ROBERTSON RESEARCH COMPANY LIMITED

OILFIELDS REPORT NO. 294

THE MICROPALAEONTOLOGY AND STRATIGRAPHY OF THE PHILLIPS (NORWAY) 2/4-1X NORTH SEA WELL

by

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Prepared for :

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ENCLOSURES

I

INTRODUCTION

This report summarises the results of the micropalaeontological, petrographical and stratigraphical analyses which have been carried out under Project No. ARP 690/504 on material received from the interval 2060' - 5340' of the Phillips (Norway) 2/4-1X North Sea Well.

This exploration well was the first drilled in block 2/4 of the Norwegian North Sea Concession Area.

The stratigraphical interval covered ranges from Pliocene deposits into sediments of Upper and Middle Miocene age. The well was terminated owing to drilling difficulties in the Middle Miocene.

We wish to acknowledge the continued co-operation and assistance received from the various members of the 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 in Table I.

II

SUCCESSION

2/4-1X

TABLE I

UNIT	INTERVAL	THICKNESS	STAGE	SYSTEM/SUBSYSTEM
A	2060' - 2180'	+ 120'	Scaldisian	Upper Pliocene
B	2200' - 2680'	± 480'	Upper Diestian	Lower Pliocene
C	2710' - 3020'	± 310'	Lower Diestian	Upper Miocene
D	3130' - 5340'	+ 2210'	-	Middle Miocene

III

MATERIALS AND METHODS

Under Project No. ARP 690/504 a total of 106 ditch cuttings was analysed utilising standard micropalaeontological techniques. Ten thin sections were made from the carbonate cuttings from the lower section of the well and these are described in the Appendix.

A summary of the information obtained from these samples was given in telephone communications and these contained 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.

The methods of treating and assessing the age of the samples were similar to those described in previous oilfields reports.

IV

TERTIARY

(a) Pliocene

UNIT A, INTERVAL 2060' - 2180'; Scaldisian, Upper Pliocene

General Lithology

This interval consists essentially of soft, grey clays with occasional thin sandy intercalations. The sands are light greyish in colour, unconsolidated, and are composed of fine-grained, colourless to white and light grey, subangular quartz grains. A little pyrite and rare lamellibranch fragments occur locally together with traces of black, lignitic shales which are present in samples below 2120'. Some reworked chalk fragments are noted at 2080'.

Micropalaeontology and Stratigraphical Conclusions

Moderate microfaunas are recorded from this section. The presence of Cassidulina laevigata var. pliocarinata, Cibicides lobatulus var. grossa and Cibicides scaldisiensis would indicate that this section is of Scaldisian, Upper Pliocene age.

Nonion, Cassidulina and Cibicides are the dominant genera present within this interval.

UNIT B, INTERVAL 2200' - 2680'; Upper Diestian, Lower Pliocene

General Lithology

The lithology of this unit is very similar to that above. However, below 2360' sands are quite rare, while below 2460' those present contain appreciable amounts of greenish quartz grains which are subrounded and have a vitreous lustre. In the basal section, from 2650' to 2680', a

few thin intercalations of buff, calcareous shale and limestone occur. Traces of red shale, probably reworked Trias, are present at 2680'.

Micropalaeontology and Stratigraphical Conclusions

The incoming of Bulimina elongata var. subulata at the top of this section may suggest that the Upper Diestian, Lower Pliocene has been penetrated.

Moderate faunas are noted towards the top of the interval but become impoverished with depth. Cassidulina, Nonion and Cibicides are again the predominant genera present with Bulimina spp. becoming a more important component of the fauna below 2420'.

(b) Miocene

UNIT C, INTERVAL 2710' - 3020'; Lower Diestian, Upper Miocene

General Lithology

This unit consists of a sequence of soft, grey clays. The uppermost sample, at 2710', is characterised by the presence of red, slightly micaceous shales and claystones which probably are reworked from the Trias. Sands again form infrequent thin intercalations and consist of angular to subangular, very fine-grained, greyish and white quartz grains. Shell fragments, principally lamellibranchs together with some gastropods and echinoderms, occur at 2740'.

Micropalaeontology and Stratigraphical Conclusions

A change in the microfaunal content is noted at the top of this section and is marked by the incoming of Cibicides peelensis, Cibicides pseudoungerianus, Rotalia beccarii var., Cibicides aknerianus and Sigmoilina celata. This change would signify that the interval is of

Upper Miocene (Lower Diestian) age.

Although moderate microfaunas are found in the uppermost part of this interval they rapidly become impoverished below 2770'. Buliminids become a noticeable component of the fauna at 2950' while at 2980' Rotalia becarii var. also becomes an important constituent.

Reworked Oligocene/Middle Miocene forms are seen at the top of the interval.

UNIT D, INTERVAL 3130' - 5340'; Middle Miocene

General Lithology

The uppermost part of this unit, from 3130' to 4690', consists predominantly of soft, grey clays, with a few shales in the lower section. Sands are rare and are generally very fine-grained and unconsolidated. Thin bands of greyish and greyish brown, micritic limestone occur at one or two horizons which are generally hard, dense and earthy. Pyrite occurs in variable quantities throughout this sequence and has often replaced fragments of echinoderm shell and spines.

The basal section of this unit, from 4960' to 5340', is very similar to the above interval. There is, however, a noticeable, but slight, increase in the number of limestone intercalations which are most common around 5220'. The limestones in the higher parts have often been strongly pyritised, while between 5180' and 5220' dolomites are common. A number of thin sections were cut from these carbonate horizons and these are fully described and discussed in the Appendix.

Micropalaeontology and Stratigraphical Conclusions

The microfaunas present throughout this interval are indicative of the Middle Miocene. On account of the microfaunal associations present it has been possible to subdivide this unit as follows :-

3130' - 3700':

A microfaunal change is noted at the top of this interval and diagnostic forms present include:-

Loxostomum sinuosum

Elphidium inflatum

Epistomina elegans

These forms would suggest a Middle Miocene age for the interval. Further evidence of this age is indicated by the occurrence of rare specimens of Uvigerina hosiusi below 3310' and the presence of Listerella communis below 3340'.

Moderately varied microfaunal assemblages are recorded from the upper section of this Middle Miocene interval while an increase in the numbers of Uvigerina spp. and planktonic foraminifera is noted towards the base.

3730' - 4720':

The top of this section is delineated by the incoming of common specimens of Uvigerina hosiusi. The remainder of the microfaunal assemblage is similar to that recorded above. Moderate faunas with common specimens of Uvigerina hosiusi are noted down to 4120' while below this depth the microfauna becomes impoverished.

4750' - 5340':

Arenaceous foraminifera are first encountered in the sample at 4750'. They gradually increase in numbers until they become the dominant forms towards the base of the interval. Arenaceous faunas are particularly noticeable at 5100'. Small planktonic foraminifera also form an important component of the faunas below 5140'.

Although many of the species present at the base of this interval

can also be found in the Lower Miocene we have assigned this entire section to the Middle Miocene. This is on account of the general absence of forms usually found towards the base of the Middle Miocene in this region of the North Sea (i.e. Radiolaria and Asterigerina staeschei).

The microfaunas recovered from this section are generally rather poor. Possible reworked Danian and ?Oligocene forms are found in the sample at 5100'.

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RJG/CWH/EWH.

APPENDIX

Ten thin sections were made of the carbonate rocks between 4690' and 5340'. In many instances, particularly in the higher parts, the amount of residue was insufficient for thin section preparation and a number of these samples were therefore composited.

PETROGRAPHY

1. Composite sample 4690' - 4780'

Micrites form the dominant carbonate rocks in this sample, although rare fragments of very finely-crystalline, anhedral dolomite also occur. The micrites are barren of fauna but a few, very small, rounded pores occur which may have been formed by the leaching of microfossils. In a few instances the micrites have been totally pyritised and some of the pyrite fragments contain rounded pore spaces typical of the micrites.

2. Composite sample 4810' - 4930'

This sample is similar to the one above, but pyritisation is more common. Some of the micrites are slightly argillaceous, occasionally silty and contain a few angular, silt-sized, quartz grains.

3. Composite sample 4960' - 5100'

This sample is identical to sample 4810' - 4930'.

4. Sample 5140'

This sample consists of micrite and pyrite as above. The micrites contain rare planktonic foraminifera.

5. Sample 5180'

This sample is composed of micrites together with subordinate amounts of pyrite. The micrites have been modified by slight grain growth and frequently have been dolomitised with the formation of a very finely-crystalline, anhedral dolomite.

6. Sample 5220'

This sample consists of very finely-crystalline, anhedral dolomite which has some intercrystalline porosity. However, it is difficult to estimate the amount of porosity from the ditch cuttings alone. A little dense micrite, containing rare planktonic foraminifera, is also present.

7. Sample 5300'

This sample consists essentially of dense micrite, containing a few planktonic foraminifera and frequent rounded solution pores similar to those in the higher samples. A little dolomite is also present.

8. Samples 5340A, 5340B and 5340C

These samples are very similar to the sample at 5300', but solution pores are rather rare. Sample 5340'B also contains a little greenish grey shale.

DEPOSITIONAL ENVIRONMENT

The lithology and fauna of the rocks between 4690' and 5340' suggest that deposition took place in a rather deep water, open marine environment.

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MICROPALAEONTOLOGICAL ANALYSIS CHART

DATE	ANALYST	LOCATION
9.10.69.	CWH, RJG.	Norwegian North Sea Well 2/4-1X

FOR	CHART No.
Phillips Petroleum Company, Norway	4 5000' - 5340'

LIMESTONE · DOLOMITE · OOLITIC LIMESTONE · CLAY · SHALE · SILTY/SANDY SHALE

SILTSTONE · SANDSTONE · CONGLOMERATE · GYPSUM · VOLCANICS · INTRUSIVES

SALT · COAL · CHERT

* ?Reworked Danian

FORAMINIFERA AND OSTRACODA

MICROFOSSILS

- Bathysiphon dubia
- Globigerina bulloides
- Globigerina angustiumbilicata
- Nonion granosum
- Rotalia beccarii var.
- Nonion boueanum
- Ammodiscus incertus
- Karreriella siphonella
- Nonion affine
- Nonion soldanii
- Sigmoilina celata
- Cibicides akneriana
- Bulimina elongata var. subulata
- Elphidium antoninum
- Cyclammina sp.
- Hormosina sp.
- Pullenia sphaeroides
- Glomospira cf. charoides
- Coscinodiscus sp.
- ?Globigerina pseudobulloides *
- Globigerina praebulloides praebulloides
- Cassidulina subglobosa
- Clavulina laevigata
- Globigerina juvenilis
- Cassidulina laevigata
- Uvigerina hosiusi
- "Cythere" latimarginata
- Lagena laevigata
- Globigerina foliata
- Epistomina elegans
- Siphotextularia labiata
- Cibicides peelensis
- Globorotalia mayeri
- Sphaeroidina bulloides
- Eponides umbonatus
- Lagena sulcata
- Uvigerina canariensis
- Haplophragmoides carinatum
- Haplophragmoides cf. narivaensis

LITHOLOGY

DEPTH IN FEET: 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000

SYSTEM: MIDDLE MIOCENE

STAGE

ZONE

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MICROPALAEONTOLOGICAL ANALYSIS CHART

DATE	ANALYST	LOCATION
9.10.69	CWH, RJG.	Norwegian North Sea Well 2/4-1X

FOR	CHART No.
Phillips Petroleum Company, Norway	3 4000' - 5000'

LIMESTONE
DOLOMITE
OOLITIC LIMESTONE
CLAY
SHALE
SILTY/SANDY SHALE
SILTSTONE
SANDSTONE
CONGLOMERATE
GYPSUM
VOLCANICS
INTRUSIVES
SALT
COAL
CHERT

LITHOLOGY | DEPTH IN FEET | SYSTEM | STAGE | ZONE

100
200
300
400
500
600
700
800
900
1000

MIDDLE MIOCENE

FORAMINIFERA AND OSTRACODA

MICROFOSSILS

Cibicides peelensis
Cibicides pseudoungerianus
Nonion affine
Nonion soldanii
Nonion boueanum
Lagena laevigata
Bulimina elongata var. subulata
Nonion granosum
Globigerina bulloides
Globigerina angustiumbilicata
Rotalia beccarii var.
Cassidulina laevigata
Sigmoilina celata
Uvigerina hosiusi
Uvigerina asperula
Uvigerina canariensis
Loxostomum sinuosum
Pullenia sphaeroides
Bulimina elongata var. tenera
Cytherella beyrichi
Cibicides aknerianus
Quinqueloculina seminulum
Lenticulina grandis
Lagena sulcata
Orbulina suturalis
Sphaeroidina bulloides
Eponides umbonatus
Glandulina laevigata
Dentalina arcuata
Nodosaria pyrula
Pullenia quinqueloba
Siphotextularia labiata
Trifarina bradyi
Bolivina floridana var. imporcata
Cassidulina subglobosa
Elphidium antoninum
Echinocythereis scabra
Bathysiphon dubia
Cyclammina sp.
Lagena striata
Glomospira cf. charoides
Ammodiscus incertus
Lenticulina haueriana
Globorotalia mayeri

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MICROPALAEONTOLOGICAL ANALYSIS CHART

DATE	ANALYST	LOCATION
8.10.69	RJG, CWH.	Norwegian North Sea Well 2/4 - 1X

FOR	CHART No. 2
Phillips Petroleum Company, Norway.	3000' - 4000'

FORAMINIFERA AND OSTRACODA

LIMESTONE
DOLOMITE
OOLITIC LIMESTONE
CLAY
SHALE
SILTY/SANDY SHALE
SILTSTONE
SANDSTONE
CONGLOMERATE
GYPSUM
VOLCANICS
INTRUSIVES
SALT
COAL
CHERT
Pyrites

LITHOLOGY | DEPTH IN FEET | SYSTEM | STAGE | ZONE | MICROFOSSILS

100
200
300
400
500
600
700
800
900
1000

UPPER MIOCENE
LOWER DIESTIAN
MIDDLE MIOCENE

Nonion granosum
Bulimina elongata var. subulata
Bulimina elongata var. tenera
Rotalia beccarii var.
Nonion soldanii
Globigerina bulloides
Pullenia quinqueloba
Loxostomum sinuosum
Pullenia sphaeroides
Sigmoilina celata
Nonion affine
Cassidulina laevigata
Elphidium inflatum
Epistomina elegans
Cibicides peelensis
Quinqueloculina seminulum
Cibicides pseudoungerianus
Glandulina laevigata
Elphidium antoninum
Nodosaria pyrula
Globigerina angustiumbilicata
Frondicularia nysti
Discorbis milletti
Bolivina beyrichi
Spiroloculina canaliculata
Nonion boueanum
Eponides umbonatus
Uvigerina asperula
Sphaeroidina bulloides
Cibicides aknerianus
Cassidulina subglobosa
Uvigerina canariensis
Karreriella siphonella
Lagena laevigata
Uvigerina hosiusi
Dentalina arcuata
Quadracythere macropora
Trifarina bradyi
Listerella communis
"Cythere" latimarginata
Lenticulina hauerina
Cytherella beyrichi
Lagena sulcata
Glandulina aequabilis
Lenticulina grandis
Asterigerina staeschei
Lagena striata

ROBERTSON RESEARCH COMPANY LIMITED

MICROPALAEONTOLOGICAL ANALYSIS CHART

DATE	ANALYST	LOCATION
7.10.69	CWH, RJG.	Norwegian North Sea Well 2/4-1X

FOR	CHART No. 1
Phillips Petroleum Company; Norway	2060' - 3000'

LIMESTONE
DOLOMITE
OOLITIC LIMESTONE
CLAY
SHALE
SILTY/SANDY SHALE
SILTSTONE
SANDSTONE
CONGLOMERATE
GYPSUM
VOLCANICS
INTRUSIVES
SALT
COAL
CHERT
F Shell fragments

* Reworked Miocene - Oligocene forms

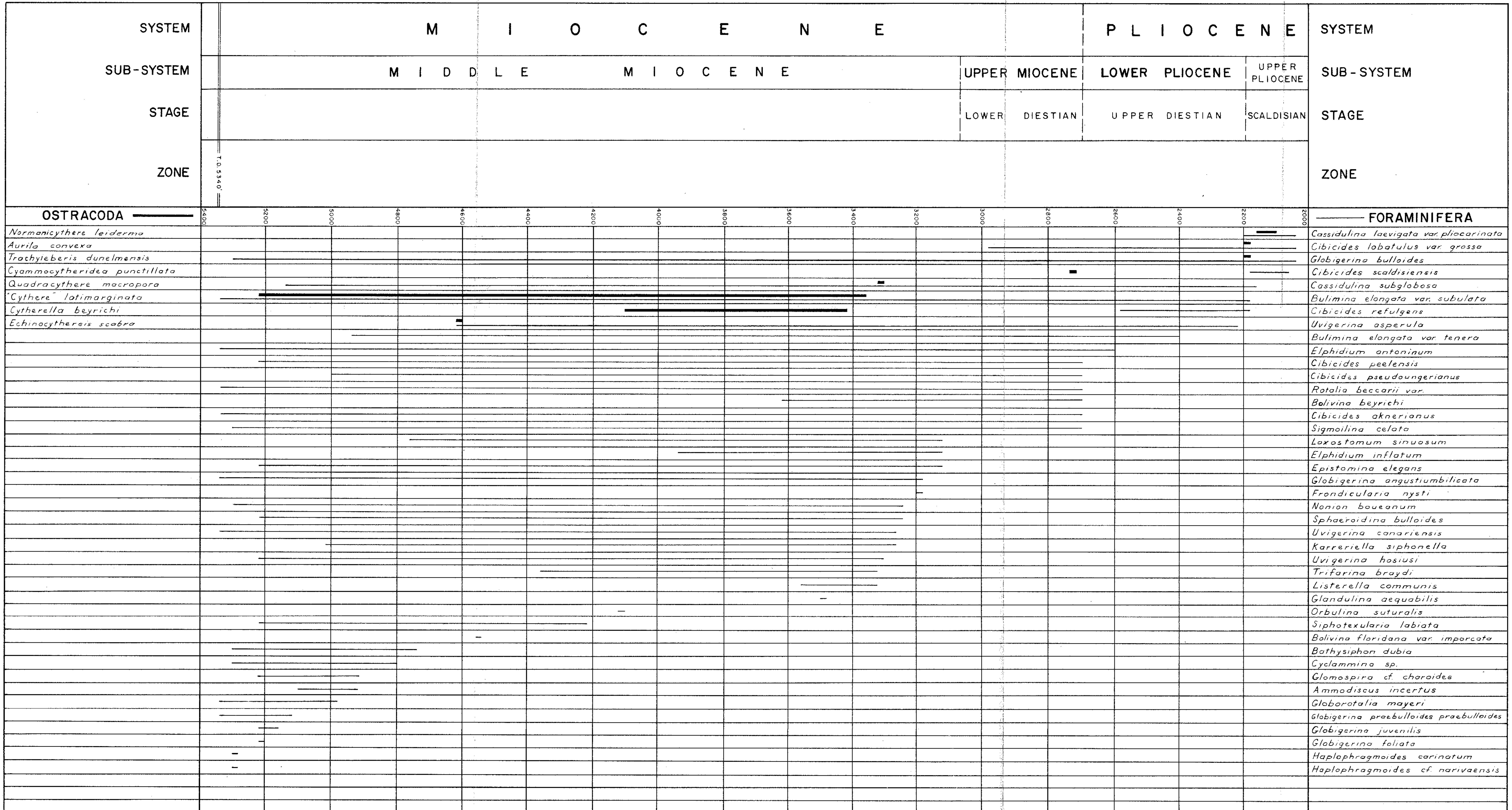
FORAMINIFERA AND OSTRACODA

MICROFOSSILS

- Cassidulina laevigata
- Cassidulina laevigata var. pliocarinata
- Nonion affine
- Glandulina laevigata
- Discorbis milletti
- Nonion granosum
- Lagena laevigata
- Cibicides lobatulus var. grossa
- Elphidium incertum
- Globigerina bulloides
- Cibicides scaldisiensis
- Normanicythere leioderma
- Quinqueloculina undosa
- Cassidulina subglobosa
- Bulimina elongata var. subulata
- Aurila convexa
- Trachyleberis dunelmensis
- Cibicides refulgens
- Cibicides lobatulus
- Uvigerina asperula
- Triloculina oblonga
- Quinqueloculina seminulum
- Bulimina elongata var. tenera
- Lenticulina grandis
- Elphidium antoninum
- Nonion soldanii
- Cibicides peelensis
- Cibicides pseudoungerianus
- Rotalia beccarii var.
- Bolivina beyrichi
- Dentalina soluta
- Cibicides aknerianus
- Sigmoilina celata
- Cyclammina placenta *
- Cyamiocytheridea punctillata

LITHOLOGY	DEPTH IN FEET	SYSTEM	STAGE	ZONE
	100	UPPER PLIOCENE	SCALDISIAN	
	200			
	300	LOWER PLIOCENE	UPPER DIESTIAN	
	400			
	500			
	600			
	700	UPPER MIOCENE	LOWER DIESTIAN	
	800			
	900			
F	1000			

3594



BIOSTRATIGRAPHIC CHART SHOWING THE DISTRIBUTION OF THE DIAGNOSTIC CAENOZOIC FORAMINIFERA AND OSTRACODA IN THE PHILLIPS (NORWAY) 2/4-1X NORTH SEA WELL

by

ROBERTSON RESEARCH COMPANY LIMITED,

Llanddulas, Abergele, Denbighshire.

Drawing No. 760

Date. 10 : 10 : 69