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THE STRATIGRAPHY AND MICROPALAEONTOLOGY OF ROUGH RANGE BORE NO. 1, CARNARVON BASIN, ~~NORTH-WEST~~ WESTERN AUSTRALIA.

by

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1. Introduction.

As a result of many years of detailed investigations in the Carnarvon Basin by geologists and palaeontologists of the Bureau of Mineral Resources and of a seismic survey for the Company by Seismograph Service Limited, West Australian Petroleum Pty. Ltd. decided to drill an exploration test well at a site in the Rough Range anticline, 16 miles south of Learmonth, Exmouth Gulf. The site of the well is at 114°4'55" East longitude and 22°25'8" South latitude and the elevation above sea level of the derrick floor is 195 feet. (Information obtained by D.J.B. from Company's Well Log on site).

"Spudding in" operations took place on September 5th, 1953, and oil was discovered on November 1st at the depth of 3,605-3,622 feet. By agreement with the West Australian Petroleum Pty. Ltd. one of us (D.J.B.) went to Learmonth on September 3rd to examine cuttings and cores for foraminifera to help in determining the formations drilled. He carried out his investigations until the well had reached the depth of 4,659 feet, and returned to Canberra on December 30th. Preliminary determinations of foraminifera and radiolaria were made at the site. This report is the result of a detailed examination of the microfossils which were brought back to Canberra. Unfortunately much valuable information regarding the stratigraphical ranges of foraminiferal species was not obtained because most of the fossiliferous rocks were recovered in the form of cuttings, which inevitably contain mixtures of micro-fossil forms from many levels. Only five cores were taken above the depth of 3,614 feet and the examination of the foraminifera in these cores yielded reliable evidence as to the age of the lithological units penetrated. An unfortunate feature of this well was the lack of samples between the depths of 200 feet and 670 feet due to loss of circulation of the drilling mud in cavernous zones.

The stratigraphical sequence of lithological units met with in the well was similar to that determined during geological surveys of the Cape Range, Rough Range, Giralia and Barrilla Anticlines and the characteristic microfaunal assemblages known from these rocks units were well represented in the cuttings with the specimens usually well preserved.

The assemblages of foraminifera indicate that ~~According to evidence given by the foraminifera,~~ the ages of the beds passed through included "f_1-f_2" stage, (upper Lower Miocene, "e" stage (lower Lower Miocene), "b" stage (Middle to Upper Eocene), probable Palaeocene, Upper Cretaceous and uppermost Lower Cretaceous. The lithological units recognised were basal Trealla Limestone, upper Mandu Limestone, Giralia Calcarenite, Cashin-Pirie Calcarenite, Madera Calcarenite, Korojon Calcarenite, Gearle Siltstone, Windalia Radiolarite, Muderong Shale and Birdrong Formation.

Two points are outstanding after this microfaunal examination:

1. The great thickening of the Gearle Siltstone as compared with its outcrop on Giralia Anticline.

2. The rich and previously unrecorded assemblage of foraminiferal specimens and species in the lower part of the Gearle Siltstone.

2. Methods of Investigation Used at the Well site.

Representative samples of rotary cuttings were taken at intervals of 10 feet and formed the bulk of the samples available. Only 5 cores were taken over the interval dealt with in this report; these are as follows:

Core No. 1 - 2,000-2,018 feet - recovery 16 feet (90%)
Core No. 2 - 2,750-2,757 feet - recovery 6 feet (86%)
Core No. 3 - 3,250-3,268 feet - recovery nil (0%)
Core No. 4 - 3,268-3,276 feet - recovery 7 feet (87%)
Core No. 5 - 3,599-3,614 feet - recovery 9 feet (from 3,599-3,608 feet)

To release foraminifera from cuttings and cores of siltstone and shale, boiling in water was found to be sufficient. Thin sections were prepared from limestone samples and also of individual specimens of larger foraminifera.

The first sample of cuttings from the well was collected by Dr. N. H. Fisher during the "spudding in" ceremony from a depth of about 15 feet. The first sample made available to Belford at the well site was from 60-70 feet. While drilling was in progress, samples were examined at intervals of about 50 feet. Further samples at intervening depths were later examined to establish more accurately the boundaries of observed faunal ranges. To assist in specific identification of foraminifera, a reference collection from surface samples representing the different lithological units in the Carnarvon Basin, was prepared at the Bureau before leaving for the well site. Those species which could not be named were given a number until literature became available. Faunal assemblage slides were prepared, also at intervals of about 50 feet, and taken to Canberra for further examination.

3. Lithological Units Recognised in Well Cuttings and Cores.

Most of the lithological units mapped in the field by geologists of the Bureau of Mineral Resources in the Cape Range and Giralia Range were recognised in the well section. It is probable that some of the formations such as the Jubiloo Calcarenite, the Boongerooda Greensand and the Miria Marl, were so thin that their identities were lost in the cuttings. However, the formations recognised and their approximate limiting depths are given below.

Formation	Approx. limiting depths
Basal Trealla Limestone	First sample taken at 15 feet.
Mandu Limestone	60-200 feet (no samples from 70 foot down to 140 feet)
No samples	200-670 feet
Giralia Calcarenite	690-1,040 feet
Cashin-Pirie Calcarenite	1,040-1,210 feet
Madera Calcarenite	1,210-1,310 feet
Korojon Calcarenite	1,340-1,450 feet
Gearle Siltstone	1,500-3,310 feet
Windalia Radiolarite	3,340-3,510 feet
Muderong Shale	3,540-3,603 feet
Birdrong Formation	3,603-3,990 feet

The cuttings at 15 feet consisted of hard, cream, partially crystalline, foraminiferal limestone, typical of the basal part of the Trealla Limestone and also of the topmost

Tulki Limestone. Field evidence, however, seems to suggest that the rock is basal Trealla rather than Tulki. The Trealla Limestone is widespread over the northern half of the coastal part of the Carnarvon Basin, whilst indications are that the Tulki Limestone, which outcrops on Rough Range, thins out on the eastern side of the Cape Range and Rough Range Structures and to the south. (Condon et al. 1954).

The creamy, chalky, foraminiferal limestone of the cuttings point to the presence of the Mandu Limestone from 60 feet down to 200 feet. However, no samples were obtained between 70 feet and 140 feet. At 200 feet circulation was lost and no further samples were available until after the depth of 670 feet.

The cream to yellowish, crystalline, slightly glauconitic limestone from 690 feet down to 1,040 feet ~~was referred to the Giralia Calcarenite~~, although the characteristic feature of the formation - the limonitized foraminifera and the rounded to ovate limonitic grains - was not recorded.

The Cashin Calcarenite and the Pirie Calcarenite have been placed between the depths of 1,040 feet and 1,210 feet. Throughout this interval the cuttings were of a greyish, silty limestone with no lithological change to enable the boundaries of the two formations to be determined.

From 1,210 feet down to 1,310 feet the cuttings were placed in the Madera Calcarenite. The sediment consisted of yellow to greenish silty limestone with glauconite common throughout.

At 1,340 feet the lithology changed to a white to yellowish slightly glauconitic, silty limestone with abundant Inoceramus prisms which characterise the Korojon Calcarenite. This lithology continued down to 1,450 feet with the sediment becoming more silty with depth.

At 1,500 feet, there was a marked change in lithology from the yellowish, silty limestone of the Korojon Calcarenite with Inoceramus prisms to the light grey, calcareous lithology of the Gearle Siltstone without Inoceramus. Below 2,000 feet the rock gradually became harder, darker grey in colour and less calcareous until the base of the formation was reached at 3,310 feet. Pyrite was abundant at 1,500 feet and occurred in small quantities down to at least 2,410 feet. The thickness of 1,860 feet of Gearle Siltstone is in striking contrast to that known from measured surface sections in the Giralia and Murilla Anticlines. The lithology of the cores Nos. 1, 2 and 4 taken in the Gearle Siltstone and listed in Section 2, is similar to that shown by the cuttings in this formation.

At 3,310 feet a marked lithological and colour change was noticeable. The rock was a light grey, porous, slightly calcareous, glauconitic, very fine-grained sediment with pyrite rare. This characteristic lithology of the Windalia Radiolarite continued down to 3,510 feet.

The hard, dark grey, slightly calcareous siltstone with little glauconite, met with at 3,510 feet is regarded as representing the Muderong Shale. This lithology continued down to 3,603 feet.

At 3,603 feet the well passed into fine to medium grained, porous, glauconitic sandstone of the Birdrong Formation, the base of which was at about 4,000 feet.

4. Notes on the Distribution Chart of Foraminifera and the Age of the Formations.

As would be expected, there was considerable contamination of foraminiferal species in many of the samples. However, some importance has been placed on the first appearance of a species in descending stratigraphical sequence of the cuttings. When comparing the micro-faunas in the cores taken in the Gearle Siltstone with those in cuttings from this formation, those forms derived from overlying beds could easily be distinguished and have been omitted from the Chart. In the samples above the cores, the stratigraphical range of some species shown in the Chart is possibly excessive. If cores are available from future wells, these limits could possibly be defined more accurately.

There are seven well marked foraminiferal assemblages indicated in the Chart and those are characteristic of the different formations. They are listed below.

	(Basal	(Austrotrillina howchini (Schl.)
	(Trealla	(Calcarina verriculata (Howchin and Parr)
Lower	(Limestone	(Marginopora cf. vertebralis (Q. & G.)
	(	
Miocene	(	(Lepidocyclina (E.) manduensis Crespin
	(Mandu	(Lepidocyclina (N.) sondaica Yabe & Hanzawa
	(Limestone	(Lepidocyclina (N.) sumatrensis (Brady)
	(	(Lepidocyclina (N.) acuta (Provale)
	(	(Bolivinopsis cubensis Cushman & Bermudez
Upper	(	(Cibicides umboniferr Parr
	(	(Cyclammina incisa Stache
to	(	(Discocyclina sp.
	(Giralia	("Globigerinella" micrum (Finlay)
Middle	(Calcar-	(Globorotalia wilcoxensis Cushman & Ponton
	(enite	(Pseudoglandulina clarkei Parr
Eocene	(	(Robulus alato-limbatus (Gumbel)
	(	(Siphonodosaria cocoaensis (Cushman)
	(	(Spiroplectammina mississippiensis var.
	(	(alabamensis (Cushman)
	(	(Vaginulinopsis echinatus Thalmann
	(	(Vaginulinopsis longiformis (Plummer)
Probable	(Combin-Pirie	(Angulogerina subangularis Parr
Lower	(Calcarenite	(Cibicides ekblomi Brotzen
Eocene-	(	
Palaeocene	(Madera	Karreria fallax Rzehak
	(Calcarenite	
	(	(Anomalina rubiginosa Cushman
	(	(Bolivinoides draco draco (Marsson)
	(	(Bulimina reussi Morrow
	(Korojon	(Dorothia bulletta (Carsey)
	(Calcarenite	(Globotruncana sp. 1.
	(	(Planulina taylorensis (Cushman)
	(	(Spiroplectammina grzybowskii Frizzell
Upper	(	(Vaginulinopsis plummerae (Cushman)
	(	
Cretaceous	(	(Eouvigerina aspera (Marsson)
	(Upper	(Bolivinitella oloyi (Cushman)
	(Gearle	(Globorotalites michelinianus (d'Orb.)
	(	(Massilina ginginensis Chapman
	(	(Reussella szajnochae (Grzybowski)

1,450 feet down to 2,000 feet, was represented only by cuttings; from 2,000 feet down to the base of the formation at 3,310 feet, cuttings were also recovered but they were supplemented by three cores which provided an uncontaminated microfauna from which reliable conclusions as to age could be drawn.

The species determined in the topmost 550 feet of the formation were typically Upper Cretaceous. However, below the depth of 2,000 feet, especially in the core samples, there was a marked change in the foraminiferal assemblage. This lower assemblage was present down to 3,310 feet. The majority of the species found in the cores were not found in the cuttings above 2,000 feet. The rich assemblage of foraminifera contains many species, both arenaceous and calcareous, recently described by one of us (Crespin, 1953) from deposits in the Great Artesian Basin of Australia which are regarded as upper Lower Cretaceous. Also present were species such as Trixtrix excavatum, Globorotalia delriensis, Globigerina planispira and Anomalina plummerae, all of which have been described from the Grayson Formation of northern Texas (Tappan, 1940) and are characteristic of formations in the upper part of the Lower Cretaceous in that region. Tappan regarded the Grayson beds as Upper Albian (topmost Lower Cretaceous) in age. More recent references (Schuchert, 1943) show that some authors consider the Grayson to be basal Cenomanian (basal Upper Cretaceous). However, it is important to note that this assemblage of species in the cores differs from any that has been previously recorded from the surface samples of the Gearle Siltstone and it seems likely that, although the lower part of the formation has been observed in outcrop in the Giralia Anticline, it has not been sampled.

In the beds below the Gearle Siltstone, foraminifera are rare. Radiolaria are abundant in the Windalia Radiolarite but are not well preserved. A few poorly preserved foraminifera are present.

One core sample was taken in the Muderong Shale. Foraminifera were rare and only one arenaceous species was determinable.

The general aspect of the foraminifera noted in the Windalia Radiolarite and the Muderong Shale is similar to that found in the lower Gearle. The suggestion of a topmost Lower Cretaceous age for the Windalia Radiolarite is in slight conflict with evidence of certain megafossils found in the formation, which are basal Upper Cretaceous (basal Cenomanian) age (R.O. Brunschweiler, personal communication), but the foraminiferal assemblage recorded from outcrops of the Windalia Radiolarite agrees with that found in the cores of the lower part of the Gearle Siltstone.

No fossils were found in the Birdrong Formation.

References.

Condon, M.A., Johnstone, D., Perry, W.J., and Crespin, I., 1953 - The Cape Range Structure, Western Australia. Bull. Aust.Bur.Min.Resour., 21.

Condon, M.A., Johnstone, D., Prichard, C.E., and Johnstone, M.H., 1954 - The Giralia and Marrilla Anticline, Western Australia. Bull.Aust.Bur.Min.Resour., 23 (in press).

Crespin, I., 1953 - Lower Cretaceous Foraminifera from the Great Artesian Basin, Australia. Contr.Cushman Fdn., 4 (1), 26-36.

Schuchert, C., 1943 - Stratigraphy of the Eastern and Central United States. John Wiley and Sons.

Tappan, H., 1940 - Foraminifera from the Grayson Formation of Northern Texas. J.Paleont., 14 (2), 93-126.