303 feet in Cape Range No.2 Bore, which contains an excellent suite of foraminifera typical of Palaeocene deposits. Globigerinidae are exceedingly abundant in that core and are equally abundant in the cuttings in No.1 Bore from 870 feet down to 1,180 feet. The calcarenite lighology persisted throughout with glauconite and pyrite in some samples.

Characteristic Palaeocene species identified were:

Anomalinoides danica Brotzen
Coleites laevigatus Plummer
Globigerina pseudobulloides Plummer
Globigerina triloculinoides Plummer
Globorotalia membranacea (Ehrenberg)
Globorotalia wilcoxensis Cushman & Ponton var. acuta Toulmin
Osangularia lens (Brotzen)
Pseudoglandulina manifesta (Reuss)
Rectoguembelina alabamensis Cushman
Vaginulinopsis longiformis (Plummer)
Vaginulinopsis midwayensis (Fox and Ross)

All these species with the exception of Rectoguembelina alabamensis have been recorded from the surface outcrops of the Wadera and Pirie Calcarenites which are of Palaeocene age.(Condon,1954).

D. Upper Cretaceous

The first evidence for beds of Upper Cretaceous age is in the cuttings from 1,180 to 1,190 feet where two species, Lituola taylorensis and Verneuilina parri were recorded in white calcarenite. Typical Upper Cretaceous forms including Globotruncana ventricosa continued down to 1,365 feet. Lituola taylorensis is known only from outcrops of the Maestrichtian Miria Marl whilst Globotruncana ventricosa is typical of the Korojon Calcarenite, which is Campanian in age.

Because of the mixed assemblage and because of the scarcity of Maestrichtian species, no attempt is made to fix the Maestrichtian-Senonian (Campanian) boundary. Apparently the Maestrichtian is exceedingly thin.

Typical Upper Cretaceous species recognised are:

Anomalina velascoensis Cushman
Arenobulimina buschi (Reuss)
Buliminella cushmani Sandidge
Dorothia bulletta (Carsey)
Frondicularia mucronata Reuss
Globigerina cretacea d'Orb.
Globotruncana ventricosa White
Globotruncana sp.nov.
Gaudryina laevigata Franke
Lituola taylorensis Cushman
Marssonella oxycona (Reuss)
Neoflabellina cf. semireticulata Cushman & Jarvis
Spiroplectammina laevis (Roemer) var. cretosa Cushman
Verneuilina parri Cushman

E. Lower Cretaceous

No microfaunal evidence has been found in the cuttings from Cape Range No.1 Bore, of beds equivalent to the Gearle Siltstone of the Giralia area. The sequence apparently passes from the Senonian (Upper Cretaceous) into the Albian (topmost Lower Cretaceous).

It is considered that beds of Lower Cretaceous age are present in the bore from 1,365 feet down to 6,966 feet (Core No.64). Evidence based on the foraminifera has been available not only from cuttings but from several cores that have been submitted below the depth of 3,302 feet. Microfaunal assemblages are present which are similar to those found in the Windalia Radiolarite and Muderong Shale of the Giralia area (Condon, 1954). Unfossiliferous glauconitic sandy siltstones underlying the beds equivalent to the Muderong Shale are referred to the Birdrong Formation; and underlying that formation are hard brownish, micaceous siltstones which

contain a rich assemblage of Lower Cretaceous species of foraminifera (Crespin, 1953). Beds of this formation do not appear to outcrop in the Carnarvon Basin. The four divisions are discussed below.

1. The lithology of the cuttings at 1,365-1,370 feet and down to 1,630 feet shows a marked change from that in the cuttings immediately overlying. The grey siltstone of the Upper Cretaceous beds passes into a friable, black, very fine-grained siltstone which contains abundant tests of radiolaria as well as typical species of Lower Cretaceous foraminifera. It is considered that these beds are equivalent of the Windalia Radiolarite.

The Lower Cretaceous foraminifera include the following species:

Ammobaculites fisheri Crespin
Ammodiscus rotalarius Loeblich and Tappan
Bigenerina loeblichi Crespin
Lenticulina australiensis Crespin
Spiroplectammina edgelli Crespin
Textularia anacooraensis Crespin

2. From 1,680 feet down to 3,475 feet, the beds are regarded as the equivalent of the Muderong Shale and belong to the Aptian Stage of the Lower Cretaceous. A continuous sequence of cores was available for examination from 3,302 feet down to 3,475 feet. The lithology is dark grey siltstone, micaceous in places and with abundant aggregates and crystals of siderite. Foraminifera are not common and many of the tests are replaced with pyrite. The arenaceous tests are usually crushed and the calcareous ones, especially those of the Lagenidae, are stained light brown.

The Lower Cretaceous species recognised are as follows:

Ammobaculites fisheri Crespin
Ammobaculites irregulariformis Bartenstein and Brand
Ammobaculites cf. romaensis Crespin
Anomalina mawsoni Crespin
Epistomina scaphiloula Loeblich and Tappan
Globigerina planispira Tappan
Haplophragmoides chapmani Crespin
Haplophragmoides dickinsoni Crespin
Lenticulina australiensis Crespin
Robulus gaultinus (Berthelin)
Robulus warreenensis (Crespin)
Valvulineria infracretacea Crespin

3. Cores were available from 3,475 feet down to 3,570 feet. The rock is a hard, unfossiliferous, sandy glauconitic siltstone which is regarded as the equivalent of the Birdrong Formation and is probably low in the Lower Cretaceous.

4. The beds from 3,570 feet down to 6,966 feet (Core 64) are regarded as basal Lower Cretaceous and probably equivalent of the Neocomian Stage. The sediments, from which many cores were taken, are hard, brownish, micaceous siltstones containing a moderately rich assemblage of Lower Cretaceous species of foraminifera. Many of the arenaceous tests, which are very numerous in some samples, are crushed, but the calcareous species for the most part were well preserved, Amongst the arenaceous forms, there are two new species of Reophax and one new species of Ammobaculites. Amongst the calcareous species there are several new species of Lenticulina. Otherwise the assemblage is identical with that described from the Lower Cretaceous deposits of the Great Artesian Basin (Crespin,1953).

Species recognised in these cores are as follows:

Ammobaculites fisheri Crespin
Ammobaculites minimus Crespin
Ammobaculites australe (Howchin)
Ammobaculites sp.1
Globigerina cf.planispira Tappan
Globigerina aff.washitensis Tappan
Globigerina sp. (pyritic casts)
Globulina minuta (Roemer)
Haplophragmoides chapmani Crespin
Haplophragmoides dickinsoni Crespin
Lenticulina australiensis Crespin
Lenticulina sp.1
Lenticulina sp.2
Lenticulina sp.3
Pelosina lagenoides Crespin
Reophax sp.1
Reophax sp.2
Spirillina minima Schacko
Spiroplectammina cushmani Crespin
Spiroplectammina edgelli Crespin
Trochammina raggatti Crespin
~~Trochammina saccata Crespin~~
Turrispirillina subconica Tappan

F. ? Jurassic

No age can be suggested for Core No.66 at 8,000-8,019 feet the last core received; Only a fragment of a test of the arenaceous genus Hyperammina and indeterminate pyritic casts were noted.

There is considerable controversy regarding the age of the beds immediately below the Birdrong Formation, that is from 3,571 feet down to 8,019 feet. The writers put forward their views based on foraminiferal evidence in a report on cores from this well (Records 1955/50) and except for suggesting a probably Jurassic age for the beds represented by Core No.66 at 8,000-8019 feet, they still adhere to those views. The absence of the typical Aptian (Lower Cretaceous) calcareous species of the Great Artesian Basin assemblage, Valvulineria infracretacea Crespin and Anomalina mawsoni Crespin in these deposits (Crespin, 1956) and the presence of several new species of Lenticulina, in association with described Lower Cretaceous species of arenaceous forms, suggests at least that the beds are stratigraphically lower in the Lower Cretaceous sequence.

Several tests of Globigerina including G.cf.planispira and G.aff.washitensis are present. Glæssner (1945, p.203) states that "Globigerina is first recorded from the Barremian (i.e. the topmost division of the Neocomian). In the Aptian small species of the genus become abundant, marking the first appearance of foraminifera as an important group of planktonic organisms." He further states that "no planktonic foraminifera have been found in Jurassic rocks."

Inquiries have been made from A.R. Loeblich of the United States National Museum, who, with his wife, Helen Tappan, are authorities on Lower Cretaceous and Jurassic foraminifera, as to the first appearance in time of Globigerina. In his reply to one of us (.I.C.) dated 17/4/56, Loeblich confirms Glaessner's statement and says that "Globigerina does not occur in the Jurassic. Its earliest record to my knowledge is in the Hautervian (Neocomian) of Russia". He further states that he and his wife have investigated the record by Morey of its occurrence in the Jurassic and have found it to be incorrect.

The writers' views were communicated to Dr. Arkell of Cambridge who has examined the Ammonites from cores in the Cape Range No.1 Bore below the depth of 3,570 feet. In his reply, Arkell stated that he had an open mind as to whether the fragmentary but well preserved Ammonites in Core No.35 at 4,293 to 4,304 feet and Core No.36 at 4,314 to 4,318 feet were Lower Cretaceous or Upper Jurassic. As regards Core No.46 at 5,200 to 5,215 feet and Core No.47 at 5,299 to 5,314 feet, his tentative dating of the age as Oxfordian (Upper Jurassic) was based on beleminites which he says he does not know well, nor trust. Core No.59 at 6,356 to 6,383 feet and Core No.61 at 6,518 to 6,536 feet according to Arkell contained definite Jurassic Ammonites. This, however, does not conform with foraminiferal evidence of basal Lower Cretaceous age of the beds for although foraminifera were scarce, a pyritic cast of Globigerina was found..

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