ROBERTSON RESEARCH COMPANY LIMITED

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THE MICROPALAEONTOLOGY AND STRATIGRAPHY OF THE PHILLIPS (NORWAY) 7/11-2X NORTH SEA WELL.

by

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I

INTRODUCTION

This report summarises the results of the micropalaeontological and stratigraphical analyses which have been carried out under Project No. ARP 689/280 on material received from the interval 1750' - 11245' of the Phillips (Norway) 7/11-2X North Sea Well.

This exploration well was the second drilled in block 7/11 of the Norwegian North Sea Concession Area.

The stratigraphic interval dealt with in the current report commences in, and ranges through a very thick and relatively complete Tertiary sequence and into the Upper Cretaceous Chalk in which the well reached T.D.

We wish to acknowledge the continued co-operation and assistance received from the various members of Phillips Petroleum Company with whom we have been associated during the course of this work.

A summary of the sequence penetrated in this well can be seen overleaf on Table 1.

II

SUCCESSION

Unit	Interval	Thickness	Stage	System/Subsystem
A	1750' - 2050'	+ 300'	Scaldisian	Upper Pliocene
B	?2100' - 2250'	± 150'	?Upper Diestian	?Lower Pliocene
C	2300' - 2450'	± 150'	Lower Diestian	Upper Miocene
D	2500' - 5100'	± 2600'	-	Middle Miocene
E	5130' - 5780'	± 650'	Burdigalian	))Lower Miocene
F	5820' - 6650'	± 830'	Aquitanian	)
G	6680' - 8740'	± 2060'	-	Oligocene
H	8780' - 9580'	± 800'	-	?Upper - ?Middle Eocene
I	9600' - 9760'	± 160'	-	?Lower Eocene - ?Palaeocene
J	9780' - 10560'	± 780'	-	Palaeocene
K	10565' - 11010'	± 445'	Danian	Lower Palaeocene
L	11020' - 11245'	+ 225'	Maestrichtian	Upper Cretaceous

III

MATERIALS AND METHODS

Under Project No ARP 689/280 a total of 336 ditch cuttings and 30 side wall cores was analysed utilising standard micropalaeontological techniques.

A summary of the information obtained from these samples was forwarded in a series of letters and telephone communications. These letters contain the framework of factual information on which this report is based. The prepared samples and recorded information are now filed and curated in the confidential records section of these laboratories.

Methods of treating and assessing the age of the samples were similar to those mentioned in our Oilfields Report No. 171.

IV

TERTIARY

(a) Pliocene

UNIT A, INTERVAL 1750' - 2050'; Scaldisian, Upper Pliocene.

General Lithology

The interval is heavily contaminated with cement, but consists dominantly of soft grey clays, with small amounts of very fine-grained, unconsolidated sand, made up of colourless, white and grey, subangular to subrounded, quartz grains. Small amounts of shell fragments occur, increasing slightly in abundance at the base of the unit, and are mostly lamellibranchs, echinoids and bryozoans.

Micropalaeontology and Stratigraphical Conclusions

The presence at the top of this interval of such foraminifera as Cibicides lobatulus var. grossa, Cibicides scaldisiensis and Cassidulina laevigata pliocarinata would suggest that Scaldisian (Upper Pliocene) deposits have already been encountered in this sample.

Good faunas are recorded from all the cuttings received from this section, the dominant genera present being Elphidium and Cassidulina with subordinate numbers of Cibicides.

UNIT B, INTERVAL ?2100' - 2250'; ?Upper Diestian, ?Lower Pliocene.

General Lithology

The samples are again contaminated with cement, and this interval is lithologically very similar to the overlying unit.

Micropalaeontology and Stratigraphical Conclusions

A slight decrease in the microfaunal content of the samples is noted in this interval and is associated with the incoming of the following species.

Bulimina elongata var. subulata
Cassidulina subglobosa
Cytheridea mülleri

Although none of these forms is diagnostic of the Lower Pliocene, a questionable Lower Pliocene (Upper Diestian) age has been assigned to this interval on the basis of the faunal changes.

The top of the interval is marked by a predominance of Cassidulina laevigata while in the deeper samples species of Quinqueloculina, Elphidium, Nonion and Cibicides become more important.

(b) Miocene

UNIT C, INTERVAL 2300' - 2450'; Lower Diestian, Upper Miocene.

General Lithology

The two samples examined from this interval consist essentially of dark grey clays; small amounts of fine sand are present in the upper sample.

Micropalaeontology and Stratigraphical Conclusions

The incoming at the top of this unit of Pyrgo bulloides, Uvigerina canariensis, Uvigerina asperula and Cibicides peelensis would indicate that the Miocene has been penetrated, most probably the Lower Diestian stage.

Only two samples were received from this section. The upper one contained a rich microfauna, however, the lower one is somewhat impoverished.

UNIT D, INTERVAL 2500' - 5100'; Middle Miocene

General Lithology

Soft, grey clays are the dominant lithotype throughout this sequence. Small amounts of fine-grained, unconsolidated sand occur in most samples in the upper part, between 2500' - 4250'. Medium grey, poorly fissile, slightly micaceous, shales are interbedded with the clays below 4690' and become more common towards the base of the unit. Thin bands of buff to greyish, argillaceous limestone occur locally and below 5050' hard, grey dolomites are present.

The clays appear to be quite strongly pyritic throughout the unit.

Micropalaeontology and Stratigraphical Conclusions

Several microfaunal assemblages occur within the samples from this interval, all being indicative of the Middle Miocene. The sequence can be subdivided into three sections which are outlined below:-

2500'-3500'

Moderate to rich microfaunas are recorded from the majority of the samples. Many of the forms present are similar to those in the overlying unit with the addition of rare specimens of Uvigerina hosiusi throughout, together with the incoming of Listerella communis at 2850'. These species would indicate that the deposits are of Middle Miocene age and this conclusion is further substantiated by the presence of Sigmoilina celata, Loxostomum sinuosum and Bolivina subspinescens.

Miliolids and species of Cibicides predominate in the majority of the samples examined.

3600' - 4900'

Moderate to rich faunas are again noted in the upper portion of this sub-unit i.e. 3600' - 4300', while below 4350' only poor faunas are recorded. Although the species present are similar to those noted above Uvigerina hosiusi becomes relatively more abundant. Planktonic foraminifera also become more important at several horizons while arenaceous foraminifera gradually increase in numbers with depth; more marked increases being noted below 4700', until at the base of the unit arenaceous forms predominate.

4950' - 5100'

Impoverished faunas are recorded from this sub-unit. However, in addition to similar forms to those noted in the overlying interval Radiolaria become an important constituent of the microfauna. Small planktonic foraminifera also increase in numbers at the top of this section, and include such species as Globigerina bradyi and Globigerina foliata.

UNIT E, INTERVAL 5130' - 5780'; Burdigalian, Lower Miocene.

General Lithology

The rocks of this unit are composed of a uniform sequence of light to medium grey, slightly micaceous, and locally pyritic clays and shales. Very thin bands of buff, dense limestone occur at one or two horizons.

Micropalaeontology and Stratigraphical Conclusions

The microfaunas within this interval tend to be poorer than in the Middle Miocene above.

The top of the Burdigalian is taken at 5130' with the presence of Globigerinoides subquadratus, whilst the sample below contains Uvigerina tenuipustulata, another Burdigalian form. Globorotalia fohsi barisanensis is not abundant but occurs in several samples below 5300'.

Sphaeroidinellopsis seminulina seminulina is conspicuous in samples below 5530'.

UNIT F, INTERVAL 5820' - 6650'; Aquitanian, Lower Miocene.

General Lithology

Shales and clays are the dominant rock types throughout the interval. Grey shales and clays at the top of the unit grade downwards into medium to dark brown shales below 6050', which are interbedded with brownish clays below 6500'. Some iron - stained and locally limonitic shales occur at the base of the interval.

Brownish silty dolomites and dolomitic siltstones occur as frequent, very thin bands in the shales between 5850' - 6500'; below this depth they become more calcareous and are here crossed by occasional light amber coloured calcite veins.

Micropalaeontology and Stratigraphical Conclusions

As in the section above the microfaunas recorded from this unit tend to be impoverished.

Globorotalia scitula praescitula indicates that the interval belongs to the Aquitanian. No specimens of Globigerinoides bisphericus appear to be present. However, Globigerinoides triloba immatura and low forms of Globigerinoides triloba triloba occur in some of the upper samples.

(c) Oligocene

UNIT G, INTERVAL 6680' - 8740'; Oligocene

General Lithology

From the top of the unit to 6840' the lithology consists of shaly clays with thin interbedded limestones. The shales are generally dark brown to grey and friable, becoming firm to hard, brittle, and pyritic locally. The limestones are dark brown, microcrystalline with calcite veining and occasionally dolomitic.

From 6870' thin dolomites alternate with clay and shale. The dolomites are dark brown, crypto - to microcrystalline, hard and locally amber in colour. They are generally found associated with light brown, firm to soft, friable shale with black carbonaceous streaks, and locally ironstained or containing fragments of ironstone. Bronze coloured pyrite nodules are occasionally noted.

The interbedded dolomites are common down to 7720', thereafter being found only occasionally in the shales. These shales are light grey, green and occasionally brown in colour and range from friable to fissile, locally becoming a blocky claystone.

They are generally slightly calcareous and are present to the base of the unit at 8740', becoming clayey and slightly pyritic in the lower part.

Micropalaeontology and Stratigraphical Conclusions

Impoverished arenaceous microfaunas are found in the majority of the samples from this unit. Below 8100', however, several moderate faunas, essentially arenaceous in character, are recorded.

The top of this interval is marked by the incoming of the following species:-

Siphonodosaria hirsuta

Globigerina praebulloides leroyi

Catapsydrax unicavus

These would suggest that the Oligocene has been encountered. A change in the arenaceous foraminiferal species present is also noted at this depth which again suggests an Oligocene age.

The Oligocene ostracod Xestoleberis mulleriana is first encountered at 6810'.

Sigmoilina tenuis initially occurs at 6900' and becomes more important below 6980' while Asterigerina gürichi and Cibicides tenellus are noted at 7310'. Glomospira charoides first appears at 7860' and then becomes a common component of the faunas below this depth. Two further Oligocene indicators are the incoming of Gyroidina girardana at 8200' and Rotaliatina buliminoides at 8490'.

Reworked Upper Cretaceous foraminifera are seen in the samples at 6840' and 7330'.

(d) Eocene

UNIT H, INTERVAL 8780' - 9580'; ?Upper - ?Middle Eocene

General Lithology

The top of the unit consists of grey-green shales which are slightly calcareous and firm to fissile, as in the overlying unit. In the upper part, from 8800' - 8960', buff limestone is present in moderate amounts, being generally hard, microcrystalline and blocky. The limestones are occasionally dense and firm, with rare light green, waxy shale inclusions. There are small amounts of black, hard, platy, and slightly calcareous shale associated with the limestone horizons.

From 8980' the shales become light grey in colour and occasionally medium grey, both types being slightly calcareous. Although clayey in the upper part the shales become progressively more fissile and contain thin dolomites and rare limestones. The dolomites are dark brown and hard, ranging from microcrystalline to finely sucrosic while limestones are buff with tan and cream mottling.

From 9100' the shales become dark grey, occasionally being dark grey-brown and micaceous, but poorly calcareous. Lower in the interval a green colouration is again apparent and grey-green, waxy shales are dominant, becoming light green between 9420' and the base of the unit at 9580'. Minor quantities of dark green, hard, fissile shale veined with fibrous calcite are present, and occasional tan cryptocrystalline to finely sucrosic dolomitic horizons are noted.

Micropalaeontology and Stratigraphical Conclusions

Impoverished arenaceous faunas are again the feature of this interval. Although a slight influx of planktonic foraminifera is noted at the top of the section where the following diagnostic species are recorded:-

Globigerina aff. venezuelana

Globorotalia aff. centralis

Globigerina cf. linaperta linaperta

These species are similar to forms normally recorded from the Middle - Upper Eocene and therefore a ?Middle - ?Upper Eocene age has been assigned to this interval. Further diagnostic foraminifera present include:-

Trochammina globigeriniformis

Trochammina globigeriniformis var. altiformis

Globigerina barbosa

Globorotalia aff. cerro-azuelensis

Bathysiphon eocenicus

The first markedly green-stained foraminifera are encountered at 9100' while reworked Upper Cretaceous forms are noted at the top of the unit.

(d) ?Eocene - ?Palaeocene

UNIT I INTERVAL 9600' - 9760'; ?Lower Eocene - ?Palaeocene

General Lithology

The grey to green shales of the overlying beds continue into this unit but rapidly acquire a red-brown colouration. Below 9620' they are variegated being of a red-brown, light green, and pinkish hue and with occasionally purple and green mottling. Small amounts of associated ironstone nodules are present and at 9680' a very sparry, buff-tan limestone is encountered. Trace amounts of small sideritic nodules are first encountered at the top of this interval increasing slightly in amount at 9620' - 9660'.

In the lower part of the unit green shales again predominate which contain finely disseminated pyrite together with amounts of bright yellow pyrite nodules which are occasionally chalcopyritic.

Rare dolomite horizons are found interbedded with the shales; the dolomite being brown, hard, microcrystalline, and locally grading into a dolomitic limestone. The incoming of dark brown-grey micaceous shale in trace amounts is seen in the lower part of the interval.

Micropalaeontology and Stratigraphical Conclusions

The incoming of small sideritic nodules and traces of purplish shale near the top of this interval may signify a break in the sequence. This, together with the incoming of Globigerina triangularis, also at 9600', may indicate that this interval is of ?Lower Eocene - ?Palaeocene age. In the lower half of the unit several arenaceous foraminifera belonging to species recorded by Haynes from the English Palaeocene deposit are first encountered.

Only poor, essentially arenaceous, faunas are present in all cuttings received from this section.

(e) Palaeocene

UNIT J, INTERVAL 9780' - 10560'; Palaeocene.

General Lithology

The unit falls into three parts, consisting of upper and lower shales which are separated by a sand sequence spanning the interval 9910' to 10230'.

The upper shales, 9780' - 9900', are light green becoming increasingly grey in colour. Traces of buff, brown and red claystone are found throughout, being particularly noticeable at the top of the interval. The shales are clayey, with minor ironstaining in the middle part of the interval, reverting to shale lower down, and with a dense, hard, grey-brown claystone marking the base at 9900'. Thin calcite veining is seen to affect the claystones locally.

Small amounts of sandstone are noted from 9910', but the first good sample is encountered at 9930' where dark green glauconite grains are found scattered throughout. The sandstonesare composed of medium sized, angular quartz grains with minor calcite cement.

At 10000' an unconsolidated sand follows the sandstone. This deposit consists of fine-grained, angular, subspherical, clear quartz sand, with occasional subangular and elongate, and medium to coarse grains. Traces of orange coloured, iron-stained calcite fragments are found in the sand, and locally buff-white, firm, and variably friable sandstones with sideritic cement are encountered. At 10140' traces of red and green shale are noted. The fine sands thereafter contain rare green-grey glauconite grains and small muscovite flakes. Occasional bitumen staining is seen where the sands become finer. At 10200' a hard buff sandstone with chalky matrix marks the base of this sand interval.

From 10250' to the base of the unit at 10560' light green shale is the dominant lithology. Minor amounts of buff, pink, red-brown and grey shales also occur. These rocks are generally flaky or fissile but are occasionally waxy with rare, thin, fine-grained, sandstone stringers as evidenced by the sidewall core samples received. Traces of buff-tan limestone are seen at 10480'.

Micropalaeontology and Stratigraphical Conclusions

The incoming of Globigerina triloculinoides, and Globigerina cf. velascoensis at the top of this interval together with the infrequent occurence of Cibicides proprius and Globigerina cf. inaequispira would suggest that deposits of Palaeocene age have been encountered. This is supported by the occurence of Spiroplectammina spectabilis and Textularia thanetana at 10335' and ?Rzehakina sp. at 10360'.

Apart from the uppermost samples and several samples below 10340', in which moderate faunas are noted, poor arenaceous microfaunas are recorded.

In many cases, the samples, especially the sidewall cores, proved to be devoid of microfossils.

Further marker horizons within this interval, in addition to those already noted, are the incoming of large green Radiolaria at 10495' and the occurrence of Globigerina cf. pseudobulloides at 10520'; the latter indicating that the lower part of the Palaeocene has been encountered.

The arenaceous foraminifera present are essentially similar to those recorded by Haynes from the Thanetian deposit of England.

UNIT K, INTERVAL 10565' - 11010'; Danian, Lower Palaeocene.

General Lithology

The unit is initially composed of white and buff chalk with minor amounts of hard grey limestone. The sidewall cores show the interval to consist predominantly of hard, light grey, microcrystalline limestone, in part shaly, and occasionally sparry. There is much grey-green shale present down to 10740' which is possibly caved, but in part representing shale intercalations.

At 10745' good samples of chalk rock are obtained which revert to grey limestone again at 10800' with a corresponding incoming of light green and pale olive cryptocrystalline dolomite. The dolomite increases in amount down to 10900' being locally dark green, mottled purple, and pyritic.

At 10920' medium sized, angular quartz grains are found in a chalky matrix with traces of fine muscovite flakes, and occasional ironstone nodules. Thereafter to the base of the unit at 11010' the lithologies are dominantly of light green and purple, firm to friable, dolomitic shales and pale olive, waxy dolomites. Towards the base the dolomites are locally dark green and traces of sand are noted.

Micropalaeontology and Stratigraphical Conclusions

The shale, limestone and dolomitic limestone samples proved to be devoid of microfossils or contain impoverished faunas. Slightly richer faunas were encountered in the chalky horizons but the majority of forms here are poorly preserved.

However, the incoming of chalk at the top of this interval together with the presence of Globigerina pseudobulloides, and Osanguiaria lens would suggest that the equivalent of the Danian Banskekalk of Denmark has been encountered. Other diagnostic Danian foraminifera noted within this sequence include Globigerina cf. daubjergensis and Globorotalia compressa.

A thicker, more argillaceous and more dolomitic developement of the Danian is present here compared with that recorded from Denmark.

V

CRETACEOUS

UNIT L, INTERVAL 11020' - 11245'; Maestrichtian, Upper Cretaceous

General Lithology

The uppermost part of the unit consists of firm to soft, white chalk with minor grey, cryptocrystalline limestone. Traces of light grey-white opaque chert are encountered near the top of the unit, having a blocky fracture. Thereafter the chalk becomes firmer, locally chalk rock, with occasional buff-pink colouration the latter possibly being due to drilling mud additives. In the lowest samples received, chalk rock grading into light grey, hard, platy, microcrystalline limestone is evident.

Micropalaeontology and Stratigraphical Conclusions

A very sparse and poorly preserved microfauna is present in this section. The appearance of Pseudotextularia elegans elegans and Pseudotextularia elegans fructicosa at 11020' indicates that the Maestrichtian stage of the Upper Cretaceous has been penetrated. The fact that Pseudotextularia elegans fructicosa, an Upper Maestrichtian form, occurs suggests that the Maestrichtian appears to be complete and that the Palaeocene may lie comformably upon the Upper Cretaceous.

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