ROBERTSON RESEARCH INTERNATIONAL LIMITED

OILFIELDS REPORT NO. 587

THE MICROPALAEONTOLOGY AND STRATIGRAPHY OF THE INTERVAL 8775' - 13370' FROM THE PHILLIPS 2/4-8X NORWEGIAN NORTH SEA WELL

GEOLOGY FILE

by

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CONTENTS

Enclosures

I

INTRODUCTION

This report summarises the results of the micropalaeontological, palynological and stratigraphical analyses which have been carried out on material received from the interval 8775' - 13370' from the Phillips 2/4-8X Norwegian North Sea Well under Project No. RRI/IIA/723/9 (RRI/IIA/187).

Under this project a total of 717 ditch cutting samples was analysed utilising standard micropalaeontological techniques. In addition 17 composite and individual samples from the Jurassic and Permian sections of the well were treated palynologically.

A summary of the determinations obtained by these analyses was communicated in a series of telex communications which contained the framework of factual information on which this report is based. A summary of the sequence penetrated in this well can be seen overleaf in Table I.

The terminology adopted for the environmental conclusions follows that of Hedgpeth 1957 from which Table II of this report is taken.

The prepared samples and recorded information are now filed and curated in the confidential records section of these laboratories.

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.

II

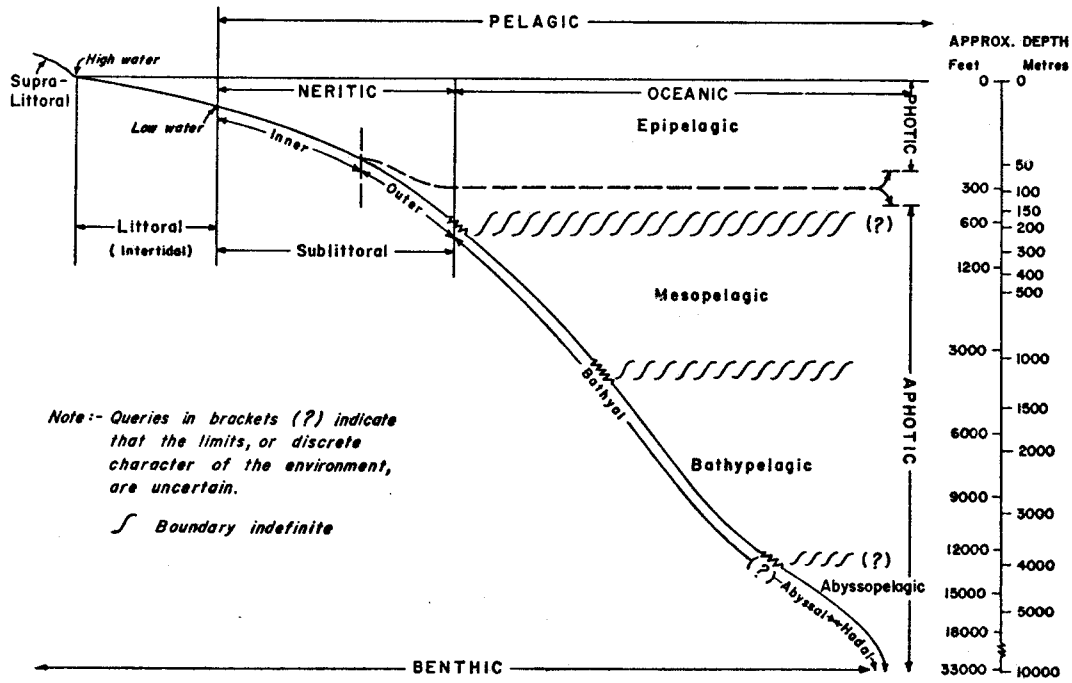
SUCCESSION

TABLE 1

INTERVAL	THICKNESS	STAGE	SYSTEM/SUBSYSTEM
8775' - 8825'	+ 50'	-	Eocene
8850' - 9430'	± 580'	-	Lower Eocene - Palaeocene
9440' - 9560'	± 120'	-	Palaeocene
9570' - 9640'	± 70'	?Danian	?Lower Palaeocene
9650' - 10135'	± 485'	Danian	Lower Palaeocene
10140' - 10895'	± 755	Maestrichtian	Upper Cretaceous
10900' - 11210'	± 310'	?Campanian	
11215' - 11915'	± 700'	Campanian-?Coniacian	
11920' - 12040'	± 120'	Coniacian	
12045' - 12060'	± 15'	Albian	Lower Cretaceous
12065' - 12120'	± 55'	-	Upper Jurassic
12125' - 13370'	+ 1245'	Zechstein	Permian

TABLE 2

CLASSIFICATION OF MARINE ENVIRONMENTS



The classification of marine environments used in this report is presented in diagrammatic form above. Pelagic (water) and Benthic (bottom) environments are recognised.

PELAGIC	BENTHIC
Neritic	Supralittoral
Oceanic	Littoral (Intertidal)
Epipelagic	Sublittoral
Mesopelagic	Inner
Bathypelagic	Outer
Abyssopelagic	Bathyal
	Abyssal
	Hadal

The classification is after Hedgpeth (1957) and results from several years discussion by a Committee of the Division of Earth Sciences, National Research Council, National Academy of Sciences, Washington D. C.

III

TERTIARY

INTERVAL 8775' - 8825'; Eocene

General Lithology

The two samples which make up this interval consist of interbedded, buff, argillaceous, pyritic limestone and dolomite; buff, micaceous, slightly carbonaceous shale; and dusky yellowish brown, cryptocrystalline to microcrystalline limestone.

Micropalaeontology and Stratigraphical Conclusions

The presence in the uppermost interval submitted of Bathysiphon eocenicus, Trochammina cf. globigeriniformis and Cyclammina cf. challinori would suggest that these samples are at least of Eocene age. The fact that a few of the foraminifera are green-stained at 8775' may suggest that the section is of Lower Eocene - Palaeocene age. However, since no diagnostic Lower Eocene - Palaeocene foraminifera are noted an Eocene age has been assigned to this section.

Environmental Conclusions

The moderate microfaunas present within this interval are composed essentially of agglutinating foraminifera and the microfaunal association present would signify that these sediments were deposited under outer sublittoral - bathyal conditions.

INTERVAL 8850' - 9430'; Lower Eocene - Palaeocene

General Lithology

This interval comprises a sequence of buff, argillaceous and dusky yellowish brown, cryptocrystalline, locally arenaceous and glauconitic limestones and dolomites intercalated with shales. These argillaceous sediments comprise grey or brown, soft, micaceous, slightly carbonaceous

shales; buff, pyritic shale; and minor green or red, occasionally mottled shales. There are also horizons of very light grey, pyritic, tuffaceous shales throughout the section. Sphaerosiderite occurs below 9000', usually as disaggregated spheres but occasionally the spheres are set in a pale green, argillaceous, dolomitic matrix. Whitish grey, banded tuffs are present below 9260'.

Micropalaeontology and Stratigraphical Conclusions

Cyclammina sp. 2 and rare radiolaria occur at 8850' indicating that this interval is of Lower Eocene - Palaeocene age. Radiolaria increase in numbers at 8875' and an influx of these forms is noted at 9050'.

Environmental Conclusions

The continued dominance of agglutinating foraminifera within this interval of moderate microfaunas would suggest a similar depositional environment to that postulated for the overlying section.

INTERVAL 9440' - 9560'; Palaeocene

General Lithology

The constituent lithologies of this section are essentially similar to those of the overlying interval and consist of grey, red and green shales with thin beds of buff, argillaceous limestone. Tuffs are also common in this interval and a particularly good horizon of medium grey, banded, moderately indurated tuff occurs at 9480'.

Micropalaeontology and Stratigraphical Conclusions

A flood of green-stained specimens of the planktonic foraminifera Globigerina triloculinoides is recorded at the top of this interval and its presence would enable a Palaeocene age to be assigned to the interval. Further evidence for a Palaeocene age is denoted by the presence of tuffaceous deposits and the occurrences of Coscinodiscus sp. 1 at 9520' and Coscinodiscus sp. 2 at 9540'.

Environmental Conclusions

Good, open marine connections are indicated for the top of this interval on account of the influx of planktonic foraminifera. Below 9480' similar conditions to those ascribed to the preceding interval are postulated although volcanic activity periodically affected the area, as is evidenced by the intermittent tuffaceous horizons.

The presence of diatoms, especially below 9520', is probably due to the increase in free silica in the sea during the periods of volcanic activity.

INTERVAL 9570' - 9640'; ?Danian, Lower Palaeocene

General Lithology

This interval consists of reddish buff, micaceous shales associated with buff limestones and light brown, glauconitic, fine-grained sandstone. There are also trace amounts of soft white chalk in the samples below 9620'.

Micropalaeontology and Stratigraphical Conclusions

The appearance at the top of this interval of Globigerina cf. pseudobulloides followed at 9620' by Bulimina midwayensis may suggest that this interval is of Danian age. However, because of the impoverished nature of the evidence it has been decided only to assign a ?Danian age to the interval.

Environmental Conclusions

A similar depositional environment to that suggested above, i.e. outer sublittoral to bathyal, is indicated for these deposits on account of the agglutinating foraminifera present.

INTERVAL 9650' - 10135'; Danian, Lower Palaeocene

General Lithology

Red and green mottled shales; red-brown, fissile, calcareous shales; and pale green, pyritic, dolomitic shales predominate in the upper 130' of this section. Associated with these shales are buff limestone, sphaerosiderite and brown, glauconitic sandstone as mentioned in the overlying ?Danian section. Small amounts of moderately indurated, buff chalk are encountered at 9780' and below this depth chalk predominates. The chalk is locally arenaceous, stylolitic, and frequently contains white chert.

Micropaleontology and Stratigraphical Conclusions

An influx of planktonic foraminifera is noted at 9660', this includes such species as Globigerina pseudobulloides, Globorotalia compressa, and Globigerina triloculinoides. The association of these forms would indicate that rocks of definite Danian age have been encountered. The first chalk is seen at 9780' while the first white-coated Danian foraminifera occur at 9795'.

Reworked Upper Cretaceous foraminifera are noted at 9680', 9760', 9780', 9795' and 9820'. These are mainly of Maestrichtian - Campanian age.

Environmental Conclusions

The upper part of this interval which is dominantly argillaceous with some arenaceous interbeds contains mainly agglutinating foraminifera with occasional planktonic and calcareous benthonic forms suggesting outer sublittoral - upper bathyal conditions. The underlying chalk interval contains planktonic assemblages with subordinate calcareous benthonic forms suggesting that it was deposited in outer sublittoral conditions with good connections to the open sea.

CRETACEOUS

INTERVAL 10140' - 10895'; Maestrichtian, Upper Cretaceous

General Lithology

This interval is characterised by buff, well indurated chalk in association with white chert. The chalk is stylolitic, occasionally pyritic and typically cryptocrystalline. Thin beds of light brownish buff, cryptocrystalline limestone and dark grey, carbonaceous limestone occur throughout the sequence. The carbonaceous limestone is occasionally seen as bands, one or two millimetres wide, within the buff chalk. Below about 10600', the chalk is whiter and has a platy appearance.

Micropalaeontology and Stratigraphical Conclusions

The incoming of Pseudotextularia elegans elegans, P. elegans fructicosa, Rugoglobigerina rugosa rugosa, Globotruncana contusa and Bolivinoides draco draco at 10140' signifies that Maestrichtian sediments have been penetrated. Pseudotextularia spp. and Globotruncana contusa are diagnostic of the Upper Maestrichtian. Some of these forms occur as reworked elements higher in the sequence, but they can be distinguished from the specimens at 10140' where they occur in greater numbers, there is generally a more varied Cretaceous fauna and they are better preserved. Other characteristic forms occurring within this interval are Stensioina pommerana, Bolivina incrassata incrassata, B. incrassata gigantea, Globotruncana arca and Biglobigerinella multispina. Above 10520', the ditch cuttings yield a moderate fauna, with the planktonic element predominating. Below this depth the section is impoverished, although this paucity may be due to the indurated nature of the chalk which renders extraction of the foraminifera difficult.

Environmental Conclusions

The chalk lithology and the predominantly planktonic-rich nature of

the upper part of the interval would suggest that sedimentation occurred in the outer sublittoral zone with good open marine connections. The lower section yields fewer microfossils but as stated previously, this cannot be presumed to signify more restricted conditions and may be due to the nature of the lithology.

INTERVAL 10900' - 11210'; ?Campanian, Upper Cretaceous

General Lithology

The lithologies of the upper 100' of this interval are similar to those of the overlying section and comprise buff and white, occasionally pyritic, platy chalk. Below 1100' the chalk is essentially similar but becomes locally green or pink. At 11120' branching burrows which have been infilled with pyrite are seen.

Micropalaeontology and Stratigraphical Conclusions

The appearance at 10900' of Stensioina exsculpta and Bolivinoides draco miliaris suggests that the Campanian has been encountered. There are abundant Rugoglobigerina rugosa rugosa and R. rugosa rotundata from 11100' to 11140' and this too is characteristic of the Campanian. However, none of these forms are restricted to the Campanian and therefore a questionable determination is given.

Environmental Conclusions

An outer sublittoral environment is again postulated for this interval on the basis of the faunas and lithologies present. The green and pink chalk may be indicative of proximity to land.

INTERVAL 11215' - 11915'; Campanian - ?Coniacian, Upper Cretaceous

General Lithology

This interval consists predominantly of white, green and pink chalk which is stylolitic, platy, cryptocrystalline and occasionally pyritic.

The chalk is frequently arenaceous below 11600' where it is white, soft and contains grains of buff sand and glauconite. There are partings of brown-black carbonaceous, calcareous shale in the lower half of the interval and also rare beds of pale grey, calcareous shale. At approximately 11600', in association with the sandy white chalk, there are thin developments of dark brown, pyritic, cryptocrystalline limestone.

Micropalaeontology and Stratigraphical Conclusions

The incoming of Globotruncana cf. marginata at 11215' indicates the presence of definite Campanian rocks and the subsequent occurrence of G. maringata and G. cf. linneiana supports this determination. The increase in numbers of Globotruncana spp. below about 11700' is reminiscent of the Coniacian and therefore a Campanian - ?Coniacian age is assigned. There is no evidence for the presence of Santonian sediments, but, since the section is only poorly to moderately fossiliferous it is not possible to be definitive regarding the presence of a possible unconformity.

Environmental Conclusions

The foraminiferal elements and lithologies are essentially similar to those described for the two overlying sections and an outer sublittoral environment is again postulated.

INTERVAL 11920' - 12040'; Coniacian, Upper Cretaceous

General Lithology

The lithologies in this interval are similiar to those previously seen higher in the Upper Cretaceous, and consists of white, green and pink, locally arenaceous, platy, cryptocrystalline chalk. There are thin beds of dark brown, carbonaceous shale throughout the sequence.

Micropalaeontology and Stratigraphical Conclusions

The presence of abundant Globotruncana marginata at 11920' in association with G. linneiana and G. linneiana cf. tricarinata implies that Coniacian sediments have been encountered.

Environmental Conclusions

A similiar environment to that proposed for the overlying interval is envisaged here.

INTERVAL 12045' - 12060'; Albian, Lower Cretaceous

General Lithology

The predominant lithologies recorded in this interval are white, green and pink chalk, but it is probable that they have caved. Associated with the chalk throughout the section is buff, micaceous (muscovite), well indurated, dolomitic shale which is rarely glauconitic and pyritic. There are also thin partings of white to light grey, micaceous, dolomitic or calcareous shale and grey-green, glauconitic, micaceous sandstone.

Micropalaeontology and Stratigraphical Conclusions

Only one of the samples seen in this section yielded Lower Cretaceous foraminifera - at 12060'. However, the top of the unit is drawn according to the lithological evidence, i.e. at the appearance of the buff, dolomitic shale at 12045'. The foraminifera recovered include Lenticulina cf. gaultina, ?Conorboides sp. and Hedbergella planispira. This last form is characteristic of the Albian and therefore that is the age given to the interval. The form termed ?Conorboides sp. may be significant as we have recorded it at similar stratigraphic horizons in this area of the North Sea.

Environmental Conclusions

An outer sublittoral environment is believed to have existed at the

time of deposition of these sediments, and the lithologies indicate that terrigenous material was being brought into the area.

V

JURASSIC

INTERVAL 12065' - 12120'; Upper Jurassic

General Lithology

The appearance of black, calcareous, pyritic, carbonaceous shale at 12065' delineates the top of this interval. This shale is interbedded with brownish black, angular, fine-grained, argillaceous, dolomitic sandstone which grades into silty shale. There are also minor developments of greenish grey, arenaceous shales, in which the angular sand grains are aligned.

Micropalaeontology, Palynology and Stratigraphical Conclusions

No stratigraphically diagnostic palynomorphs, foraminifera or ostracoda were recovered from this interval and the determination is based on the lithological evidence as the black shales and sandstone described above are typical of Upper Jurassic sediments in this region of the North Sea.

Environmental Conclusions

The impoverished microfaunas suggest that sedimentation occurred in deeper waters relative to the overlying intervals and a questionable bathyal environment is assigned.

VI

PERMIAN

INTERVAL 12125' - 13370'; Zechstein, Upper Permian

General Lithology

Above 12500' only caved Jurassic shales and subordinate amounts of gypsum are present in the samples. Salt and anhydrite were recorded in this upper section on the basis of information supplied by the operating company. Salt is first seen at 12510' and the remainder of the interval is composed entirely of light pink and white halite.

Palynology and Stratigraphical Conclusions

No diagnostic palynomorphs were found in this interval. The presence of thick evaporites suggests that the Zechstein has been penetrated.

Environmental Conclusions

Great thicknesses of salt and anhydrite as found in this well were probably deposited in an enclosed sea or lagoon under hot and arid climatic conditions.

VII

CONCLUSIONS

The oldest deposits studied in this well are of Permian age and were probably laid down in an enclosed sea or lagoon. These salts and anhydrites are overlain by Upper Jurassic shales and sandstones and therefore there was an intervening period of non-deposition or deposition and subsequent erosion involving Triassic to Middle Jurassic rocks. The Jurassic seas in which the black shales were deposited were probably of a bathyal nature. A further period of non-deposition/ deposition plus erosion followed, since almost the entire Lower Cretaceous is absent. Sedimentation recommenced in an outer sublittoral environment, where Albian shales were deposited. However, slight uplift again occurred as Cenomanian and Turonian chalk is not represented. The Coniacian to Maestrichtian chalk was also deposited in an outer sublittoral environment with occasional good open marine connections resulting in high numbers of planktonic foraminifera. Similar conditions continued into the basal Tertiary times for the deposition of the Danian Chalk. The seas then become generally deeper for the remainder of Danian times and also during deposition of the Palaeocene and Eocene sediments, these being laid down in an outer sublittoral to bathyal environment. Volcanic activity is indicated in Palaeocene times by the presence of tuffs and tuffaceous shales and a period when good connections to open marine conditions prevailed is suggested at the top of the Palaeocene by the influx of planktonic foraminifera.

BIBLIOGRAPHY

BANDY, O.L.	1967	Cretaceous Planktonic Foraminiferal Zonation. Micropaleontology, Vol. 13, No. 1.
BARTENSTEIN, H. et al.	1962	Leitfossilien der Mikropalaontologie. Gebruder Borntraeger, Berlin.
BARTENSTEIN, H., BETTENSTAEDT, F. & BOLLI, H.M.	1957	Die Foraminiferen der Unterkreide von Trinidad, B.W.I. Ecologae Geol. Helv., Vol. 50, No. 1.
BERGGREN, W.A.	1969	Paleogene biostratigraphy and planktonic Foraminifera of Northern Europe. Proc. 1st Internat. Conf. Planktonic Microfossils. Geneva 1967, Vol. 1.
DAM, A.T.	1944	Die Strat-gliederung des Niederlandischen Palaozans and Eozans nach Foraminifera. Med. Geol. Sticht., Ser. C-V-No. 3.
DÖRING, H., KRUTZSCH, W., MAI, D. & SCHULZ, E.	1966	Erlauterungen zu den sporen stratigraphischen Tabellen von Zechstein bis zum Oligozan. Abh. Zentr. Geol. Inst. Vorabdruck H.8.
HAYNES, J.	1956	Certain smaller British Paleocene Foraminifera. Pt. 1. Cont. Cush. Found. For. Res., Vol. VII, Pt. 3.
HAYNES, J. & WOOD, A.	1957	Certain smaller British Paleocene Foraminifera. Pt. II: Cibicides and its allies. Cont. Cush. Found. For. Res., Vol. VIII, Pt. 2.
HAYNES, J.	1958	Certain smaller British Paleocene Foraminifera. Pt. III: Polymorphinidae. Cont. Cush. Found. For. Res., Vol. IX, Pt. 1.
HAYNES, J.	1958	Certain smaller British Paleocene Foraminifera. Pt. IV: Arenacea, Lagenidea, Buliminidea and Chilostomellidae. Cont. Cush. Found. For. Res., Vol. IX, Pt. 3.

HAYNES, J.	1958	Certain smaller British Paleocene Foraminifera. Pt. V: Distribution. Cont. Cush. Found. For. Res., Vol. IX, Pt. 4.
HOFKER, J.	1966	Maestrichtian, Danian and Paleocene Foraminifera. Palaeontographica, Suppl. 10.
KAASSCHIETER, J.P.H.	1961	Foraminifera of the Eocene of Belgium. Inst. Roy. des Sciences Nat. de Belgique, Mem. No. 147.
KEIZER, J. & LETSCH, W.J.	1963	Geology of the Tertiary of the Netherlands. Verhandelingen, Vol. 2, Pt. 2. (Trans. Jubilee Convention Pt. 2).
SHERLOCK, R.L.	1947	The Permo-Triassic Formations. A World Review.
SORGENFREI, Th. & BUCH, A.	1964	Deep Tests in Denmark 1935-1959. Geol. Surv. of Denmark, III, Series No. 36.
STEJN, J.	1957	Micropalaeontological stratigraphy of the Lower Cretaceous in Central Poland. Instytut Geologiczny. Prace., Tom. XXII.
TROELSEN, J.C.	1957	Some Planktonic Foraminifera of the type Danian and their stratigraphic importance. Studies in Foraminifera U.S. Nat. Mus., Bull. 215.

ROBERTSON RESEARCH LABORATORIES

MICROPALAEONTOLOGICAL ANALYSIS CHART

DATE	ANALYST	LOCATION
13.3.72.	CWH, JMB.	Norwegian North Sea Well 2/4-8X

FOR: Phillips Petroleum Company, Norway.

CHART No. 1. 8775' - 9000'

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

FORAMINIFERA

OTHER FOSSILS

MICROFOSSILS

Ammodiscus incertus
Bathysiphon eocenicus
Cyclammina cf. challinori
Trochammina cf. globigeriniformis
Cribrostomoides sp.
Cyclammina exigua
Sigmoilina tenuis
Sigmoilina schlumbergeri
Hormosina sp.
Recurvoides sp.
Coscinodiscus sp.
Haplophragmoides cf. obliquicameratus
Pelosina sp.
Haplophragmoides carinatum
Glomospira charoides
Cyclammina sp. 2
Cyclammina sp. 1
Gravelina cf. nativaensis

Radiolaria

LITHOLOGY	DEPTH IN FEET	SYSTEM	STAGE	ZONE
P P P P P ⊙	100 200 300 400 500 600 700 800 900 1000	EOCENE / LOWER EOCENE - PALAEOCENE		

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ROBERTSON RESEARCH LABORATORIES

MICROPALAEONTOLOGICAL ANALYSIS CHART

DATE	ANALYST	LOCATION
13.3.72.	CWH, JMB.	Norwegian North Sea Well 2/4-8X

FOR	CHART No 2
Phillips Petroleum Company, Norway	9000' - 10000'

LIMESTONE
DOLOMITE
OOLITIC LIMESTONE
CLAY
SHALE
SILTY/SANDY SHALE
SILTSTONE
SANDSTONE
CONGLOMERATE
GYPSUM
VOLCANICS
INTRUSIVES
SALT
COAL/Lignite
CHERT
Pyrite
Sphaerosiderite
Glauconite
Buff chalk
LCM Lost circulation material
Sandy buff chalk
* Reworked Upper Cretaceous forms

LITHOLOGY | DEPTH IN FEET | SYSTEM | STAGE | ZONE

100
200
300
400
500
600
700
800
900
1000

PALAEOCENE - LOWER EOCENE
PALAEOCENE
?LOWER PALAEOCENE
LOWER PALAEOCENE
?DANIAN
DANIAN

FORAMINIFERA | OTHER FOSSILS

MICROFOSSILS

Glomospira charoides
Bathysiphon eocenicus
Cyclammina sp. 2
Cyclammina exigua
Hormosina sp.
Ammodiscus incertus
Pelosina sp.
Trochammina cf. globigeriniformis
Recurvoides sp.
Gravelina cf. nariyaensis
Cribrostomoides sp.
Haplophragmoides cf. obliquicameratus
Cyclammina cf. challinori
Trochammina sp.
Cyclammina cf. incisa
Cyclammina sp. 1
Sigmoilina tenuis
Verneuilina subeocaena
Spiroplectammina spectabilis
Coscinodiscus sp.
Globigerina triloculinoides
Globigerina inaequispira
Haplophragmoides carinatum
Coscinodiscus sp. 1
Coscinodiscus sp. 2
Globigerina cf. pseudobulloides
Bulimina midwayensis
Lamarckina paleocenica
Robulus cf. turbinatus
Pullenia americana
Globigerina pseudobulloides
Globorotalia compressa
Dorothia bulletta
Osangularia lens
Gavelinella cf. danica
Cyroidinoides subangulata
Globorotalia aff. pusilla
Pseudotextularia elegans fructicosa *
Heterohelix globulosa *
Globigerinelloides aspera *
Bulimina versa
Bulimina trigonalis
Gavelinonion nobilis
Guttulina problema
Globigerina daubjergensis
Allomorphina paleocenica
Anomalinoides velascoensis
?Rugoglobigerina rugosa rotundata *
Cibicides bosqueti
Globigerina danica
Bolivinoides aff. delicatulus
Marginulina jarvis

Radiolaria

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MICROPALAEONTOLOGICAL ANALYSIS CHART

DATE	ANALYST	LOCATION
15.3.72.	CWH, JMB.	Norwegian North Sea Well 2/4-8X

FOR: Phillips Petroleum Company, Norway.

CHART No. 3. 10000' - 11000'

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

SILTSTONE · SANDSTONE · CONGLOMERATE · GYPSUM · VOLCANICS · INTRUSIVES

SALT · COAL · CHERT · White and buff chalk · Pyrite

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

FORAMINIFERA

Globigerina trilocul inoides
Marginulina jarvisi
Osangularia lens
Gavelinella bullata
Globigerina pseudobulloides
Dorothia bulletta
Globigerina danica
Lamarckina paleocenica
Globorotalia compressa
Pseudotextularia elegans fructicosa
Globotruncana contusa
Bolivinoides draco draco
Rugoglobigerina rugosa rugosa
Pseudotextularia elegans elegans
Rugoglobigerina rugosa rotundata
Bolivinoides delicatulus
Pullenia cretacea
Stensioina pommerana
Heterohelix globulosa
Bolivina incrassata incrassata
Praebulimina carseyae
Globigerinelloides aspera
Gyroidinoides nitida
Lenticulina pseudovalis
Anomalinoides velascoensis
Bolivina incrassata gigantea
Gavelinella vombensis
Globotruncana arca
Arenobulimina chapmani
Gavelinopsis cf. voltziana
Biglobigerinella multispina
Dorothia sp.
Reussella szajnochae szajnochae
Ataxophragmium trochoides
Lenticulina pseudovortex
Stensioina exsculpta
Bolivinoides draco miliaris
Globotruncana sp.

DEPTH IN FEET	SYSTEM	STAGE	ZONE
100	LOWER PALAEOCENE	DANIAN	
200			
300			
400	UPPER CRETACEOUS	MAESTRICHTIAN	
500			
600			
700			
800			
900		?CAMPANIAN	
1000			

Med 239

ROBERTSON RESEARCH LABORATORIES

MICROPALAEONTOLOGICAL ANALYSIS CHART

DATE	ANALYST	LOCATION
17.3.72	JMB.	Norwegian North Sea Well 2/4-8X

FOR: Phillips Petroleum Company, Norway

CHART No 4: 11000' - 12000'

LIMESTONE
DOLOMITE
OOLITIC LIMESTONE
CLAY
SHALE
SILTY/SANDY SHALE
SILTSTONE
SANDSTONE
CONGLOMERATE
GYPSUM
VOLCANICS
INTRUSIVES
SALT
COAL
CHERT
White, green and grey chalk
Pink chalk
Sandy white chalk

G Glauconite

LCM Lost circulation material

FORAMINIFERA

MICROFOSSILS

- Gavelinella vombensis
- Gyroidinoides nitida
- Rugoglobigerina rugosa rugosa
- Rugoglobigerina rugosa rotundata
- Praebulimina carseyae
- Stensioina pommerana
- Globotruncana cf. marginata
- Globotruncana formicata
- Globigerinelloides aspera
- Globotruncana cf. linneiana
- Dorothia sp.
- Globotruncana marginata
- Tritaxia dubia
- Ataxophragmium trochoides
- Marssonella cf. oxycona
- Armodiscus sp.
- Haplophragmoides sp.
- Heterohelix globulosa
- Marssonella cf. trochus
- Gaudryina sp. 1
- Globotruncana sp. 1
- Lenticulina pseudovalis
- Arenobulimina chapmani
- Hedbergella delrioensis
- Globotruncana linneiana
- Globotruncana linneiana cf. tricarinata
- Gaudryina sp. 2

LITHOLOGY | DEPTH IN FEET | SYSTEM | STAGE | ZONE

100
200
300
400
500
600
700
800
900
1000

L C M G G

UPPER CRETACEOUS

?CAMPANIAN

?CONIACIAN - CAMPANIAN

CONIACIAN

Med 239

ROBERTSON RESEARCH LABORATORIES

MICROPALAEONTOLOGICAL ANALYSIS CHART

DATE	ANALYST	LOCATION
22.3.72.	CWH, JMB, ACK, JWC.	Norwegian North Sea Well 2/4-8X

FOR: Phillips Petroleum Company, Norway

CHART No. 5: 12000' - 13000'

LIMESTONE
DOLOMITE
OOLITIC LIMESTONE
CLAY
SHALE
SILTY/SANDY SHALE
SILTSTONE
SANDSTONE
CONGLOMERATE
GYPSUM/Anhydrite
VOLCANICS
INTRUSIVES
SALT
COAL
CHERT
White and green chalk
Pink chalk
Glauconite
Dolomitic shale
Pyrite

LITHOLOGY | DEPTH IN FEET | SYSTEM | STAGE | ZONE

SYSTEM	STAGE	ZONE
UPPER CRETACEOUS	CONIACIAN	
L. CRETACEOUS	ALBIAN	
UPPER JURASSIC		
UPPER PERMIAN		
ZECHSTEIN		

MICROFOSSILS

FORAMINIFERA

- Marssonella cf. oxycona
- Tritaxia dubia
- Gaudryina sp. 1
- Heterohelix globulosa
- Rugoglobigerina rugosa rugosa
- Gyroidinoides nitida
- Globotruncana linneiana linneiana
- Haplophragmoides spp.
- Ammodiscus sp.
- Stensioina pommerana
- Lenticulina cf. gaultina
- Hedbergella planispira
- Globigerinelloides aspera
- ?Conorboides sp.
- Spiroplectinata sp.
- Saracenaria sp.
- Glomospira sp.
- Trochammina sp.
- Textularia sp.
- ?Globigerinelloides sp.
- Epistomina sp.

OTHER FOSSILS

- Dictyomitra sp.

ROBERTSON RESEARCH LABORATORIES

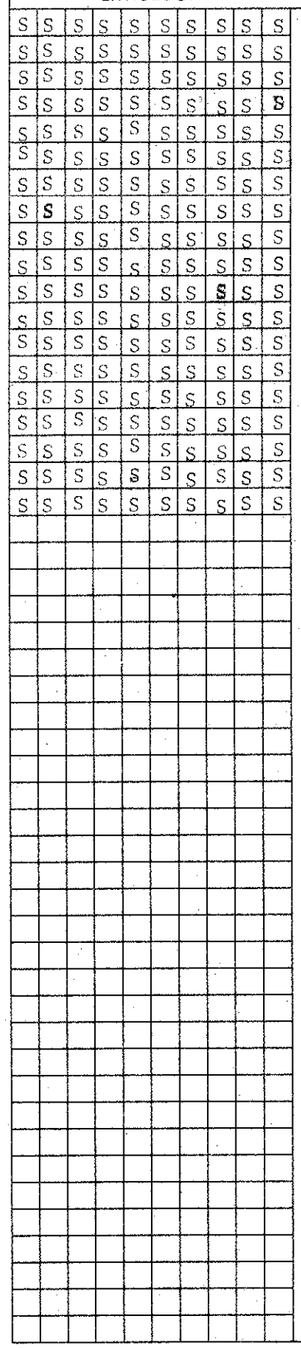
MICROPALAEONTOLOGICAL ANALYSIS CHART

DATE	ANALYST	LOCATION
27.3.72.	ACK.	Norwegian North Sea Well 8/1-1X

FOR	CHART No. 6.
Phillips Petroleum Company, Norway.	13000' - 13370'

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 | MICROFOSSILS



100
200
300
400
500
600
700
800
900
1000

UPPER PERMIAN

ZECHSTEIN

GENERALISED LITHOLOGY

SYSTEM: PERMIAN | JURASSIC | CRETACEOUS | PALAEOCENE | EOCENE PALAEOCENE

SUB-SYSTEM: UPPER PERMIAN | UPPER JURASSIC | L. CRET. | UPPER CRETACEOUS | LOWER PALAEOCENE | ?LOWER PALAEOC. | PALAEOCENE – LOWER EOCENE

STAGE: ZECHSTEIN | ALBIAN | CONIACIAN | ? CONIACIAN – CAMPANIAN | ?CAMPANIAN | MAESTRICHTIAN | DANIAN | ? DANIAN

ENVIRONMENT OF DEPOSITION: CONTINENTAL | DELTAIC/BRACKISH/LAGOONAL | LITTORAL | INNER SUBLITTORAL | OUTER SUBLITTORAL | BATHYAL

OSTRACODA

12200 12000 11800 11600 11400 11200 11000 10800 10600 10400 10200 10000 9800 9600 9400 9200 9000 8800 8600

FORAMINIFERA

- *Ammodiscus incertus*
- *Bathysiphon eocenicus*
- *Cyclammina cf. challinori*
- *Trochammina cf. globigeriniformis*
- *Haplophragmoides cf. obliquicameratus*
- *Glomospira charoides*
- *Cyclammina sp. 2*
- *Cyclammina sp. 1*
- *Cyclammina cf. incisa*
- *Verneuilina subeocaena*
- *Spiroplectammina spectabilis*
- *Globigerina triloculinoides*
- *Globigerina inaequispira*
- *Globigerina cf. pseudobulloides*
- *Bulimina midwayensis*
- *Lamarkina paleocenica*
- *Globigerina pseudobulloides*
- *Globorotalia compressa*
- *Dorothia bulletta*
- *Osangularia lens*
- *Gavelinella cf. danica*
- *Gyroidinoides subangulata*
- *Gavelinopsis nobilis*
- *Globigerina daubjergensis*
- *Allomorphina paleocenica*
- *Anomalinoides velascoensis*
- *Globigerina danica*
- *Pseudotextularia elegans fructicosa*
- *Globotruncana contusa*
- *Bolivinoides draco draco*
- *Rugoglobigerina rugosa rugosa*
- *Pseudotextularia elegans elegans*
- *Rugoglobigerina rugosa rotundata*
- *Stensioina pommerana*
- *Bolivina incrassata incrassata*
- *Bolivina incrassata gigantea*
- *Globotruncana arca*
- *Biglobigerinella multispina*
- *Stensioina exculpta*
- *Bolivinoides draco milianis*
- *Globotruncana cf. marginata*
- *Globotruncana fornicata*
- *Globotruncana cf. linneiana*
- *Globotruncana marginata*
- *Tritaxia dubia*
- *Hedbergella delrioensis*
- *Globotruncana linneiana*
- *Globotruncana linneiana cf. tricarinata*
- *Globotruncana linneiana linneiana*
- *Lenticulina cf. gaultina*
- *Hedbergella planispira*
- *? Conorboides sp.*
- *Glomospira sp.*

BIOSTRATIGRAPHIC CHART SHOWING THE DISTRIBUTION OF THE DIAGNOSTIC TERTIARY AND MESOZOIC FORAMINIFERA FROM THE INTERVAL 8775' – 12200' IN THE PHILLIPS 2/4-8X NORWEGIAN NORTH SEA WELL

SHEET 1 OF 1

by
ROBERTSON RESEARCH INTERNATIONAL
'Ty'n-y-Coed', Llanrhos, Llandudno.

For key to lithology symbols see Micropalaeontological Analysis Chart

Drawing No: 1713

Date 12:4:72