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STRATIGRAPHICAL AND PALEONTOLOGICAL CONSULTANTS.

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Client Company	<u>PHILLIPS PETROLEUM COMPANY, NORWAY.</u>
Title	<u>WELL 2/4-7X</u> <u>(INTERVAL 10,410' - 11,440')</u> <u>STRATIGRAPHICAL/PALAEONTOLOGICAL FINAL REPORT</u>
Project No.	766.
Stratigraphers	<u>H.W. BAILEY.</u> <u>L.O. ALLEN.</u> Directors: Dr. V. L. Roveda, Dr. D. D. Bayliss.
Date	February, 1981.

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ENCLOSURE 1. Stratigraphic Log,
Scale 1:500.



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1. INTRODUCTION.

The data presented in this report result from the study of samples from the Well 2/4-7X, drilled in the Norwegian sector of the North Sea. This study was carried out at the request of Phillips Petroleum Company, Norway.

Core chips collected at approximately 10' intervals were received from 10,410' to 10,955', including a major sample gap from 10,830' to 10,880' and several minor gaps between 10,880' and 10,955'. There was a further sample gap between 10,955' and 10,990'. Between 10,990' and 11,440' ditch samples were received at 10' intervals. Three ditch samples were also received from the interval 10,610'-10,660', which was not originally cored. Sample depths are plotted at the base of the interval represented by the sample and the ranges of fossils are indicated accordingly on the Stratigraphic Log (Enclosure 1), e.g. fossils in the sample labelled 11,400' are plotted from 11,390' to 11,400'. Since the core samples were extremely hard twenty six thin sections were cut in order to examine the microfauna.

A total of 13 core samples were examined palynologically through the interval 10,415' to 10,812'.

The core samples were too hard to yield nannoplankton, however 12 ditch samples were examined for nannoflora from the interval 10,990' to 11,440'; two additional ditch samples were analysed at 10,620' and 10,660'. This work was carried out by Dr. K. Perch-Nielsen. Nannofossil names in this report and on the stratigraphic log are recorded in italic print to distinguish them from other microfossils.

A figure illustrating the environmental terminology used in this report (after Hedgpeth, 1957) is enclosed at the end of the text.



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2. CONCLUSIONS.

1. The highest sample received (10,410') was a chalky limestone dated as Early Paleocene (Danian) on the evidence of the poorly preserved microfauna.
2. Early Paleocene (Danian) chalk/limestone of the Ekofisk Formation is present from 10,410' to 10,820'. Deposition took place in an outer sublittoral, carbonate rich sea with open oceanic circulation. Reworking of older (Late Cretaceous) material is also evident.
3. The chalk sequence is extremely hard as a result of compactional diagenesis, causing poor microfossil preservation throughout.
4. The chalk of the Tor Formation (10,820'-11,200') can be divided into the Gorm and Skjold Members, recognised elsewhere in the southern Norwegian offshore and offshore Denmark. From 11,200' to 11,440' (T.D.) the chalk is believed to represent the Hod Formation.
5. Late Cretaceous (Late Maastrichtian) foraminiferids and nannoplankton are present in the core chips and ditch samples from 10,820'-11,020'.
6. The Late Cretaceous (Maastrichtian-Late Campanian) sequence (10,820'-11,440') contains a poorly preserved microfauna and nannoflora because of the hardness of the chalk. Deposition was in an open marine, outer sublittoral, carbonate rich, shelf sea, affected by oceanic circulation.



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3. STRATIGRAPHIC SUMMARY.

3.1 Biostratigraphy:

<u>Interval</u>	<u>Age</u>	<u>Thickness</u>
10,410' - 10,820'	Early Paleocene (Danian)	410'
10,820' - 11,020'	Late Cretaceous (Late Maastrichtian)	200'
11,020' - 11,090'	" " (?Late-Early Maastrichtian)	70'
11,090' - 11,440'	" " (Early Maastrichtian - Late Campanian)	350'

3.2 Lithostratigraphy:

The lithostratigraphic units used are those defined by Deegan and Scull (1977). The Tor Formation has been emended by Svendsen (1979) and the members defined by him are recognised here.

<u>Interval</u>	<u>Age</u>	<u>Thickness</u>
10,410' - 10,820'	Chalk Group (Ekofisk Formation)	410'
10,820' - 11,090'	" " (Tor Formation; Gorm Member)	270'
11,090' - 11,200'	" " (Tor Formation; Skjold Member)	110'
11,200' - 11,440'	" " (Hod Formation)	240'



4. STRATIGRAPHY:

This discussion supplements the information presented on the Stratigraphic Log (Enclosure 1), giving details of the lithostratigraphy, biostratigraphy and environmental interpretation.

4.1 10,410'-10,820' EARLY PALEOCENE (DANIAN).

Lithostratigraphy:

Chalk Group (Ekofisk Formation).

Limestone/chalk, white-grey, extremely hard, splintery, calcilititic, with common dark grey clay dissolution seams towards the top of the unit. Claystone, grey, calcareous, occasionally shaly, rarely pyritic, present below 10,430' and common below 10,700', occurring as distinct beds up to 10' thick.

Biostratigraphy:

10,410'-10,820' Early Paleocene (Danian).

Microfauna: The planktic foraminiferid *Globigerina pseudobulloides* is present in the chalk sample at 10,410', indicating that the highest sample received is of Danian age. Other characteristic species present include *G. triloculinoides* at 10,430' and *G. ?daubjergensis* at 10,485'. Spherical Radiolaria occur throughout the interval. Reworked Late Cretaceous (Maastrichtian) foraminiferids are present in the core chips at 10,545' and ditch samples between 10,610' and 10,630'. Evidence of bioturbation is visible rarely in the cores, including the trace fossil *Zoophycos* sp. (at 10,780') which is known to occur commonly in the early Danian chalk of offshore Denmark (Svendsen 1979).



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Microflora: Palynomorph yields are variable, rich assemblages occur in samples from clay-rich horizons, particularly towards the base of the interval, at 10,755' and below.

Assemblages contain long ranging dinoflagellate cyst species, including *Areoligera coronata* and *A. senonensis* which are reported to range from the Eocene to the Late Cretaceous (Campanian). *Palaeoperidium pyrophorum* first appears (downhole) at 10,550'. Although this is known to range from the basal Thanetian to Campanian, the species is characteristic of the Danian. The presence of *Renidinium membraniferum* at 10,645' and below, and the presence of *Spongodinium delitiense*, which first appears downhole at 10,735' (and is abundant at 10,805' and 10,812'), also indicates an age of Danian or older.

Several horizons have potential for local correlation within this Danian sequence, particularly the level with common *Areoligera* spp. (at 10,435'), the horizon with common *Glaphrocysta* spp. (at 10,770') and the top occurrence of abundant *Spongodinium delitiense* (at 10,805').

Nannoplankton: Only two ditch samples were examined from this interval at 10,620' and 10,660' as the core chips were too hard for satisfactory nannoplankton recovery. The nannoflora recorded at 10,620' includes *Chiasmolithus bidens* and *Neochiastozygus perfectus* which would indicate a top Danian-Selandian age (Subzones D10/S1), however as the sample is taken from well down in the Danian sequence these species are believed to be caved.



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A Late Danian (Subzone D8/9) age was obtained from the sample at 10,660'; this again seems young and may be the result of heavy caving through the section which was not cored.

Reworked Late Cretaceous nannoplankton, particularly *Arkhangelskiella cymbiformis*, were present in both samples.

Environment:

Open marine, outer sublittoral, carbonate rich, shelf sea.

4.2 10,820'-11,440' LATE CRETACEOUS, (MAASTRICHTIAN-LATE CAMPANIAN).

Lithostratigraphy:

Chalk Group:

10,820'-11,090' Tor Formation (Gorm Member).

Chalk/limestone, creamy white, micritic, with common stylolites. Dolomite rhombs were observed commonly in the core sample at 10,955'. Flint occurs very rarely.

11,090'-11,200' Tor Formation (Skjold Member).

Chalk/limestone, creamy white, biomicritic, with common calcispheres, which constitute a high proportion of the lithology. This last character is used by Svendsen (1979) to define the top of Skjold Member.

11,200'-11,440' Hod Formation.

Chalk/limestone, grey-creamy white, hard, splintery, rarely stylolitic, with rare crystalline pyrite.



Biostratigraphy:

10,820'-11,020' Late Maastrichtian.

Microfauna: The top of the interval is defined on the common occurrence of Cretaceous planktic foraminiferids *Globigerinelloides* sp., *Heterohelix* sp. and *Rugoglobigerina* sp. in the core sample at 10,820'. Other age diagnostic planktic species present include *Globotruncana contusa* (10,885'), *Pseudotextularia elegans* (10,940') and *Racemibolivina fructicosa* (10,955'), which are all used to define the Late Maastrichtian elsewhere in the North Sea.

Nannoplankton: Only one sample studied falls within this interval, at 10,990'. This sample contains an extensive nannoflora, including the Late Maastrichtian species *Cribrosphaerella daniae*, together with the longer-ranging Maastrichtian species *A. cymbiformis*.

11,020'-11,090' ?Late-Early Maastrichtian.

Microfauna: The benthic foraminiferid *Bolivina incrassata crassa* is used here to define the top of the interval, as this subspecies is restricted to the basal part of the Late Maastrichtian and the Early Maastrichtian regionally. The associated fauna comprises only long-ranging taxa.

Nannoplankton: Two ditch samples were examined from this interval (11,040' and 11,080'), however only the higher of the two contained a diagnostic nannoflora. It is similar to that of the overlying interval with *C. daniae* in association with the Late Maastrichtian zonal marker - *Nephrolithus frequens*. This assemblage, if in-place, suggests a Late Maastrichtian age, but preservation is poor and the marker species may be caved.



11,090'-11,440' Early Maastrichtian-Late Campanian.

Microfauna: The common occurrence of calcispheres in the chalk is a consistent regional marker, which has been dated elsewhere as Early Maastrichtian-Late Campanian on the basis of the associated foraminiferids. The microfauna in the present well is poorly preserved, but the occurrence of *Globotruncana arca* (at 11,100'), *Angulogavelinella bettenstaedti* (at 11,160'), and *Reussella szajnochae szajnochae* (at 11,360') accords with this age determination.

Nannoflora: All nine samples contain a similar poorly preserved nannoflora, with *A. cymbiformis* present throughout; this species is characteristic of the "mid"-Late Maastrichtian and is probably caving down at the base of the section. A single specimen of the index species for the basal Maastrichtian, *Reinhardtites levis* occurs at 11,390'.

Environment:

Open marine, outer sublittoral, carbonate rich, shelf sea, affected by oceanic circulation.



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WELL 2/4-7x

(Interval 10410'-11440')

STRATIGRAPHIC LOG

SCALE 1 : 500

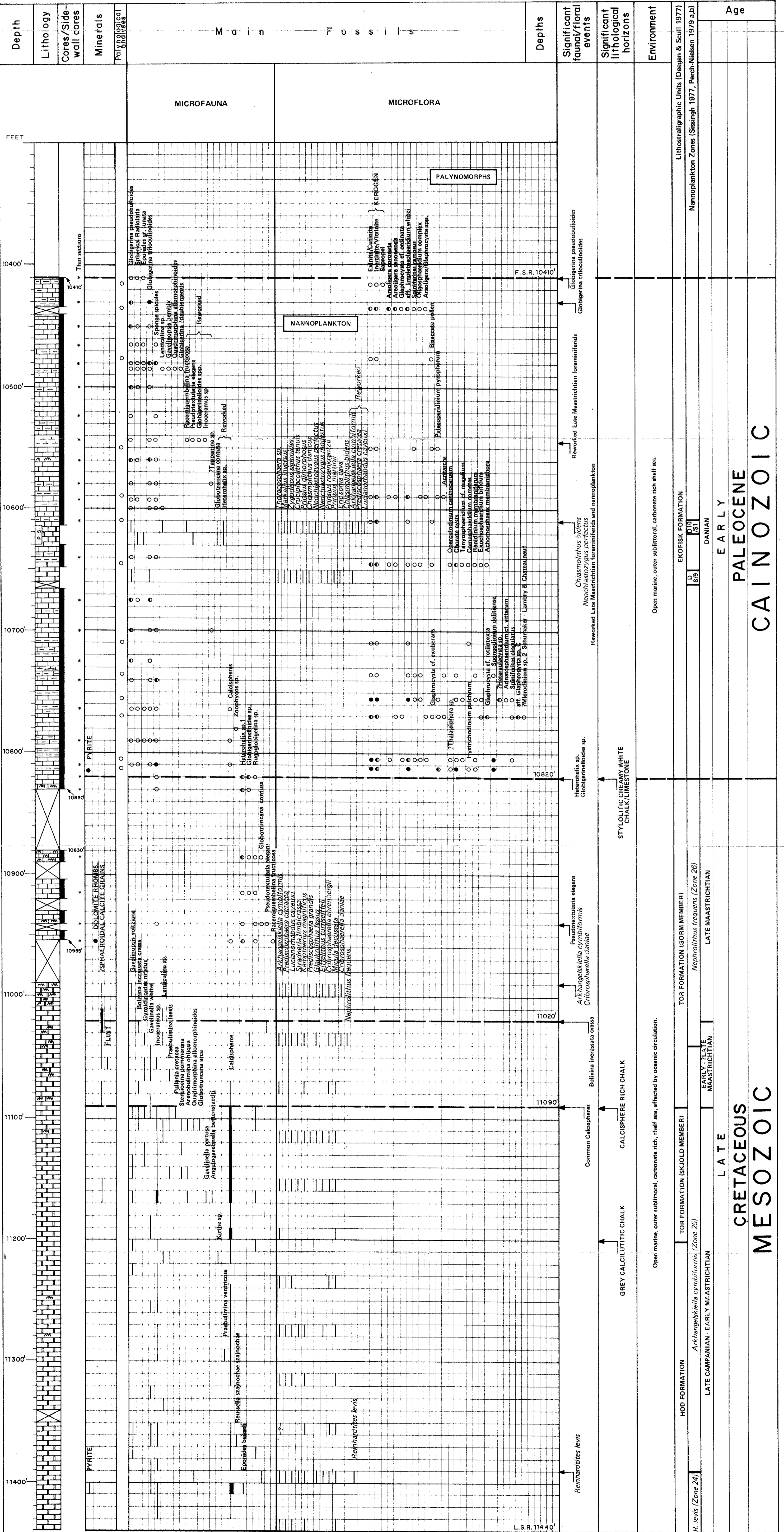


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UNIT 15, PARAMOUNT INDUSTRIAL ESTATE,
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LEGEND

- | | | | | | |
|--|-------------------------|--|---------------------------|--|------------------|
| | CLAY/CLAYSTONE | | SANDSTONE | | LIMESTONE |
| | SHALE | | CONGLOMERATE | | CHALK |
| | MARL - CALCAREOUS SHALE | | VOLCANICS LAVAS/TUFFS | | DOLOMITE |
| | SILTSTONE/SILT | | UNDIFFERENTIATED BASEMENT | | SALT |
| | SAND | | NO SAMPLES | | ANHYDRITE/GYPSUM |
| | MEGAFOSSILS | | GLAUCONITE | | MICA |
| | CHERT | | SIDERITE | | CORES |
| | PYRITE | | LIGNITE/COAL | | SIDEWALL CORES |
| | STYLOLITES | | | | POOR SAMPLES |
-
- | | | | |
|--|---------------------------------|--|----------------|
| | Boundary | | Abundant |
| | Unconformity | | Common |
| | T.D. (Total depth) | | Rare |
| | Partial or interrupted sequence | | Abundant |
| | F.S.R. First sample received | | Common |
| | L.S.R. Last sample received | | Rare |
| | | | Thin sections. |



PALEOCENE

CRETACEOUS

EARLY CRETACEOUS