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 STATOIL

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WELL 34/10-19
NORWEGIAN OFFSHORE
STRATIGRAPHICAL/PALEONTOLOGICAL
FINAL REPORT.



CLIENT COMPANY

STATOIL

PROJECT

*WELL 34/10-19
NORWEGIAN OFFSHORE
STRATIGRAPHICAL/PALEONTOLOGICAL
FINAL REPORT.*

STRATIGRAPHERS

R.W.MEYRICK.

J.B.KEEGAN.

J.JACOVIDES.

D.JUTSON.

DATE

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PROJECT No.

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PALEOSERVICES LTD
GEOLOGICAL CONSULTING SERVICES



Managing Director: Dr. V.L. Roveda (IT.)
Company Incorporated in U.K. No. 838 353
VAT Registration No. 197 2350 44

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1. INTRODUCTION

This report presents the results of the stratigraphical and paleontological study of samples from Well 34/10-19, drilled by Statoil in the North Sea (Norwegian offshore) during 1983.

Material available

The samples received comprise ditch cuttings collected at the following intervals:

5m between 1,595m and 1,620m
2.5m between 1,620m and 2,215m
3m between 2,215m and 2,218m

30 core chips between 1,763.1m and 1,874.4m were also received. No sidewall cores were received for analysis.

Analyses

Micropaleontological analyses were carried out at an average of 10m intervals on the ditch cuttings with greater sample density at certain boundaries. 26 core chips were analysed for micropaleontology.

A total of sixty-three samples (18 cores and 45 ditch cuttings) were analysed for palynology.

Calcareous nannoplankton analyses were carried out on two core chips in order to resolve the position of the junction between the Late and Early Cretaceous. Petrographic analyses were carried out on five core chips in order to determine the possibility of reworking of Early Cretaceous clasts/fossils into the Late Cretaceous (see Appendix 1).

This report is the result of work carried out by Paleoservices Ltd. staff only.

Boundary definition

All boundaries defined in this report are based on sample depths and are taken at significant lithostratigraphic or biostratigraphic events. No petrophysical logs were made available for the study.



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Lithostratigraphic terminology

The lithostratigraphic nomenclature used in this report is that defined by Deegan and Scull (1977).



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2. SUMMARY

CAINOZOIC

1. Claystones and limestones assignable to the Rogaland Group (Lista Formation) are present between 1,595m and 1,667.5m. The presence of a diverse agglutinating foraminiferid fauna dates this interval within the Late Paleocene and indicates that deposition took place in a marine, outer sublittoral to bathyal environment.
2. There is no lithological or paleontological evidence for the presence of rocks of "Middle" and/or Early Paleocene age in this well. Claystones of Late Paleocene age rest unconformably on calcareous claystones of Late Cretaceous (Late Maastrichtian) age at 1,667.5m.

MESOZOIC

LATE CRETACEOUS

3. Grey calcareous claystones and interbedded limestones of the Shetland Group are recorded from 1,667.5m to 1,777m. The presence of a diagnostic assemblage of palynomorphs and planktic and calcareous benthic foraminiferids in the upper part of the interval enables the dating of Late Maastrichtian from 1,667.5m to 1,687.5m and Maastrichtian to Late Campanian from 1,687.5m to 1,777m.

The whole of this interval was deposited in a marine, outer sublittoral to bathyal environment; however the dominance of agglutinating foraminiferids below 1,763m suggests periods of deeper water deposition.

The core chips at 1,765m, 1,774.6m, 1,776m and 1,776.5m contain mixed Early and Late Cretaceous faunas. This is either the result of contamination of the cores at wellsite or reworking of the Early Cretaceous faunas into the Late Cretaceous.

4. Late Cretaceous sediments of Maastrichtian or Late Campanian age rest unconformably on grey, green and red claystones of the Cromer Knoll Group (Early Cretaceous) at 1,777m.



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EARLY CRETACEOUS

5. Only c.2.25m of rocks assigned to the Cromer Knoll Group are recorded in this well, between 1,777m and 1,779.25m. They range in age from Middle/Early Barremian to Hauterivian.

EARLY JURASSIC

6. At 1,779.25m, white micritic limestone of the Cromer Knoll Group rests unconformably on poorly dated silty claystones assigned to the Early Jurassic (?Late Pliensbachian).
7. There is no lithological or paleontological evidence for the presence of the Kimmeridge Clay Formation, Heather Formation, Brent Formation or the Drake Member of the Dunlin Formation in this well.
8. Definite Late Pliensbachian sediments typical of the Dunlin Formation are recorded from 1,780.4m to 1,947.5m. A number of faunal/floral events are recognised and indicated on the log for dating and correlation purposes. Early Pliensbachian sediments are recorded from 1,947.5m to 2,007.5m. Deposition of sediments of the Dunlin Formation took place mainly in a marine, sublittoral environment.
9. From 2,007.5m to 2,215m, relatively clean, coarse to medium grained sands of the Statfjord Formation are recorded with red and green mottled claystones occurring between 2,215m and 2,218m (T.D.). Lithological comparisons suggest that this basal interval (2,215m-2,218m) can be assigned to the basal part of the Statfjord Formation/topmost Cormorant Formation.

The Statfjord and Cormorant Formations were deposited in marginal marine to continental environments and probably range in age from Sinemurian to Rhaetian but are not dated here due to the lack of paleontological evidence.



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3. STRATIGRAPHICAL SUMMARY

<u>Interval</u>	<u>Lithostratigraphic</u> <u>Unit</u>	<u>Age</u>	<u>Thickness</u>
F.S.R.			
1,595m - 1,667.5m	Rogaland : Lista	Late Paleocene	72.5m
-----UNCONFORMITY-----			
1,667.5m - 1,687.5m	Shetland	Late Cretaceous (Late Maastrichtian)	20m
1,687.5m - 1,777m	Shetland	Late Cretaceous (Maastrichtian-Late Campanian)	89.5m
-----UNCONFORMITY-----			
1,777m - 1,779.25m	Cromer Knoll	Early Cretaceous (Middle/Early Barremian- Hauterivian)	2.25m
-----UNCONFORMITY-----			
1,779.25m - 1,780.4m	?Dunlin	?Early Jurassic (?Late Pliensbachian)	1.15m
1,780.4m - 1,947.5m	Dunlin : ?Cook- Amundsen	Early Jurassic (Late Pliensbachian)	167.1m
1,947.5m - 2,007.5m	Dunlin : Amundsen	Early Jurassic (Early Pliensbachian)	60m
2,007.5m - 2,218m	Statfjord- T.D. Cormorant	Early Jurassic-Late Triassic (?Sinemurian- ?Rhaetian)	210.5m



STAGE TERMINOLOGY FOR THE JURASSIC AND
TRIASSIC AS USED BY PALEOSERVICES LTD. IN THIS REPORT.

JURASSIC	LATE	PORTLANDIAN	VOLGIAN	LATE
		KIMMERIDGIAN S.L.		MIDDLE
		OXFORDIAN		EARLY
		CALLOVIAN	KIMMERIDGIAN S.S.	
	MIDDLE	BATHONIAN	BAJOCIAN S.L.	
		BAJOCIAN S.S.		
		AALENIAN		
	EARLY	TOARCIAN		
		PLIENSCHACHIAN		
		SINEMURIAN		
		HETTANGIAN		
TRIASSIC	LATE	RHAETIAN		
		NORIAN		
		KARNIAN		
	MIDDLE	LADINIAN		
		ANISIAN		
	EARLY	SCYTHIAN		

FIG. 2



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4. STRATIGRAPHY

4.1 1,595m-1,667.5m LATE PALEOCENE

Lithostratigraphy:

Rogaland Group (Lista Formation)

1,595m-1,635m Claystone, grey/green, moderately hard, subblocky, pyritic; limestone, grey.

1,635m-1,667.5m Claystone, as above, with sand, medium to fine grained.

Sample quality is extremely poor between 1,610m and 1,667.5m

Biostratigraphy:

1,595m-1,667.5m Late Paleocene

Microfauna: This interval is defined by the presence of an abundant microfauna of agglutinating foraminiferids comprising the taxa *Ammodiscus polygyrus*, *Rhabdammina* gr. *discreta* and *Bathysiphon* sp. Large specimens of *Bolivinospectabilis*, characteristic of the Paleocene, are present at 1,600m.

This assemblage is diagnostic of the Late Paleocene in the North Sea and persists through the majority of the interval down to 1,650m. Below 1,650m only rare agglutinating foraminiferids are recorded. No diagnostic "Middle" and Early Paleocene fossils are recorded, indicating that the Late Paleocene rests unconformably on the Late Maastrichtian at 1,667.5m.

Microflora: The first sample examined at 1,595m contains the dinoflagellate cyst *Apectodinium augustum*. Even though this taxon is thought to range up into the basal Eocene it is most characteristic of the Late Paleocene. The dinoflagellate cyst *Alisocysta margarita* appears downhole at 1,627.5m. This is a paleoevent which regionally occurs within the Late Paleocene in the northern North Sea.



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A number of older taxa are found reworked within this interval, including the Early Paleocene-Late Cretaceous dinoflagellate cyst *Palaeoperidinium pyrophorum* (1,642.5m) and the long-ranging Mesozoic miospores *Callialasporites dampieri* and *Cerebropollenites mesozoicus* (1,642.5m). Extensive reworked palynomorphs characteristically occur within this interval in adjacent wells.

Environment:

Marine, outer sublittoral to bathyal environment.

Comments:

There is no paleontological evidence for the presence of Early-"Middle" Paleocene sediments in this well. The Late Paleocene rests unconformably on calcareous claystones assigned to the Shetland Group, of Late Maastrichtian age.

4.2 1,667.5m-1,777m LATE CRETACEOUS (Maastrichtian-Campanian)

Lithostratigraphy:

Shetland Group

Samples are of small size and are contaminated by drilling additive and cement.

1,667.5m-1,710m Claystone, light grey, firm to moderately hard, calcareous, pyritic; with limestone, cream/brown, hard, micritic, below 1,702.5m.

1,710m-c.1,777m Claystone, grey, silty, slightly calcareous; with fine-very fine grained, micaceous sandstone and rare glauconite (1,730m-1,740m).



Lithological description of core chips in Appendix 2.

Biostratigraphy:

1,667.5m-1,687.5m Late Maastrichtian

Microfauna: The top of the Late Maastrichtian is marked by the downhole appearance of common planktic and benthic foraminiferids at 1,667.5m. The diagnostic planktic assemblage includes *Pseudotextularia elegans*, *Globotruncana arca*, *Globotruncana stuarti* gr., *Globotruncana contusa*, *Globigerinelloides messinae* and *Heterohelix striata*.

Microflora: The dinoflagellate cyst *Ceratiopsis striata* occurs downhole in the one sample examined from this interval at 1,672.5m. The presence of this taxon, even though it ranges up into the Early Paleocene, is more characteristic of sediments of Maastrichtian to Campanian age.

1,687.5m-1,777m Maastrichtian-Late Campanian

Microfauna: The highest occurrence of the benthic foraminiferid *Reussella szajnochae szajnochae* at 1,687.5m defines the top of this interval. Although this subspecies ranges up into the Late Maastrichtian, it occurs commonly in the early part of the stage.

In the upper part of this interval *R. szajnochae szajnochae* occurs in association with common to abundant specimens of the genus *Rugoglobigerina*.

The dominance of planktic and calcareous benthic foraminiferids in the upper part of this interval decreases downhole and below 1,765m long-ranging agglutinating foraminiferids such as *Trochammina irregularis* increase substantially. This level probably approximates to the abundance level of agglutinating foraminiferids recorded in other wells in the block.



The red claystone horizon conventionally used to define the top of the Campanian in the northern North Sea is not recorded in this well and there is no precise microfaunal evidence for the penetration of Campanian sediments in this well.

In the core-chips examined between 1,763.1m and 1,776.5m long-ranging agglutinating foraminiferids are dominant, but rare to common specimens of red stained Early Cretaceous foraminiferids (*Hedbergella* spp. and *Gavelinella barremiana*) are recorded in the core chips at 1,765m, 1,774.6m, 1,776m and 1,776.5m. These taxa are either the result of contamination of the cores by drilling fluid at wellsite or the result of reworking.

Nannoflora: One core sample was examined, at 1,763.1m; the presence of *Micula staurophora*, together with *Arkhangelskiella cymbiformis* and *Discolithus octocentralis*, indicates an age not older than Santonian.

Microflora: *Laciniadinium arcticum/firmum* and *Palaeohystrichophora infusorioides* appear downhole at 1,687.5m. These two taxa indicate a Late Cretaceous age, Maastrichtian or older. A number of other palynomorph markers which characteristically occur within the Maastrichtian in nearby wells also appear downhole in this interval, including the miospore *Aquilapollenites* spp. and the dinoflagellate cysts *Trithyrodinium suspectum* and *Spongodinium delitiense* (1,717.5m), *Membranosphaera maastrichtica* (1,747.5m) and *Chatangiella* spp. (1,763.1m).

S. delitiense occurs in the core samples down to 1,776.5m indicating an age not older than Late Campanian for the base of this interval.

The dinoflagellate cysts *Raphidodinium fucatum* and *Odontochitina costata* (common) appear downhole in the core chips at 1,774.6m and 1,776m respectively. In adjacent wells both these taxa have appeared downhole below the top of the Campanian.



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The Jurassic miospores *Kraeuselisporites reissingeri* and *Quadraeculina anellaeformis* and the long-ranging form *Callialasporites dampieri* occur reworked in the core chips between 1,763.1m and 1,763.9m.

Environment:

Marine, outer sublittoral to upper bathyal, environment. A general increase in depth of deposition is probably reflected by the gradual increase and dominance of agglutinating foraminiferids in the lower part of this interval below 1,765m.

Comments:

There is no paleontological or lithological evidence in this well for the presence of Late Cretaceous sediments of Santonian to Cenomanian age. Claystones of probable Late Campanian age are considered to rest unconformably on a thin interval of calcareous grey, green and red claystone/marl of Middle/Early Barremian age at 1,777m.

4.3 1,777m-1,779.25m EARLY CRETACEOUS (Middle/Early Barremian-Hauterivian)

Lithostratigraphy:

Cromer Knoll Group

1,777m-1,778.3m Claystone/marl grey, green and red, calcareous.

1,778.3m-1,779.25m Limestone, white, micritic.

Lithological description of core chips in Appendix 2.

Biostratigraphy:

1,777m-1,779.25m Middle/Early Barremian-Hauterivian

Microfauna: The downhole occurrence of common Early Cretaceous white and red stained benthic foraminiferids in the core chips from 1,777m and 1,778.3m and the ditch cutting from 1,777.5m-1,780m defines this interval. The diagnostic forms recorded include *Gavelinella barremiana*, *Uvigerinamina* sp.1 (internal species) and *U. moesiana* (common). Associated forms include *Paalzowella pazdroae*,



Lithological description of core chips in Appendix 2.

Biostratigraphy:

Microfauna: No microfauna was recorded from the three core chips (1,779.25m, 1,780.3m and 1,780.4m) examined from this interval.

Microflora: Three core chips were processed at 1,779.25m, 1,780.3m and 1,780.4m. As they contained no palynomorphs, age determination is not possible. The ditch cutting sample at 1,780m to 1,782.5m contains a combination of caved Late Cretaceous/Cainozoic forms and Early Jurassic taxa and is discussed in the interval below.

Comments:

Although this interval cannot be dated paleontologically, an age is inferred by its stratigraphic position above well dated Late Pliensbachian sediments and on lithological comparisons.

4.5 1,780.4m-2,007.5m EARLY JURASSIC (Pliensbachian)

Lithostratigraphy:

Dunlin Formation

?Cook-Burton-Amundsen Members (undifferentiated)

1,780.4m-1,822.5m Claystone, grey and brown, pyritic; with limestone, brown (1,785m-1,817.5m).

1,822.5m-1,840m Claystone/siltstone, as above, micaceous, with sand, fine-medium grained, subangular-subrounded.

1,840m-2,007.5m Extremely poor samples comprising rare claystone as above, drilling artifacts and additives. Sand/sandstone, fine-medium grained, angular to subangular, micaceous, from 1,962.5m. Chamositic oolites are recorded in the core chip at 1,849.6m.



Marssonella trochus, *Lenticulina bettenstaedti*, together with rare specimens of the smooth ostracod *Pontocyprrella* sp. This association is typical of a Middle Barremian-Hauterivian age in the area.

The planktic foraminiferid *Hedbergella* spp. occurs commonly at 1,777m. Its occurrence may possibly indicate a thin Albian/Aptian level.

Nannoflora: The occurrence of *Ellipsogelosphaera britannica* together with *Sphenoradiatus serratus* and *Chiastozygus bilamellus* at 1,777.5m suggests a Hauterivian age. At the same depth accompanying Early Cretaceous species include *Micrantholithus hoschulzi*, and *Cribrosphaerella* cf. *primitiva*.

Microflora: Three core chips were examined for palynology but were devoid of palynomorphs and were thus undatable. The ditch cutting 1,777.5m-1,780m was dominated by taxa which occur in the overlying Late Cretaceous interval. It also contains the dinoflagellate cyst *Ovoidinium scabrosum/verrucosum*, which ranges from the Early Cenomanian to the Aptian, but is most characteristic of the Albian.

Environment:

1,777m-1,779.25m Marine, sublittoral, carbonate rich shelf deposition.

Comments:

The Early Cretaceous sequence recorded in this well is represented by only c.2.25m of sediments. These rocks rest unconformably on Early Jurassic (?Late Pliensbachian) claystones at 1,779.25m.

4.4 1,779.25m-1,780.4m EARLY JURASSIC (?Late Pliensbachian)

Lithostratigraphy:

?Dunlin Formation

1,779.25m-1,780.4m Claystone, green/grey, subplaty, micromicaceous, non-calcareous, silty with fine sandy laminations.



Biostratigraphy:

1,780.4m-1,947.5m Late Pliensbachian

Microfauna: The first microfaunal evidence for sediments of Late Pliensbachian age occurs at 1,797.5m, where the calcareous benthic foraminiferid *Marginulina prima* is first recorded. This taxon is not known to occur in sediments younger than Late Pliensbachian in the northern North Sea.

At 1,817.5m is the highest occurrence of the ostracod genus *Ogmoconchella*. Although records exist of this genus from onshore sequences in the basal Toarcian (*D. tenuicostatum* ammonite zone) its 'top' in this area is conventionally taken as Late Pliensbachian.

Other significant regional faunal markers within the Late Pliensbachian that provide consistent correlation are *Ogmoconchella aequalis* (1,827.5m and below), *Saracenaria sublaevis* (1,837.5m), *Dentalina matutina* (1,847.5m and below), *Ogmoconchella transversa* and *Wicherella semiora* (core chip at 1,853.95m and below). The occurrence of *W. semiora* is the lowest recognised event in the Late Pliensbachian of this area.

Microflora: The ditch cuttings at 1,780m-1,782.5m contain the taxa *Chasmatosporites* spp. (common), *Nannoceratopsis triceras* and *Leuhndea spinosa*. Even though the latter taxon is known to range up into the Early Toarcian, it is most characteristic of the Pliensbachian. The presence of *L. spinosa* and *N. triceras*, which does not range below the Late Pliensbachian, combined with the absence of definite Early Toarcian markers indicates a Late Pliensbachian age. As the core chips from within this interval are devoid of palynomorphs, the top of this interval is taken at the base of the core at 1,780.4m.

Nannoceratopsis gracilis appears downhole at 1,782.5m; this indicates an age not older than Late Pliensbachian; *N. gracilis* occurs in a core chip at 1,860.20m and in the ditch cuttings at



1,935m suggesting a Late Pliensbachian age to at least this depth. The core chip at 1,860.20m also contains *L. spinosa*, which indicates an age not older than Pliensbachian.

Most of the samples examined, including the core chips, contain assemblages which are dominated by long-ranging miospores, with bisaccate pollen, *Chasmatosporites* spp. and *Classopollis torosus* the dominant forms. The common/abundant occurrence of *Chasmatosporites* spp. is often a characteristic feature of assemblages from sediments of Pliensbachian age.

Cerebropollenites thiergartii, which appears downhole at 1,827.5m, is characteristic of Pliensbachian or older sediments.

1,947.5m-2,007.5m Early Pliensbachian

Microfauna: The Early Pliensbachian ostracod *Gammacythere ubiquita* is recorded in this well at 1,947.5m and defines the top of this interval. Other restricted Early Pliensbachian ostracods include *Ogmoconcha amalthei* form A., and *O. amalthei rotunda*. These taxa occur throughout this interval, together with *Ogmoconchella danica* which ranges from the basal part of the Late Pliensbachian into the upper part of the Late Sinemurian.

A microfaunal event marked by the presence of small, ornamented ostracods of the genus *Kinkelinella*, *Gramannella* and *Cytheropteron*, recorded in previous wells from this area near the base of the Early Pliensbachian, is not present in the ditch cutting samples examined from this interval. Its absence may imply a minor unconformity between the basal Dunlin member and the Statfjord Formation in this well, or that the topmost part of the Statfjord Formation recorded from 2,007.5m may be diachronous (i.e. younger than in other nearby wells).



Microflora: Most of the taxa recorded from this interval continue through from the overlying interval. *Iraquisporites laevigatus*, which appears downhole at 1,992.5m is characteristic of Early Jurassic to Late Triassic sediments.

Environment:

Marine, sublittoral-littoral. The diverse faunal assemblage recorded from this interval suggests a well oxygenated "shelf" environment.

The level of chamositic oolites recorded from the core chip at 1,849.6m correlates throughout much of the northern North Sea and reflects a period of extremely slow or non-deposition.

4.6 2,007.5m-2,218m EARLY JURASSIC-LATE TRIASSIC (?Sinemurian-?Rhaetian)

Lithostratigraphy:

Statfjord Formation

2,007.5m-2,157.5m Sand, clean, fine-coarse, angular-subangular, trace pyrite and lignitic debris. Claystone, brown-grey, silty, rare. Sphaerosiderite is recorded between 2,082.5m and 2,120m.

2,157.5m-2,215m Sand, as above, with claystone, green, and grey. micaceous.

Basal Statfjord-Cormorant Formations

2,215m-2,218m Claystone, red/purple and mottled green. Sand, clean-red stained, fine-coarse, angular-subangular.

Biostratigraphy:

2,007.5m-2,218m ?Sinemurian-?Rhaetian

Microfauna: No in place microfauna recorded.

Microflora: The samples from this interval contain very sparse assemblages of possible in-situ palynomorphs. All the taxa present continue through from higher up the well. No short-ranging Sinemurian or Hettangian taxa were recorded.



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As no SWCs or cores were available from the lower part of the well, it is not possible to confirm whether the occurrences of *C. mesozoicus* here and in the underlying interval are in-situ. *C. mesozoicus* has been recorded from the Hettangian, but it usually does not range below the Sinemurian. Its occurrence here is probably the result of caving.

No definite short ranging Hettangian/Rhaetian taxa are present in the assemblages from this interval.

Environment:

2,007.5m-2,085m Marine, inner sublittoral.

2,085m-2,215m Marine to transitional; near shore; high energy.

2,215m-2,218m Continental; high energy fluvial sands with low energy deposition of overbank claystones.

Comments:

On regional lithological evidence, the top of the Statfjord Formation approximates conventionally with the Pliensbachian-Sinemurian boundary and the basal Statfjord is within the Rhaetian. There is no palynological evidence for dating the lower part of this interval in this well.



5. REFERENCES

DEEGAN, C. E. and SCULL, B.J. 1977. A proposed standard
lithostratigraphic nomenclature for the Central and Northern North
Sea. Rep. Inst. Geol. Sci., No.77/25.



APPENDIX 1 : Petrographic analyses of core chip samples 1,776m, 1,776.5m, 1,777m "below 1,777m" and 1,778.4m

INTRODUCTION

Petrographic analysis was undertaken on thin-sections prepared from core chips at depths 1,776m, 1,776.5m, 1,777m, below 1,777m and 1,778.4m to try and determine if there was any evidence of reworking of Early Cretaceous clasts/faunas in this interval.

Two thin-sections were prepared from each sample and impregnated with blue dyed araldite to facilitate the recognition of porosity. The sample at 1,778.4m was also stained with Alizarin Red-S and Potassium Ferricyanide to aid identification of carbonate mineralogy.

The petrographic data is summarised in the Petrographic Data Sheets (Tables 1 and 2).

LITHOLOGY AND PETROGRAPHY

1,778.4m

Hand specimen : Bioclastic marl; buff, moderately indurated, bioclastic packstone. Common mouldic porosity with pores generally less than 2mm across, some lined by calcite spar. Rare detrital quartz grains up to cl grade.

Petrography : Bioclastic argillaceous packstone to wackestone. Bioclasts include echinoderm plates and spines, disarticulated bivalves preserved as casts, ostracods and foraminiferids in a matrix of micritic clay. Packstone to wackestone texture. Biomouldic and ?pel mouldic porosity is common. Zoned non-ferroan to ferroan. Calcite cement lines and fills mouldic and intraparticle porosity.

Microporosity within the matrix and echinoderm plates is indicated by the presence of an oil stain.



Effects of Diagenesis on Poroperm Characteristics

Microporosity within the matrix may have been preserved due to early micritic cementation inhibiting compactional diagenesis. Dissolution of unstable (aragonitic ?) grains occurred during early burial; much of this porosity was filled or reduced by calcite cement. Permeability will be controlled by the interconnection of the moulds via the intercrystalline microporosity within the matrix. As the intercrystalline microporosity appears to be low and patchy in distribution, permeability is likely to be poor.

Diagenetic Summary

The diagenetic sequence is as follows:

- i) deposition of marine sediments.
- ii) ?carbonate cementation within matrix.
- iii) minor compaction during early burial.
- iv) dissolution of unstable grains.
- v) precipitation of zoned non-ferroan to ferroan calcite cement.
- vi) emplacement of hydrocarbons.

"below 1,777m" (between 1,777m-1,778.4m)

Argillaceous dolomite, greenish grey, finely crystalline, moderately indurated, large irregular vugs up to 7mm across.

Petrography: Argillaceous dolowackestone. Contains abundant agglutinated foraminiferids. The larger foraminiferids have an limonitic iron stain and commonly limonitic clay infills intraparticle porosity. Smaller agglutinated foraminiferids generally are not iron stained. The presence of limonitic "Liesegang" type diffusion rings surrounding irregular vugs and limonite lining stylolites suggests in-situ "staining" as opposed to reworking of iron-stained faunas. No clasts have been identified.



1,777m

Claystone, light grey green, poorly indurated, dark grey green partings, laminated.

Petrography: Bioclastic silty claystone. Bioclasts predominantly agglutinated foraminiferids. No evidence of iron stained faunas. The claystone has a clotted appearance with opaque 'clots' surrounded by clearer clay. Clay filled microfractures common.

1,776.5m

Claystone, medium to dark grey, poorly indurated, subfissile, laminated, silty.

Petrography: Silty claystone. Laminated to lensoid bedded with silt and glauconite-rich lenses. Framboidal pyrite cement has grown as lenses parallel to lamination. No recognisable bioclasts.

1,776m

Claystone, medium to dark green, grey, poorly indurated, dark clay partings, sub-blocky, laminated.

Petrography: Silty claystone. Vague laminated to clotted appearance with silt-rich lenses, pyrite cement common-occurs as disseminated framboids and poikilotopically enclosing silt.

CONCLUSION

The only samples to contain recognisable foraminiferids are at 1,778.4m, 1,777m and immediately below 1,777m. Iron stained faunas only occur in the sample "below 1,777m". Iron staining appears to have preferentially affected the larger foraminiferids. The presence of limonitic diffusion fronts (Leisegang rings) within the matrix dolomite/clay indicates in-situ staining of the faunas. No recognisable clasts occur in any of the samples examined.

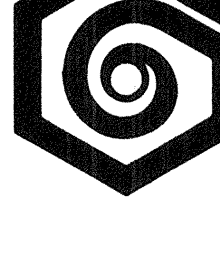


WELL 34/10-19

INTERVAL 1595m-2218m I.D.

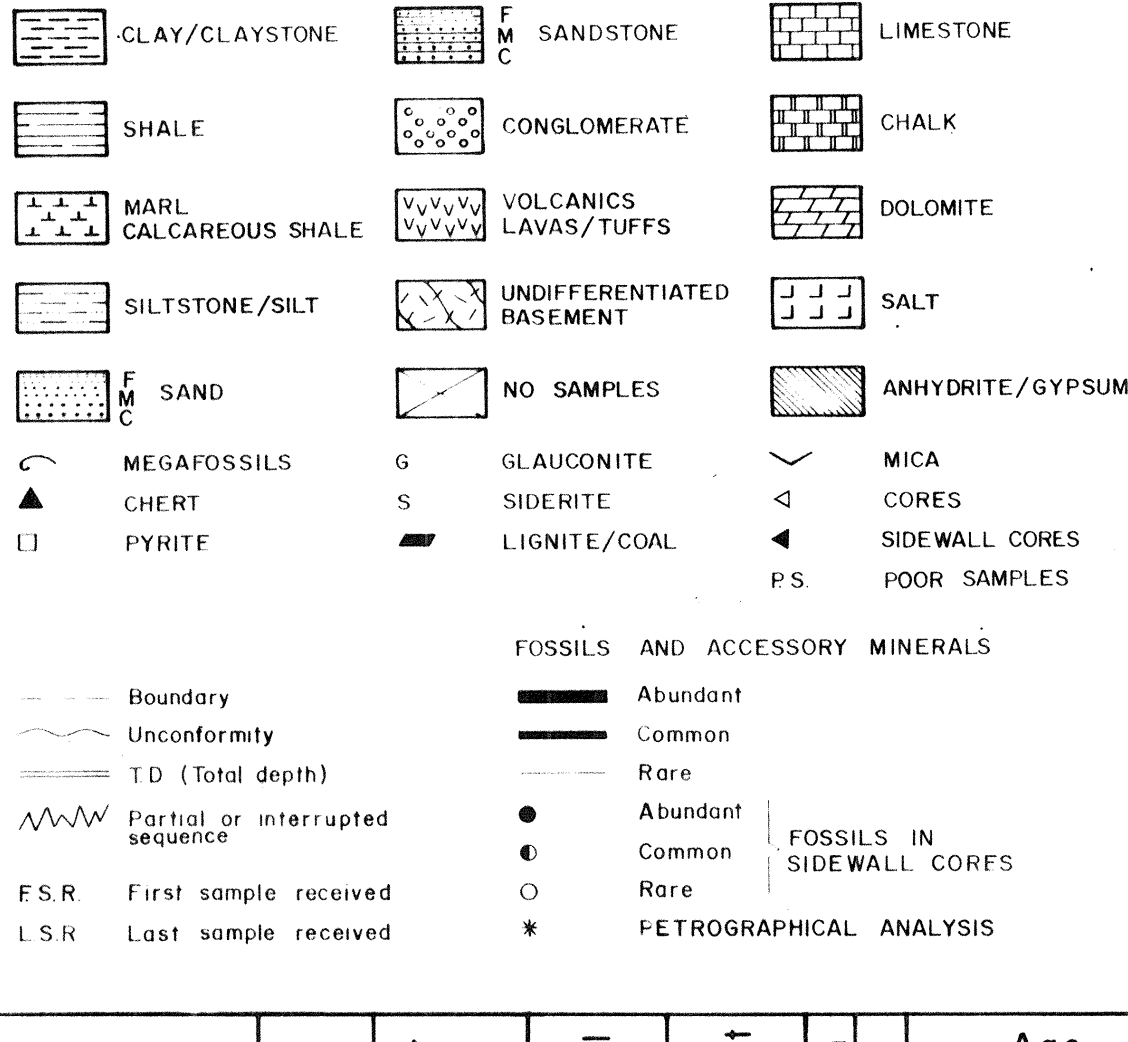
NORWEGIAN OFFSHORE

PALYNOSTRATIGRAPHICAL LOG



UNIT 15, SANDOWN ROAD, WATFORD WD2 4UB ENGLAND.

LEGEND



Depth

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5

10

1500

1550

1600

1650

1700

1750

1800

1850

1900

1950

2000

2050

2100

2150

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2300

2350

2400

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2500

2550

2600

2650

2700

2750

2800

2850

2900

2950

3000

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3100

3150

3200

3250

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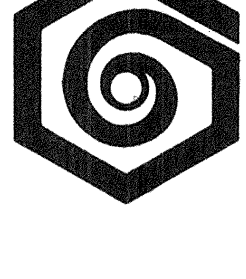
WELL 34/10-19

INTERVAL 1595m - 2218m T.D.

NORWEGIAN OFFSHORE

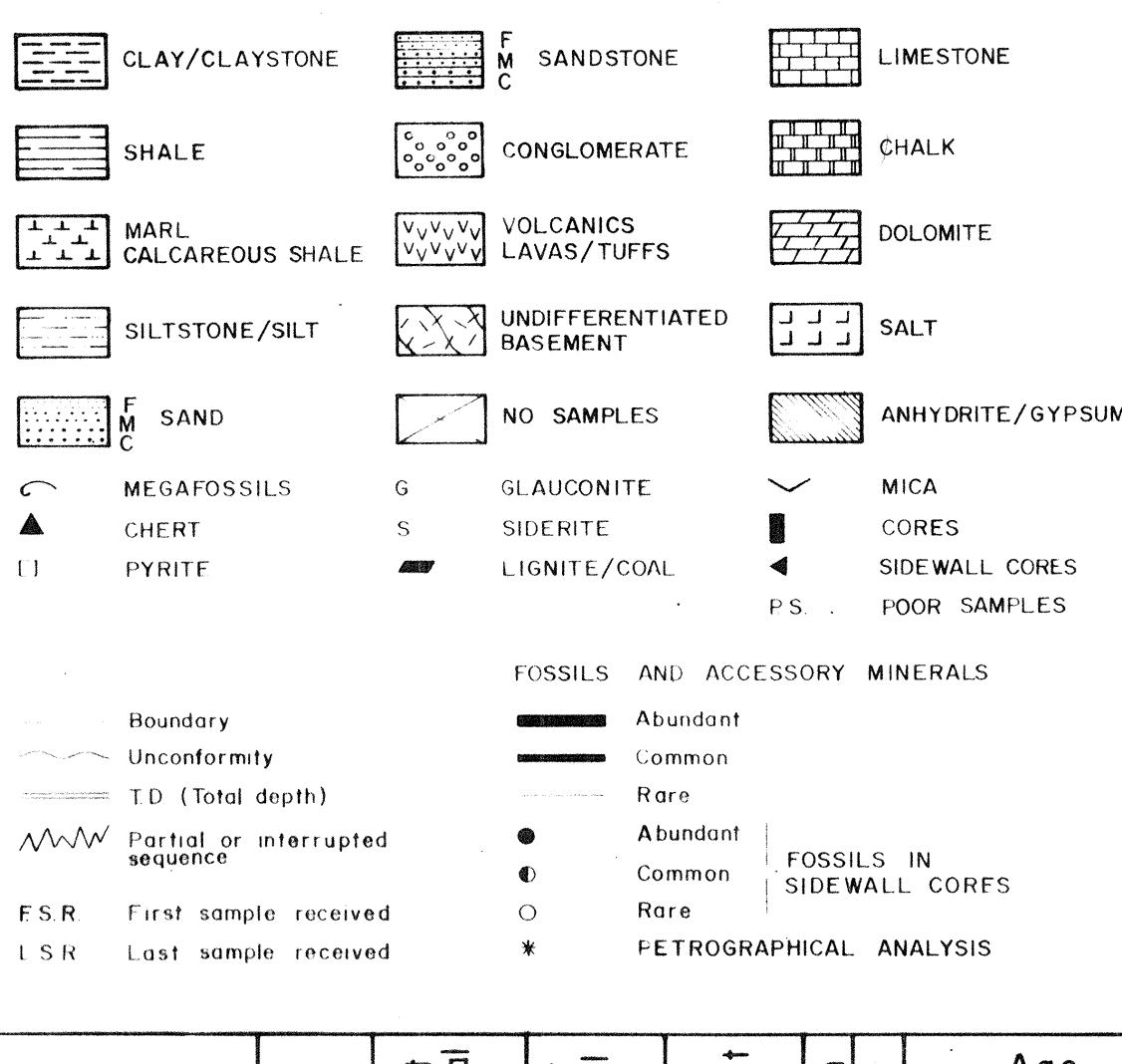
STRATIGRAPHIC LOG

SCALE 1: 500



PALEOSERVICES
UNIT 15, SANDOWN ROAD, WATFORD WD2 4UB ENGLAND.

LEGEND



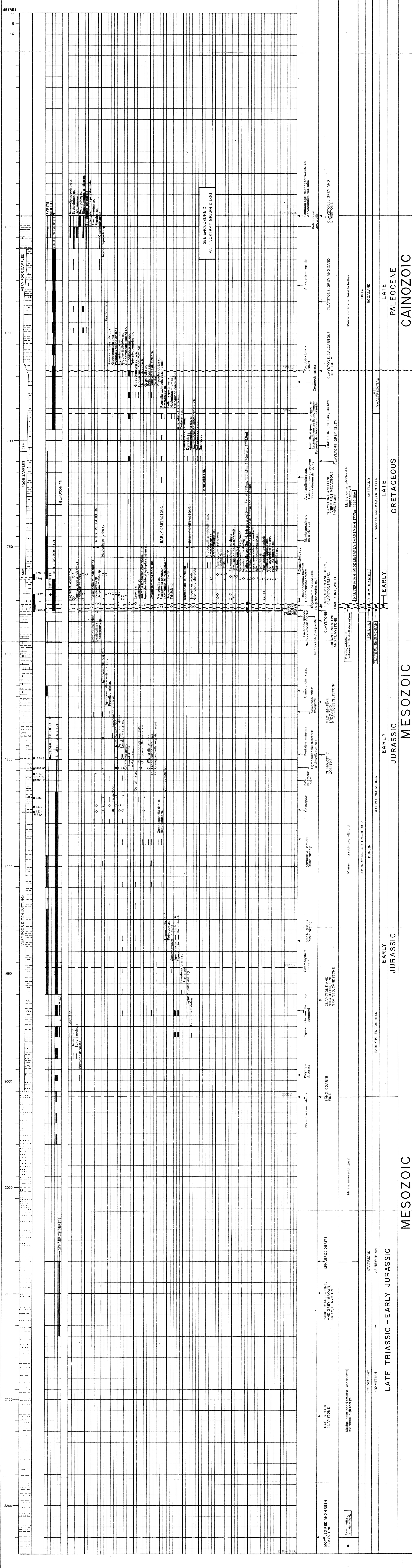
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SEDIMENTARY HISTORY®

CLIENT:

STATOIL

WELL NO:

34/10-19

FIGURE:

1

DATE:

MARCH 1984

PROJECT NO:

1226

ANALYSTS:

J.J., J.B.K., R.W.M.



PALEOSERVICES

Unit 15, Paramount Industrial Estate,
Sandown Road,
Watford, WD2 4UB, England.

KEY:



Missing section



Volcanics



Open marine circulation



Restricted circulation



Mainly coarse clastics (sand)



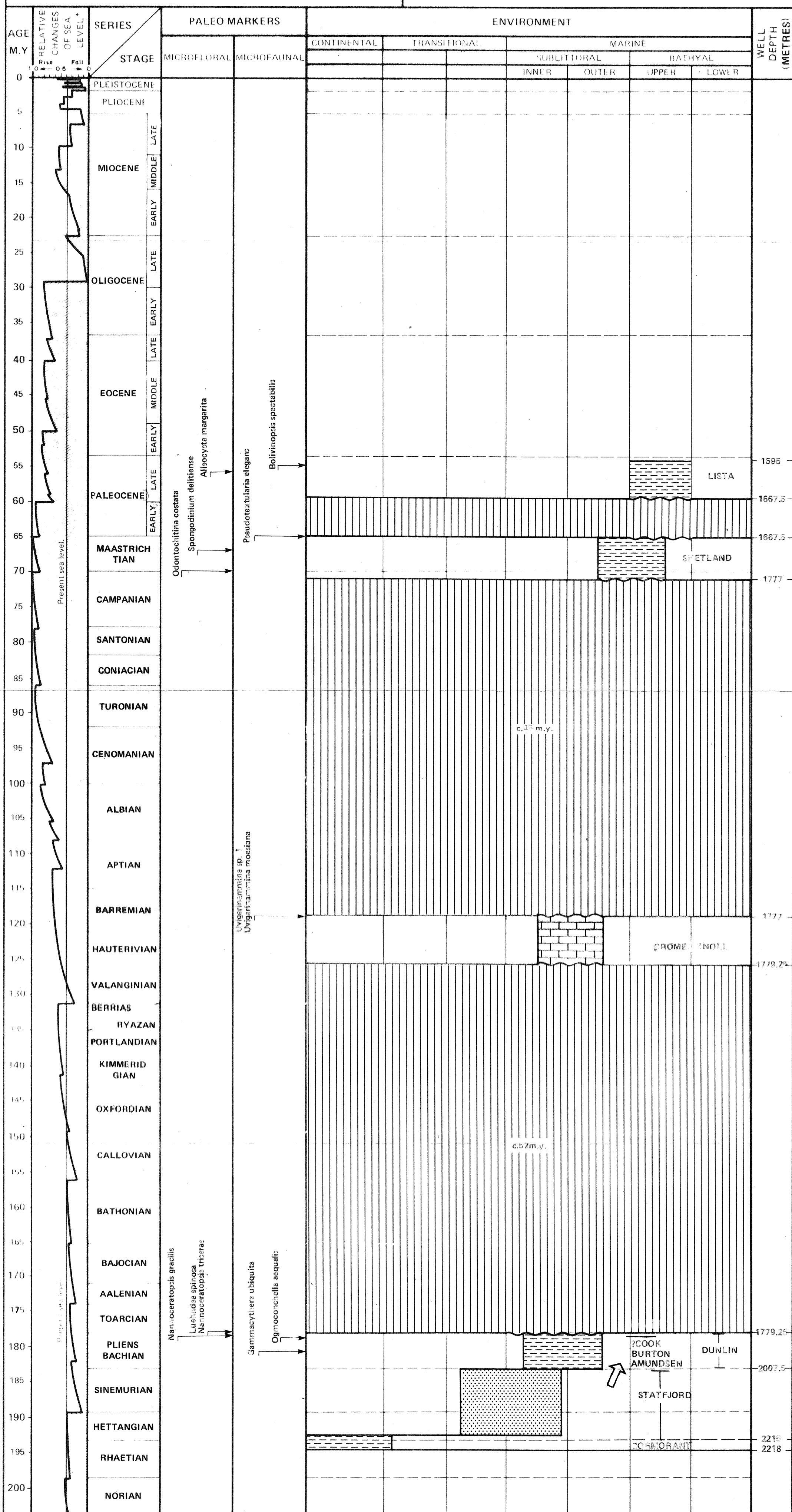
Mainly fine clastics (silt, clay)



Carbonates



Evaporites



APPENDIX 2 : Core chip descriptions

<u>Depth</u>	<u>Core No.</u>	<u>Quality</u>	<u>Analyses</u>	<u>Lithology</u>
1,763.1m -.13m	1	Good	M.P.N.	<u>Claystone</u> , very dark grey/black, subplaty, trace micromicaceous, silty, non-calcareous, pyritic.
1,763.85m-.9m	1	Good	M.P.	<u>Claystone</u> , as above, trace lignitic debris.
1,765m	1	Good	M.P.	<u>Claystone</u> , medium grey, calcareous, pyritic, trace lignitic debris.
1,772m	1	Good	M.P.	<u>Claystone</u> , as above, non-calcareous.
1,772.6m-.65m	1	Good	M.	<u>Claystone</u> , very dark grey/green, subplaty, micromicaceous, soft, silty, non-calcareous, trace lignite.
1,773.9m-.95m	1	Good	M.P.	<u>Claystone</u> , dusky red, sub-blocky-subplaty, silty, trace mica, sideritic, non-calcareous.
1,774.6m-.65m	1	Good	M.P.	<u>Claystone</u> , olive black, subplaty, silty, micromicaceous, trace lignite, non-calcareous.



PALEOSERVICES

1,775m*	1	Good	Pt.	<u>Claystone</u> , dark grey/black, subplaty, micaceous, non-calcareous.
1,775.5m*	1	Good-Mod. (rubble)	Pt.	<u>Claystone</u> , dark grey/black, as above, (taken from rubble).
1,776m	1	Good	M.P.	<u>Claystone</u> , very dark grey/black, subplaty, trace mica, silty, pyritic, lignitic, non-calcareous.
1,776m*	1	Moderate (rubble)	Pt.	<u>Claystone</u> , dark green/grey, subblocky, laminated, silty.
c.1,776.5m	1	Good	M.P.	<u>Claystone</u> , medium grey, pyritic, trace lignite, non-calcareous.
1,776.5m*	1	Moderate	Pt.	<u>Claystone</u> , medium to dark grey, laminated, silty.
1,777m	1	Good	M.P.	<u>Claystone</u> , olive grey, patchy, subblocky, silty, non-micaceous, non-calcareous.
1,777m*	1	Moderate (rubble)	M.Pt.	Argillaceous <u>dolomite</u> , greenish grey.
1,777.5m	1	Mod-Good	M.P.N.	<u>Claystone-marly claystone</u> , yellowish/brown-brown, calcareous, fossiliferous.



PALEOSERVICES

1,778.4m	1	Good	M.Pt.	<u>Limestone</u> , white, hard, micritic.
1,779.0m	1	Moderate	M.P.	<u>Limestone</u> , cream coloured, micritic.
1,779.25m	1	Good	M.P.	<u>Claystone</u> , green/grey, subplaty, very micromicaceous, non-calcareous, silty with fine sandy laminations.
1,780.3m	1	Good	M.P.	<u>Claystone</u> , as above.
1,780.4m	1	Good	M.P.	<u>Claystone/siltstone</u> , greenish grey, as above.
1,849.6m	2	Good	M.P.	<u>Claystone</u> , green/black, very sandy, medium-fine grained, silty, micaceous, lignitic, chamositic, fossiliferous.
1,853.95m	2	Good	M.	<u>Claystone</u> , grey, subplaty, silty, micromicaceous, lignitic, calcareous.
1,857m	3	Good	M.	<u>Claystone</u> , medium-light grey, micaceous, organic debris, slightly calcareous.
1,857.05m	3	Good	M.	<u>Claystone</u> , as above.



PALEOSERVICES

1,860.15m-.0.2m	3	Good	M.P.	<u>Claystone</u> , as above.
1,868m	3	Good	M.	<u>Claystone</u> , as above, silty.
1,872.5m	3	Good	M.P.	<u>Claystone/sandstone</u> , laminated, <u>claystone</u> as above, <u>sandstone</u> , fine grained, angular.
1,874m	3	Good	M.P.	<u>Claystone</u> , grey, subplaty, silty, micromicaceous, organic debris, slightly calcareous.
1,874.4m	3	Good	M.	<u>Claystone</u> , as above.

KEY

M = Micropaleontology
N = Nannoplankton
P = Palynology
Pt = Petrography
* = additional samples sent



SEDIMENTARY HISTORY®

CLIENT:

STATOIL

WELL NO:

34/10-19

FIGURE:

I

DATE:

MARCH 1984

PROJECT NO:

1226

ANALYSTS:

J.J.,J.B.K.,R.W.M.

PALEOSERVICES

Unit 15, Paramount Industrial Estate,
Sandown Road,
Watford, WD2 4UR, England

KEY:

Missing section

Open marine circulation

Restricted circulation

Mainly coarse clastics (sand)

Mainly fine clastics (silt, clay)

Carbonates

Evaporites

Volcanics

Transgression

