

ROBERTSON RESEARCH COMPANY LIMITED

OILFIELDS REPORT NO. 397

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

by

J. W. CHURCH

M. DEMPSEY

C. W. HASKINS

R. V. HUGHES

Project No. ARP 701/2485

Prepared for:

Phillips Petroleum Company Norway,
Portland House,
Stag Place,
LONDON S.W.1.

October, 1970.

C O N T E N T S

	<u>Page No.</u>
I INTRODUCTION	1
II SUCCESSION	2
III MATERIALS AND METHODS	3
IV TERTIARY	4
V TERTIARY - CRETACEOUS	13
VI CRETACEOUS	14
VII BIBLIOGRAPHY	15

Enclosures

Micropalaeontological Analysis Charts Nos. 1 - 9.

Biostratigraphic Chart showing the distribution of the diagnostic Tertiary and Cretaceous Foraminifera in the Phillips (Norway) 2/4-4X North Sea Well.

INTRODUCTION

This report summarises the results of the micropalaeontological and stratigraphical analyses which have been carried out under Project No. ARP 701/2485 on material received from the interval 2280' - 10893' of the Phillips (Norway) 2/4-4X North Sea Well.

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

A thick Tertiary sequence overlies Chalk of Danian and Upper Cretaceous age, the well reaching T.D. in Maestrichtian Chalk.

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 succession penetrated follows on page 2, overleaf.

II

SUCCESSION

TABLE I

<u>Unit</u>	<u>Interval</u>	<u>Thickness</u>	<u>Stage</u>	<u>System/Subsystem</u>
A	2280' - 2550'	+ 270'	Upper Diestian	Lower Pliocene
B	2610' - 2940'	+ 330'	Lower Diestian	Upper Miocene
C	2970' - 5260'	+ 2290'	-	Middle Miocene
D	5280' - 5460'	+ 180'	Burdigalian) Lower Miocene
E	5470' - 5790'	+ 320'	Aquitanian	
F	5810' - 6220'	+ 410'	-	?Oligocene
G	6260' - 7920'	+ 1660'	-	Oligocene
H	7960' - 8830'	+ 870'	-	Upper - Middle Eocene
I	8900' - 9540'	+ 640'	-	Lower Eocene - Palaeocene
J	9570' - 9690'	+ 120'	-	Palaeocene
K	9730' - 9920'	+ 190'	?Danian	?Lower Palaeocene
L	9940' - 10374'	+ 434'	Danian	Lower Palaeocene
M	10380' - 10420'	+ 40'	?Danian - ?Maestrichtian	?Lower Palaeocene - ?Upper Cretaceous
N	10424' - 10893'	+ 469'	Maestrichtian	Upper Cretaceous

III

MATERIALS AND METHODS

Under Project No. ARP 701/2485 a total of 293 ditch cuttings samples, together with 42 core pieces and 12 side-wall cores, were analysed using standard micropalaeontological techniques.

A summary of the information obtained from these samples was forwarded in a series of telex and telephone communications. These 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. The methods of treating and assessing the age of the samples are similar to those mentioned in earlier Oilfields Reports.

(a) Pliocene

UNIT A, INTERVAL 2280' - 2550'; Upper Diestian, Lower Pliocene

General Lithology

The samples from the upper part of this unit, between 2280' and 2430', are contaminated by cement but they appear to consist of grey, lignitic, locally pyritic and shaly clays and greenish-grey, fine to medium-grained, angular, quartz sands. The clays and sands continue to the base of the interval. Trace amounts of lamellibranch shell fragments occur in the samples below 2430'.

Micropalaeontology and Stratigraphical Conclusions

The upper part of this interval, between 2280' and 2430', is characterised by good faunas consisting predominantly of specimens of the genera Cassidulina, Nonion and Elphidium, with Cibicides spp. as a common component. Below 2430', the faunas become impoverished, although the same species occur as in the upper part. An Upper Diestian, Lower Pliocene age is suggested for the interval by the occurrence of Bulimina elongata var. subulata, Cibicides lobatulus var. grossa and Bulimina elongata var. tenera within the unit. Specimens of reworked older Tertiary foraminifera are recorded at 2280'.

(b) Miocene

UNIT B, INTERVAL 2610' - 2940'; Lower Diestian, Upper Miocene

General Lithology

with subordinate amounts of greenish-grey sands. The sands are generally made up of fine to medium-grained, angular to subrounded grains but in the lowermost sample at 2940' a few coarse, rounded grains also occur. Minor quantities of grey, calcareous shale are present below 2850'. Lamellibranch and gastropod shell fragments are commonly found within the clays.

Micropalaeontology and Stratigraphical Conclusions

The incoming of a new assemblage, which includes Globigerina bulloides, Rotalia beccarii var. and Bolivina aff. beyrichi, at the top of this interval indicates that sediments of Lower Diestian, Upper Miocene age have been encountered. Globigerina praebulloides praebulloides is first recorded at 2670' and adds support to the above determination. Species of the genus Bulimina form the main constituents of the fauna, although Cassidulina spp., Nonion spp. and Elphidium spp. are also moderately common throughout the interval.

UNIT C, INTERVAL 2970' - 5260'; Middle Miocene

General Lithology

This interval is made up dominantly of soft, pyritic and slightly sandy clays. Varied amounts of brown to brownish-grey, micaceous, locally pyritic and silty shales are associated with the clays below 4310'. Buff to dark brown, cryptocrystalline dolomite and dolomitic limestone occurs locally in minor quantities between 3660' and 5140'. Thin beds of greenish-grey, cryptocrystalline limestone are present between 3150' and 3240' and also from 5220' to the base of the interval. Trace amounts of lamellibranch shell fragments are present in the samples above 3270'.

Micropalaeontology and Stratigraphical Conclusions

A Middle Miocene age determination has been awarded to this interval

on the basis of the included microfauna, it has been possible to further sub-divide the section in the following way:-

INTERVAL 2970' - 3630'

The appearance of Globigerina cf. angustum, Cancris auriculus and Globigerina cf. venezuelana at 2970', followed by Siphotextularia labiata and Loxostomum sinuosum later in the unit, suggests that Middle Miocene rocks are present here. The interval is characterised by rich faunas, Uvigerina asperula being common throughout the interval. Uvigerina hosi first appears at 3300' and occurs in small numbers throughout the remainder of the unit.

INTERVAL 3660' - 4580'

This interval is characterised by the presence of Uvigerina hosi, which is common down to 4030', but relatively rare below this depth. Several oil-stained fossils and rock fragments were noted at 4300' and in several samples below this depth. The faunas become impoverished toward the base of the interval.

INTERVAL 4600' - 5180'

Poor faunas characterise this interval, particularly in the upper part, arenaceous foraminifera are the most common types found in the section. For example, Glomospira charoides, which is first recorded at 4860', occurs in relatively large numbers in the sample from 4900'. The last few samples of the interval show an increase in numbers of arenaceous foraminifera.

INTERVAL 5200' - 5260'

The incoming of radiolaria, together with large numbers of small, well-preserved, planktonic foraminifera at 5200', distinguish this final interval of the Middle Miocene.

Aquitanian marker-fossils Globigerinoides bisphericus and Globorotalia aff. scitula praescitula. Accordingly, an Aquitanian, Lower Miocene age is proposed for this unit. Planktonic foraminifera dominate the moderate faunas of the interval, with Globorotalia spp. being fairly common down to 5570'. At 5590', and below, Globigerinoides spp. are the dominant planktonic species. Small radiolaria are common throughout the interval.

(c) Oligocene

UNIT F, INTERVAL 5810' - 6220'; ?Oligocene

General Lithology

This interval is made up of brown and greenish-grey, shales and clays together with some brown and green, cryptocrystalline dolomite and dolomitic limestone. Moderate amounts of soft, white limestone are also present in the sample at 5890'.

Micropalaentology and Stratigraphical Conclusions

Although Lower Miocene faunas continue to occur in this interval, several forms appear which may indicate that Oligocene deposits have been penetrated. At 5810', Globigerina cf. ouachitaensis ciperensis is first recorded with Globigerina cf. ouachitaensis gnaucki occurring at 5830'.

Because of the conflicting evidence an age determination of ?Oligocene is proposed for this interval.

UNIT G, INTERVAL 6260' - 7920'; Oligocene

General Lithology

This unit is composed dominantly of dark brown and brownish-grey, locally pyritic shales and clays with a few thin beds of buff to tan, in part black, pyritic, cryptocrystalline dolomite and dolomitic limestone. Varied amounts of soft, white limestone are also present in the samples

UNIT D, INTERVAL 5280' - 5460'; Burdigalian, Lower Miocene

General Lithology

The uppermost part of this unit, i.e. 5280' - 5340', is composed of light greenish-grey, micaceous, slightly pyritic shales and clays together with thin developments of greenish-grey, cryptocrystalline limestone and dark brown dolomite. The underlying section, i.e. 5380' - 5400', consists predominantly of soft clays with very rare, thin limestone beds. Fish teeth are locally recorded in the shales. The samples from the basal section, i.e. 5430' - 5460', although contaminated by cement, appear to consist essentially of light grey, slightly micaceous and calcareous shales.

Micropalaeontology and Stratigraphical Conclusions

The appearance of Globorotalia scitula scitula and Uvigerina tenuipustulata at 5280' indicates that the sediments of this unit are of Burdigalian, Lower Miocene age. Between 5280' and 5340' only poor faunas are recorded; at 5380', however, there is a marked increase in fauna with Angulogerina gracilis var. tenuistriata and Siphonina sp. first occurring. Good faunas continue down to the bottom of the interval.

UNIT E, INTERVAL 5470' - 5790'; Aquitanian, Lower Miocene

General Lithology

The upper part of this unit, i.e. 5470' - 5570', is similar in lithology to the overlying beds and consists of light grey shales together with subordinate amounts of light green dolomite and dolomitic limestone.

The underlying beds, i.e. 5590' - 5790', consists of brown and light greenish-grey, micaceous shales together with brown dolomite at 5590' and green, slightly pyritic dolomite between 5650' and 5670'.

Micropalaeontology and Stratigraphical Conclusions

A new assemblage is noted at 5470' which includes the characteristic

Micropalaeontology and Stratigraphical Conclusions

Definite Oligocene deposits occur at 6260' as indicated by the incoming of Asterigerina gürichi. Planktonic foraminifera are common in the top sample of the unit, but arenaceous forms soon increase in numbers and become the dominant element of the assemblages. ?Rotaliatina sp. is noted at 6450' as a single occurrence, although Rotaliatina bulimoides can be recognised at 7110' and may suggest that Middle Oligocene sediments occur around this depth. Moderate arenaceous faunas characterise the interval. Reworked Older Tertiary and Upper Cretaceous foraminifera are recorded within the unit.

(d) Eocene

UNIT H, INTERVAL 7960' - 8830'; Upper - Middle Eocene

General Lithology

This interval consists essentially of dark brown and brownish-grey, slightly pyritic clays and shales associated with minor amounts of buff, slightly argillaceous limestone. Some buff to tan, cryptocrystalline dolomite is present in the uppermost sample at 7960' and also between 8370' and 8410'.

Micropalaeontology and Stratigraphical Conclusions

At 7960', specimens of Trochammina globigeriniformis and Globorotalia aff. centralis are first noted, suggesting that Eocene deposits have been encountered. This determination is confirmed by the later appearance at 8000' of Truncorotaloides pseudodubia, Bathysiphon eocenicus and Vertebralina laevigata. The assemblage, as a whole, suggests an Upper - Middle Eocene age for the unit.

(e) Eocene - Palaeocene

UNIT I, INTERVAL 8900' - 9540'; Lower Eocene - Palaeocene

General Lithology

This interval is made up of dark brown and brownish-grey shales and clays together with some dark brown, locally pyritic, cryptocrystalline to finely sucrosic dolomite. Sphaerosiderite, locally in a green, marly matrix, is common throughout the unit.

Micropalaeontology and Stratigraphical Conclusions

Large, green-stained radiolaria are first recorded at 8900', these fossils are normally taken to indicate sediments of Lower Eocene - Palaeocene age. The occurrence of Haplophragmoides cf. obliquicameratus in the same sample supports this age determination for the unit. Good, green-stained, arenaceous faunas dominate the interval. Several reworked Danian fossils are noted in the sample at 9260'.

(f) Palaeocene

UNIT J, INTERVAL 9570' - 9690'; Palaeocene

General Lithology

This unit is composed essentially of pale grey, locally pyritic shales with some brown, cryptocrystalline, locally sphaerosideritic dolomite. Thin beds of white to light grey, fine-grained, calcareous and glauconitic sandstone occur within the shales at 9620' and 9690'.

Micropalaeontology and Stratigraphical Conclusions

Several green-stained specimens of Globigerina triloculinoides appear at the top of the interval suggesting that Palaeocene deposits have been encountered. Rather poor, predominantly arenaceous faunas characterise this

UNIT K, INTERVAL 9730' - 9920'; ?Danian, ?Lower Palaeocene

General Lithology

The uppermost sample from this interval, at 9730', consists of light grey shales which contain laminae of fine-grained, glauconitic sandstone. Traces of buff chalk and light grey flint are also found.

The underlying section (9750' - 9920') is made up dominantly of pale grey to greenish-grey and reddish-brown shales with green mottling. The shales are generally pyritic and contain thin sandstone laminae similar to those at the top of the interval. Varied amounts of brown, finely sucrosic to sphaerosideritic dolomite are found in association with the shales.

Micropalaeontology and Stratigraphical Conclusions

At the top of this interval, a fauna characteristic of the Danian stage of the Palaeocene is encountered. The new fauna includes Allomorphina halli, Globorotalia compressa, Globigerina pseudobulloides and Osangularia lens. However, in the following samples, no further evidence for a Danian age can be found; it is not until 9920' that some of the above forms, together with further Danian fossils - such as Gavelinonion nobilis and Lamarckina paleocenica - reappear. As reworked Upper Cretaceous fossils are also present at 9730', it is not impossible that all the new fauna noted at this level is reworked. Therefore, we prefer to give a determination of ?Danian to this section.

UNIT L, INTERVAL 9940' - 10374'; Danian, Lower Palaeocene

General Lithology

The topmost sample of this unit, at 9940', is lithologically similar to the interval above and consists of pale grey to greenish-grey and reddish-brown, pyritic shales with traces of brown dolomite and light grey, fine-grained sandstone. Buff chalk with stylolites first appears in the

sample at 9960' and is the dominant rock throughout the remainder of the interval. The samples through this section include cuttings, core pieces and side-wall cores. Varied amounts of white and light grey flint are found in association with the chalk. Some light grey, green and reddish-brown, calcareous shales occur locally as laminae within the chalk.

Micropalaeontology and Stratigraphical Conclusions

At 9940', Danian planktonic foraminifera, particularly Globorotalia compressa, return in large numbers; they are all brown-stained specimens. In the following sample, at 9960', buff-coloured and white Danian fossils are present, confirming a Danian age for this interval. A side-wall core was examined from 10374' and contains a specimen of Globigerina triloculinoides, indicating that the chalk at this depth is still Danian in age.

TERTIARY - CRETACEOUSUNIT M, INTERVAL 10382' - 10420'; ?Danian - Maestrichtian, ?Lower Palaeocene -Upper CretaceousGeneral Lithology

This interval consists of pale buff chalk with traces of white flint.

Micropalaeontology and Stratigraphical Conclusions

A flood of Upper Cretaceous foraminifera occurs in the ditch cuttings sample at 10380', including Bolivinoides draco draco, Globotruncana contusa, Pseudotextularia elegans elegans, Pseudotextularia elegans fructicosa and Bolivina incrassata incrassata. In the same sample, several Danian planktonics are recorded but may have caved from the above section. However, a side-wall core taken at 10382' also contains possible Danian planktonics and, in this case, caving would be less likely to occur. As it is possible for the Upper Cretaceous fossils at 10380' to be reworked, this short interval must be given a questionable Danian - Maestrichtian age determination.

CRETACEOUSUNIT N, INTERVAL 10424' - 10893'; Maestrichtian, Upper CretaceousGeneral Lithology

This unit is composed of white to pale buff chalk. The core samples between 10468' and 10608' display widespread subvertical fracturing. Minor quantities of white flint are present at 10670'.

Micropalaeontology and Stratigraphical Conclusions

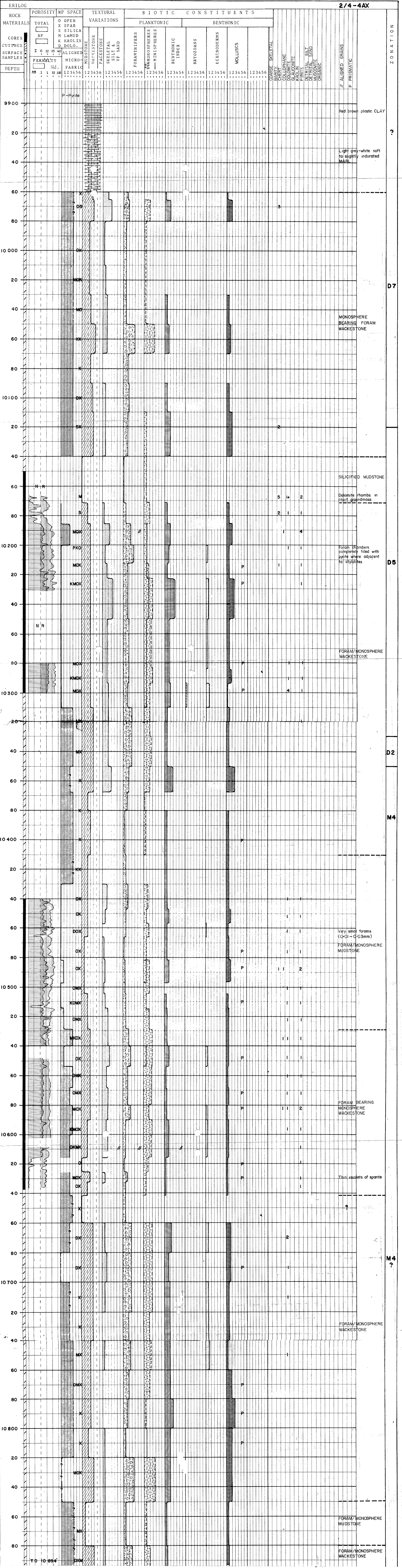
The side-wall core taken at 10424' contains many well-preserved, white-stained specimens of Pseudotextularia elegans elegans, Pseudotextularia elegans fructicosa, Stensioina pommerana and Bolivinoidea draco draco which are taken to indicate chalk of definite Maestrichtian age. At 10440', and below, poor faunas are encountered until, at 10657' there is an increase in fauna, when Hedbergella sp. is fairly common. The side-wall core at 10673' contains numerous specimens of Rugoglobigerina rugosa rugosa and also the first recorded specimens of Rugoglobigerina rugosa rotundata, which may suggest that Lower Maestrichtian deposits are present.

BIBLIOGRAPHY

- BANDY, O.L. 1967 Cretaceous Planktonic Foraminiferal Zonation. *Micropaleontology*, Vol. 13, No. 1.
- BARR, F.T. 1962 Upper Cretaceous planktonic Foraminifera from the Isle of Wight, England. *Palaeontology*, Vol. 4, Pt. 4.
- BARTENSTEIN, H. et. al. 1962 Leitfossilien der Mikropaläontologie Gebrüder Borntraeger, Berlin.
- BATJES, D.A.J. 1958 Foraminifera of the Oligocene of Belgium. *Inst. Roy. des Sciences Nat. de Belgique*, Mem. No. 143.
- BERGGREN, W.A. 1967 Paleogene Biostratigraphy and Planktonic Foraminifera of Northern Europe. *Proc. First Inter. Conf. Plank. Micro.* Vol. 1.
- BOLLI, H.M. et. al. 1957 Studies in Foraminifera. *U.S. Nat. Mus. Bull.* 215.
- CHATWIN, C.P. 1961 East Anglia and adjoining areas. *Handbook of British Regional Geology*.
- DAM, A.T. 1944 Die Strat-gliederung des Niederländischen Paläozäns und Eozäns nach Foraminifera. *Med. Geol. Sticht. Ser. C-V-No.* 3.
- DAM, A.T. & REINHOLD, Th. 1941 Die Stratigraphische Gliederung des Niederländischen Pliopleistozäns nach Foraminiferen. *Med. Geol. Sticht. Ser. C-V-No.* 1.
- DAM, A.T. & REINHOLD, Th. 1942 Die Stratigraphische Gliederung des Niederländischen Oligo-Miozäns nach Foraminifera. *Med. Geol. Sticht. Ser. C-V-No.* 2.

- GROSSHEIDE, K. & TRUNKO, L. 1965 Die Foraminiferen des Doberges bei Bunde und von Astrup. Beih. Geol. Jb., Vol. 60.
- HAYNES, J. 1956 Certain smaller British Paleocene Foraminifera. Pt. I. 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. 1957 Foraminiferen der Oberkreide von Nordwestdeutschland und Holland. Geol. Jahrb. Beih. No. 27.
- 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)
- SORGENFREI, Th. & BUCH, A. 1964 Deep Tests in Denmark 1935-1959. Geol. Surv., of Denmark, III Series No. 36.

- TROELSEN, J.C. 1957 Some Planktonic Foraminifera of the type Danian and their stratigraphic importance. Studies in Foraminifera. U.S. Nat. Mus. Bull. 215.
- VOORTHUYSEN, J.H. van 1950 The quantitative distribution of the Plio-Pleistocene Foraminifera of a boring at the Hague (Netherlands). Med. Geol. Stricht. N.S.4.
- VOORTHUYSEN, J.H. van 1950 The quantitative distribution of the Pleistocene, Pliocene and Miocene Foraminifera of boring Zaandam (Netherlands). Med. Geol. Stricht. N.S. 4.
- VOORTHUYSEN, J.H. van 1950 La distribution verticale quantitative des foraminifères du Diestien, du Scaldisien et du Poederlien au Kruisschans, près d'Anvers. Bull. de la Soc. Belge de Géol.



ZONATION

D7

D5

D2

M4

M4?

ERILOG

ROCK MATERIALS

CORES

CUTTINGS

SURFACE SAMPLES

DEPTH

DEPTH	TOTAL	OPEN SPAR	STILICA	LBMUD	KAOLIN	DOLD.	TEXTURAL VARIATIONS		BIOTIC CONSTITUENTS						
							MUDSTONE	WACKESTONE	PLANKTONIC			BENTHONIC			
	BP								FORAMINIFERS	MONOSPHERES	MINISPHERES	BENTHONIC INDEX	BRYZOANS	ECHINODERMS	MOLLUSCS
9900															
10000															
10100															
10200															
10300															
10400															
10500															
10600															
10700															
10800															

T D 10-894