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STATOIL 30/3-3 NORWEGIAN NORTH SEA WELL:

BIOSTRATIGRAPHY OF THE INTERVAL 1900m - 3418m

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10. The well terminated within the arenaceous Statfjord Formation of probable Sinemurian age.

INTRODUCTION

This report summarises the results of the micropalaeontological, palynological and stratigraphical analyses which have been carried out on material received from the section 1900m-3418m from the Statoil 30/3-3 Norwegian North Sea Well under Project No. RRPS/834/A/10581.

The following analyses were carried out:
Lithology: 300 ditch cuttings, 33 sidewall core and 4 core samples from the entire section.
Micropalaeontology: 146 ditch cuttings and 9 sidewall core samples from the interval 1900m-3380m.
Palynology: 64 ditch cuttings, 25 sidewall core and 4 core samples from the interval 2500m-3418m.

The basic breakdown obtained by these analyses has already been communicated by telex and telephone and forms the framework of factual information on which this report is based. A summary of the sequence penetrated in this well can be seen on pages 5 and 6.

All rock colour references in this report conform to the "Rock-Color Chart" distributed by the Geological Society of America. The lithological descriptions of the sidewall cores can be seen in Appendix 1, whilst those of the core samples occur in Appendix 2.

It should be noted that the lithostratigraphic terminology is taken from Deegan and Scull (1977). The stratigraphic significance of the Rhaetian - Volgian dinocyst zones is summarised in Appendix 3.

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 Statoil with whom we have been associated during the course of this work.

Robertson Research staff involved in this study were:

Jim Fenton : Palynology and Project Co-ordinator
Paul Frame : Micropalaeontology
Nick Miles : Palynology
Alison Shaw : Lithostratigraphy
Dave Shipp : Micropalaeontology

BIOSTRATIGRAPHIC SUCCESSION

Age		Tops
Late Palaeocene		1900m(top not seen)
Early Palaeocene	Danian	2170m
----------	----------Unconformity----------	----------
Late Cretaceous	late Maastrichtian - Maastrichtian	2210m
	early Maastrichtian	2280m
	late Campanian	2340m
	early Campanian	2425m
	Santonian	2652.50m
----------	----------Unconformity----------	----------
Early Cretaceous	middle Albian - Barremian	2655m
----------	----------Unconformity----------	----------
Early Cretaceous - Late Jurassic	early Ryazanian - late Volgian	2664m(log)
Late Jurassic	middle - early Volgian	2740m
	Kimmeridgian	2770m(SWC)
	early Kimmeridgian - middle Oxfordian	2782.50m
	early Oxfordian	2855m(SWC)
	late Callovian	2887.50m
	middle Callovian	2917.50m
	early Callovian	2970m
----------	----------Unconformity----------	----------
Middle Jurassic	early Bathonian - late Bajocian	2977.50m(log)
	----------Unconformity----------	----------
	middle - early Bajocian	2991m(log)

Middle - Early Jurassic	earliest Bajocian - middle Toarcian	3070m
Early Jurassic	early Toarcian	3186m(SWC)
	late Pliensbachian - Sinemurian	3220m(SWC)-3418m

This breakdown has been achieved by the analysis of ditch cuttings, sidewall core and core piece samples. Electric log information was made available.

LITHOSTRATIGRAPHIC SUCCESSION

Units	Age	Tops
Rogaland Group:		
Balder Formation	Late Palaeocene	1900m(top not seen)
Sele Formation	Late Palaeocene	2006m(log)
Lista Formation	Late Palaeocene	2070m
Montrose Group:		
Maureen Formation Equivalent	Early Palaeocene, Danian	2170m
Shetland Group:	late Maastrichtian - Maastrichtian to Santonian	2210m
Cromer Knoll Group:	middle Albian - Barremian	?2655m
Humber Group:		
Kimmeridge Clay Formation	early Ryazanian - late Volgian to Kimmeridgian	2664m(log)
Heather Formation	Kimmeridgian - early Callovian	2780m(log)
Brent Group:		
Tarbert Formation	early Bathonian - late Bajocian	2977.50m(log)
Ness Formation	middle - early Bajocian	2991m(log)
Unassigned Unit:	middle - early Bajocian to earliest Bajocian - middle Toarcian	3034m(log)

Dunlin Group:		
Drake Formation	earliest Bajocian - middle Toarcian to late Pliensbachian - Sinemurian	3116m(log)
"Sand Unit"	late Pliensbachian - Sinemurian	3241m(log)
"Shale Unit"	late Pliensbachian - Sinemurian	3288m(log)
Statfjord Formation	late Pliensbachian - Sinemurian	3387m(log)-3418m

LITHOSTRATIGRAPHY

The lithostratigraphic nomenclature used in this report is taken from Deegan and Scull (1977). Wireline logs were provided for use in the study and all but four of the lithostratigraphic boundaries are based on log breaks.

All depths quoted are uncorrected drillers depths unless otherwise stated.

LITHOSTRATIGRAPHIC UNITS

ROGALAND GROUP: 1900m(top not seen)-2170m; Age: Late Palaeocene.

Balder Formation: 1900m(top not seen)-2006m(log).
The predominant lithologies in this unit are shales which are light grey to greenish grey, greyish red and micromicaceous. The shales become mainly medium grey below 1980m. Subordinate tuffaceous shales are recorded throughout and become particularly common below 1985m; these sediments are grey and white, waxy and rubbly.

Pyrite and siderite are common accessories throughout and traces of hard, pale orange limestone are considered to represent stringers or concretions.

Sele Formation: 2006m(log)-2070m.
The upper boundary of this formation is based on a log break. The lithologies comprise shales which are weakly fissile, finely laminated and medium dark grey. Traces of limestone, siderite and pyrite occur throughout. Lithologies are masked by casing cement and lost circulation material between 2050m and 2065m.

Lista Formation: 2070m-2170m.
The upper limit of this unit is marked by an influx of fine to medium grained, loose sand in ditch cuttings samples. Shales remain the predominant lithology; these are medium dark grey to olive grey and greenish grey, micromicaceous and non-laminated. Traces of glauconite, siderite, pyrite and limestone are recorded. Fragments of limestone become particularly common below 2150m, consisting of hard, medium grey, slightly argillaceous limestone and probably

representing stringers or concretions.

MONTROSE GROUP: 2170m-2210m; Age: Early Palaeocene, Danian.

Maureen Formation Equivalent

The upper boundary of this formation is based on the increase in the calcareous nature of the shales. These shales are olive grey to medium grey and weakly calcareous, becoming medium light grey and moderately calcareous below 2185m. Traces of crystalline calcite and glauconite are recorded with subordinate, light brownish grey limestone below 2185m. Glauconite grains become abundant below 2205m.

SHETLAND GROUP: 2210m-?2655m; Age: Late Cretaceous, late Maastrichtian - Maastrichtian to Santonian.

The upper limit of this unit is based on an influx of white, slightly chalky limestone in the ditch cuttings samples at 2210m. Wireline log evidence suggests a depth of 2211m for the top of this limestone. This discrepancy is explained by the difference between drillers and loggers depths, which may be as much as 4m. Calcareous claystones are the predominant lithology below 2215m. These sediments are medium grey to greenish grey, olive grey and micromicaceous. Traces of glauconite, pyrite, calcite and common microfossils are recorded throughout. Subordinate limestone stringers occur sporadically, consisting of white to light grey limestone. A thicker development of pale brown limestone is indicated in wireline logs between 2412m(log) and 2424.50m(log).

Traces of fine, loose sand are recorded intermittently throughout, probably representing thin stringers of sandstone. Rare siderite occurs below 2590m and becomes abundant below 2650m.

CROMER KNOLL GROUP: ?2655m-2664m(log); Age: Early Cretaceous, middle Albian - Barremian.

The upper boundary of this unit is tentatively placed at 2655m, based on biostratigraphic evidence. No change in lithotype is observed until a depth of 2560m, where fragments of white to very light grey limestone are recorded, probably representing the older part of this interval.

Calcareous claystones are the predominant lithology; these sediments are medium grey to medium dark grey with traces of calcite, pyrite and sand. Minor white to very light grey limestones occur at 2659m(log) and between 2662m(log) and 2664m(log).

HUMBER GROUP: 2664m(log)-2977.50m(log); Age: Early Cretaceous - Late Jurassic, early Ryazanian - late Volgian to Late Jurassic, early Callovian.

Kimmeridge Clay Formation: 2664m(log)-2780m(log); Age: Early Cretaceous - Late Jurassic, early Ryazanian - late Volgian to Late Jurassic, Kimmeridgian.

The upper boundary of this formation is based on a log break reflecting a change in lithotype to the black shales typical of the Kimmeridge Clay Formation. Due to the discrepancy between drillers and loggers depths, however, these shales are first recorded in the ditch cuttings sample at 2662.50m.

The shales are fissile, olive black to brownish black, dark grey, micromicaceous and non-calcareous. Traces of pyrite, siderite, carbonaceous material and sand occur sporadically throughout. Increasing amounts of medium grey shale with subordinate brownish grey limestone are recorded below 2755m, with abundant sphaerosiderite between 2755m and 2765m.

Heather Formation: 2780m(log)-2977.50m(log); Age: Late Jurassic, Kimmeridgian to early Callovian.

The upper limit of this unit is based on a log break marking the top of a sequence of shales and minor limestones with a lower gamma ray response than that of the overlying Kimmeridge Clay Formation shales.

The shales are fissile, medium grey to dark grey, olive black, micromicaceous and locally highly micaceous. Subordinate limestones are brownish grey with calcite, probably representing stringers or concretions. Fragments of limestone become increasingly common in ditch cuttings samples below 2840m. Shale is present in subordinate quantities down to 2830m, below which depth shales become the predominant lithology. These shales are brownish grey to dark grey, olive black and micaceous, locally becoming slightly silty and dusky yellowish brown.

Pyrite and calcite are common throughout and abundant sphaerosiderite is recorded at 2890m and from 2910m to 2935m.

BRENT GROUP: 2977.50m(log)-3034m(log); Age: Middle Jurassic, early Bathonian - late Bajocian to middle - early Bajocian.

Tarbert Formation: 2977.50m(log)-2991m(log); Age: Middle Jurassic, early Bathonian - late Bajocian.

This formation comprises argillaceous sandstone, which is well cemented, medium light grey, very fine to fine grained and micaceous with carbonaceous fragments. Argillaceous partings of medium dark grey, micaceous shale are present locally.

Ness Formation: 2991m(log)-3034m(log); Age: Middle Jurassic, middle - early Bajocian.

This unit comprises a sequence of sandstones interbedded with shales, claystones, coals and argillaceous sandstones.

Between 2991m(log) and 3000m(log), brownish grey and olive black claystones predominate, with minor coals and sandstones. From 3000m(log) to 3017m(log), sandstones become the main lithology and these sediments are white, fine to medium grained and kaolinitic with rare coarse grains. Shales and coals dominate the section from 3017m(log) to 3028m(log) with sandstones and shales comprising the remainder of the interval. A coal marks the base of this unit.

UNASSIGNED UNIT: 3034m(log)-3116m(log); Age: Middle Jurassic, middle - early Bajocian to Middle - Early Jurassic, earliest Bajocian - middle Toarcian.

This interval has a similar log character to the sand unit which is usually assigned to the Etive/Rannoch Formations in this area of the North Sea. Biostratigraphic evidence suggests, however, that the lower part of this sand is older than nearby Brent Group sediments, hence this unit has not been assigned to the Brent Group.

The predominant lithology is sandstone which is white to pinkish grey, fine tocoarse grained, kaolinitic, micaceous and locally weakly calcareous. Minor argillaceous interbeds are indicated on wireline logs, consisting of shales which are brownish grey to dark grey and micromicaceous with rare carbonaceous fragments.

DUNLIN GROUP: 3116m(log)-3387m(log); Age: Middle - Early Jurassic, earliest Bajocian - middle Toarcian to Early Jurassic, late Pliensbachian - Sinemurian.

One formation and two informal units are recognised within this group.

Drake Formation: 3116m(log)-3241m(log); Age: Middle - Early Jurassic earliest Bajocian - middle Toarcian to Early Jurassic, late Pliensbachian - Sinemurian.

This formation consists predominantly of shales which are dark yellowish brown to dark grey and olive black to olive grey, micromicaceous, locally silty with rare carbonaceous fragments and pyrite. A minor sandstone unit is recorded between 3152m(log) and 3166m(log). These sediments are friable, light grey to white, very fine to medium grained and kaolinitic with traces of pyrite.

"Sand Unit": 3241m(log)-3288m(log); Age: Early Jurassic, late Pliensbachian - Sinemurian.

This unit comprises sandstones which become finer grained and increasingly argillaceous with depth. The sandstones are white, fine grained and kaolinitic, locally with calcareous cement, becoming very pale orange to dark yellowish brown and very fine grained with minor shale partings.

"Shale Unit": 3288m(log)-3387m(log); Age: Early Jurassic, late Pliensbachian - Sinemurian.

The predominant lithology in this unit is shale which is olive black, micaceous and locally very weakly calcareous with carbonaceous fragments. Below 3346m(SWC), the shales become dusky yellowish brown micaceous and locally sandy, grading into argillaceous sandstone. Rare fragments of limestone and calcite are recorded between 3330m and 3345m, probably representing stringers or concretions.

Traces of white, fine grained sandstone occur below 3376m(SWC).

STATFJORD FORMATION: 3387m(log)-3418m; Age: Early Jurassic, late Pliensbachian - Sinemurian.

The upper boundary of this formation is marked by an influx of fine to coarse grained sand. This is first recorded in the ditch cuttings sample at 3380m, however, wireline logs indicate an upper limit of 3387m. This discrepancy is explained by the difference between drillers and loggers depths which may be up to 7m.

The sandstones are fairly friable, pinkish grey to white, fine to coarse grained and kaolinitic with carbonaceous fragments and traces of pyrite. These sediments are locally light grey and slightly argillaceous.

BIOSTRATIGRAPHY

VI (1) TERTIARY

INTERVAL 1900m-2170m; LATE PALAEOCENE (top not seen)

Lithostratigraphic Units:
Rogaland Group;
Balder Formation: 1900m-2006m(log),
Sele Formation: 2006m(log)-2070m,
Lista Formation: 2070m-2170m.

Environment: marine, outer shelf to upper bathyal.

The age of this interval is based on the following lithostratigraphic and micropalaeontological criteria:

- the presence of volcanic, tuffaceous deposits from 1900m.
- the occurrence of the diatom Coscinodiscus sp.1 at 1920m and the foraminifer Trochammina sp.A at 2100m.

MICROPALAEONTOLOGY

The microfaunas of this interval are dominated by agglutinated species, particularly of the Bathysiphon/Rhizammina Group, Haplophragmoides spp., Recurvoides spp. and Cyclammina spp.

Common, red stained planktonic foraminifera including Globigerina linaperta and G. triloculinoides were recovered from the uppermost section of this interval (1900m-1920m). The presence of the latter species and the associated red staining characteristically indicate the presence of the Globigerina triloculinoides Assemblage of Early Eocene age. In view of the occurrence of typical Late Palaeocene tuffaceous deposits at 1900m, however, a Late Palaeocene age can be assigned to the interval and the above species are considered to be caved.

The first micropalaeontological evidence confirming the age of the interval occurs at 1920m with the presence of the diatom Coscinodiscus sp.1 indicating the development of the Coscinodiscus sp.1 Assemblage of Late Palaeocene age. The subsequent occurrence of Trochammina sp.A at 2100m further supports this age determination.

Early Palaeocene, Danian reworking is recorded at 1940m and 2020m.

INTERVAL 2170m-2210m; EARLY PALAEOCENE, DANIAN

Lithostratigraphic Unit:
Montrose Group;
Maureen Formation Equivalent.

Environment: marine, inner to outer shelf.

The upper limit and age of this interval are based on the following micropalaeontological criteria:

- the presence of Globigerina trivialis at and below 2170m.
- the subsequent occurrence of Globorotalia pseudobulloides (2180m) and G. cf. compressa (2190m).

The base of this interval is marked by an unconformity separating the Tertiary from the Late Cretaceous and resulting in the absence of part of the Early Palaeocene, Danian.

MICROPALAEONTOLOGY

As in the overlying section agglutinated foraminifera dominate the microfaunas of this interval. The presence of rare planktonic species, however, is also recorded.

The occurrence of Globigerina trivialis at 2170m is taken to represent the Late/Early Palaeocene boundary. The incoming of this species and the subsequent occurrence of Globorotalia pseudobulloides (2180m) and G. cf. compressa (2190m) also indicate penetration of the P.2 Zone of the Early Palaeocene, Danian. No evidence for the older P.1 Zone is recorded.

INTERVAL 2210m-2280m; LATE CRETACEOUS, LATE MAASTRICHTIAN - MAASTRICHTIAN

Lithostratigraphic Unit:
Shetland Group (part).

Environment: marine, inner to outer shelf.

The upper limit and age of this interval are based on the following micropalaeontological criterion:

- the appearance of Pseudotextularia elegans fructicosa, P. elegans elegans and Globotruncana contusa at 2210m.

MICROPALAEONTOLOGY

Planktonic foraminifera dominate the microfaunas of this interval, being represented mainly by the Rugoglobigerina/Archaeoglobigerina complex, Globigerinelloides asper and at the top of the interval, Pseudotextularia spp. and Globotruncana contusa.

The presence of common Pseudotextularia elegans fructicosa, P. elegans elegans and Globotruncana contusa at 2210m indicates a late Maastrichtian age at that depth. It has not proved possible to subdivide the late Maastrichtian and Maastrichtian deposits, although the assemblages recorded suggest that both intervals are present.

A number of other Late Cretaceous species also have their first occurrences in this interval. These include Stensioina pommerana (2210m), Abathomphalus mayaroensis (2225m (SWC)), Reussella szajnochae szajnochae (2230m), Heterohelix costulata (2230m), Heterohelix globulosa (2250m) and Reussella szajnochae elongata (2260m).

Tertiary caving occurs in this interval and continues through most of the underlying Late Cretaceous.

Late Cretaceous, Campanian reworking was recorded at 2240m, 2250m and 2260m.

INTERVAL 2280m-2340m; LATE CRETACEOUS, EARLY MAASTRICHTIAN

Lithostratigraphic Unit:
Shetland Group (part).

Environment: marine, inner to outer shelf.

The upper limit and age of this interval are based on the following micropalaeontological criterion:

- the influx of abundant Rugoglobigerina/Archaeoglobigerina complex together with common, consistently occurring Rugoglobigerina rugosa rotundata at 2280m.

MICROPALAEONTOLOGY

Planktonic foraminifera again dominate the microfaunas, being represented principally by the Rugoglobigerina/Archaeoglobigerina complex.

The marked influx of abundant Rugoglobigerina/Archaeoglobigerina complex at 2280m indicates the development of the Rugoglobigerina/Archaeoglobigerina Assemblage of early Maastrichtian age. The associated occurrence of common and consistently occurring Rugoglobigerina rugosa rotundata at and below this depth supports the age determination.

INTERVAL 2340m-2425m; LATE CRETACEOUS, LATE CAMPANIAN

Lithostratigraphic Unit:
Shetland Group (part).

Environment: marine, inner to outer shelf.

The upper limit and age of this interval are based on the following micropalaeontological criterion:

- the occurrence, at 2340m, of Globotruncana sp.1 and G. marginata.

MICROPALAEONTOLOGY

Planktonic foraminifera, principally of the Rugoglobigerina/Archaeoglobigerina complex, are again dominant throughout this interval.

The presence of Globotruncana sp.1 and Globotruncana marginata from 2340m indicates a late Campanian age for the interval. The occurrence of these two species allows the microfaunas of the interval to be assigned to the Globotruncana marginata Assemblage.

Tertiary caving is present throughout the section.

INTERVAL 2425m-2652.50m; LATE CRETACEOUS, EARLY CAMPANIAN

Lithostratigraphic Unit:
Shetland Group (part).

Environment: marine, inner to outer shelf.

The upper limit and age of this interval are based on the following micropalaeontological and palynological criteria:

- the occurrence of Tritaxia dubia and Dorothia sp.1 at 2425m.
- the subsequent occurrence of Tritaxia tricarinata (2535m).
- the appearance of Callaiosphaeridium asymmetricum at 2560m.

MICROPALAEONTOLOGY

Very consistent microfaunas, again dominated by the planktonic Rugoglobigerina/Archaeoglobigerina complex, occur throughout this interval. The appearance of the agglutinating species Tritaxia dubia and Dorothia sp.1 at 2425m, however, indicates that the early Campanian has been penetrated. The subsequent occurrence of Tritaxia tricarinata at 2535m supports this determination.

PALYNOLOGY

Assemblages recovered at and below 2500m are dominated by microplankton, with miospores being a very minor constituent. Palynofloras are characterised by the common to abundant occurrences of the Spiniferites ramosus group, Ceratiopsis diebelii, Palaeoperidinium pyrophorum, Hystrichosphaeridium tubiferum, Areoligera spp., Chatangiella spp./Isabelidinium spp., Cyclonephelium spp., Chatangiella granulifera and Trithyrodinium suspectum. Palaeocene cavings are conspicuous in most assemblages.

The overall composition of the palynofloras is indicative of a Campanian age, with the co-occurrences of large numbers of C. diebelii, Spongodinium delitiense and Raphidodinium fucatum, in association with taxa such as T. suspectum, Alterbia acutula (2500m), Odontochitina spp., Chatangiella granulifera and Trichodinium castaneum. An age no younger than early Campanian is indicated at 2560m by the appearance of Callaiosphaeridium asymmetricum.

The sidewall core at 2640m yielded a palynoflora of early Campanian age, characterised by the simultaneous presence of Callaiosphaeridium asymmetricum, Spinidinium clavum, Trigonopyxidia ginella, Hystrichosphaeridium sp.2 McIntyre, abundant specimens of T. suspectum and numerous specimens of Raphidodinium fucatum.

Reworked miospores are occasionally encountered reflecting recycling of deposits of Permo-Triassic and Late - Middle Jurassic ages.

INTERVAL 2652.50m-2655m; LATE CRETACEOUS, SANTONIAN

Lithostratigraphic Unit:
Shetland Group (part).

Environment: marine, inner to outer shelf.

The upper limit and age of this interval are based on the following micropalaeontological criterion:

- the occurrence of common, green stained spongodiscid radiolaria at 2625.50m.

The base of this interval is marked by an unconformity separating the Late and Early Cretaceous, resulting in the absence of any Coniacian to late Albian deposits.

MICROPALAEONTOLOGY

Moderately common foraminifera were recorded in this interval with planktonic and agglutinated species predominating.

No foraminiferal marker species were recovered from the interval. The presence of common, green stained spongodiscid radiolaria at 2652.50m, however, suggests the presence of Santonian deposits, these radiolaria being a common feature of the Santonian.

INTERVAL 2655m-2664m(log): EARLY CRETACEOUS, MIDDLE ALBIAN - BARREMIAN

Lithostratigraphic Unit:
Cromer Knoll Group.

Environment: shallow marine, inner shelf.

The upper limit and age of this interval are defined upon the following micropalaeontological and palynological criteria:

- the presence of Praebulimina sp.1 at 2655m and the overall nature of the microfaunas.
- the occurrence of a specimen of Cribroperidinium cornutum at 2655m.

An unconformity is present at the base of this interval resulting in the absence of sediments of Hauterivian - late Ryazanian age.

MICROPALAEONTOLOGY

A marked decline in planktonic abundance occurs throughout this interval with an associated increase in agglutinated and, to a lesser extent, calcareous benthonic abundances.

The foraminifera recovered from this interval suggest that sediments of a broad age range are represented. The occurrence of Praebulimina sp.1 at 2655m indicates that sediments of middle Albian - Aptian age have been penetrated. This is supported by the predominance of agglutinated species in the samples, including Recurvoides spp. and Glomospira spp. The increased occurrence lower in the section of calcareous benthonic species, particularly Lenticulina spp. and ostracods, however, may also indicate the presence of sediments of an older, Barremian age. It is not possible, due to the sample intervals received, to subdivide this interval further or to determine whether it represents a condensed sequence of sediments or if there are any hiatuses present in the section. Consequently, only a broad middle Albian to Barremian age can be assigned.

PALYNOLOGY

Palynofloras recovered from 2655m and 2660m are considerably modified by caved taxa of Eocene/Palaeocene and Late Cretaceous ages. Assemblages are

characterised by common/abundant specimens of Palaeoperidinium pyrophorum and species of Chatangiella, associated with taxa such as Raphidodinium fucatum, Odontochitina spp., Trithyrodinium suspectum and Spongodinium delitiense. Miospores are a minor constituent. In situ palynomorphs are impoverished.

A single specimen of Cribroperidinium cornutum was recorded at 2655m, a taxon stratigraphically restricted to deposits of Barremian age. The only specimens thought to be in situ at 2660m are those of Oligosphaeridium complex exhibiting "typical" Early Cretaceous process development.

VI (3) CRETACEOUS - JURASSIC

INTERVAL 2664m(log)-2740m; EARLY CRETACEOUS - LATE JURASSIC, EARLY RYAZANIAN - LATE VOLGIAN

Lithostratigraphic Unit:
Humber Group (part);
Kimmeridge Clay Formation (part).

Environment: marine, inner shelf with anaerobic/dysaerobic conditions at the sediment/water interface and possible water stratification.

A log break defines the interval top. The age is based upon the following palynological criteria:

- the appearance of Cannosphaeropsis thula at 2665m(SWC).
- the presence, at 2703m(SWC), of Aldorfia spongiosa and of Batioladinium pomum at 2710m.

MICROPALAEONTOLOGY

The appearance of a specimen of Haplophragmoides infracalloviensis at 2662.50m provides evidence for the penetration of the Kimmeridge Clay Formation. The fact that the log break marking the top of this formation is at 2664m suggests that there is a slight discrepancy between the drillers depths and log depths. Rare specimens of Haplophragmoides spp., exhibiting the brown preservation associated with the Kimmeridge Clay Formation, are the only other in situ foraminifera present, although caved Tertiary and Cretaceous forms are frequently seen. The presence of common specimens of the radiolarian Lithostrobus spp. at and below 2685m may prove of use for local correlations.

PALYNOLOGY

The palynological analysis of ditch cuttings and sidewall core samples from this interval yielded microplankton dominated assemblages, typical of the Kimmeridge Clay Formation in composition and preservation. Elements of the Hystrichosphaerina orbifera group and the prasinophycean algae Pterospermella spp. and large leiospheres occur consistently, and are sometimes numerous to common.

A specimen of Cannosphaeropsis thula at 2665m(SWC) indicates an age no younger than the early Ryazanian, Cannosphaeropsis sp.A Subzone (VC). The subsequent occurrence of Aldorfia spongiosa at 2703m(SWC), a dinocyst with a stratigraphic range of early Ryazanian - late Volgian, supports this age assignment, as does the occurrence of Batioladinium pomum at 2710m.

INTERVAL 2740m-2770m(SWC); LATE JURASSIC, MIDDLE - EARLY VOLGIAN

Lithostratigraphic Unit:
Humber Group (part);
Kimmeridge Clay Formation (part).

Environment: marine, inner shelf, with anaerobic/dysaerobic bottom conditions and partial water mass stratification.

The age and upper limit of the interval are defined upon the following palynological criteria:

- the appearance of Glossodinium dimorphum at 2740m.
- the subsequent occurrences of specimens of Gonyaulacysta longicornis and Oligosphaeridium pulcherrimum sensu Ioannides et al. in the ditch cuttings sample at 2770m.

MICROPALAEONTOLOGY

The microfaunas recovered from this interval are essentially the same as those seen above, with rare Haplophragmoides spp. being recorded together with specimens of Lithostrobus spp.

PALYNOLOGY

Three ditch cuttings samples analysed from this interval continued to yield abundant amorphous organic matter. The palynofloras recovered were dominated by microplankton; characteristic elements of the assemblages including members of the Systematophora areolaria and Hystrichosphaerina orbifera groups, Tubotuberella apatela, and prasinophycean algae such as Pterospermella spp. and Tasmanites spp. Bisaccate pollen (abundant at 2762.50m), Cerebroipollenites mesozoicus and Callialasporites dampieri are typical elements of the miospore suite.

The appearance of Glossodinium dimorphum at 2740m indicates an age no younger than the middle Volgian, Dichadogonyaulax pannea Subzone (VIIA). Evidence for the presence of sediments of early Volgian age is seen only in the ditch

cuttings sample at 2770m, where specimens of Oligosphaeridium pulcherrimum sensu Ioannides et al. and Gonyaulacysta longicornis are encountered. The combined occurrence of these two taxa characterises deposits assignable to the Egmontodinium polyplacophorum Subzone (IXA) of the G. longicornis Zone (IX).

INTERVAL 2770m(SWC)-2782.50m; LATE JURASSIC, KIMMERIDGIAN

Lithostratigraphic Units:
Humber Group (part);
Kimmeridge Clay Formation (part): 2770m(SWC)-2780m(log),
Heather Formation (part): 2780m(log)-2782.50m.

Environment: marine, inner shelf with aerobic/dysaerobic bottom conditions.

The age and upper limit of the interval are defined upon the following palynological criterion:
- the appearance of Gonyaulacysta jurassica at 2770m(SWC).

MICROPALAEONTOLOGY

Rare Haplophragmoides spp. and specimens of Lithostrobus spp. continue to be recorded from this thin interval.

PALYNOLOGY

A miospore dominated palynoflora was recovered from the sidewall core at 2770m, characterised by common undifferentiated bisaccates.

The appearance of Gonyaulacysta jurassica indicates an age no younger than the Kimmeridgian, Scriniodinium luridum Subzone (IXB) of the Gonyaulacysta longicornis Zone (IX).

A single specimen of Lycospore sp. is present reflecting reworking of Carboniferous deposits.

INTERVAL 2782.50m-2855m(SWC); LATE JURASSIC, EARLY KIMMERIDGIAN - MIDDLE OXFORDIAN

Lithostratigraphic Unit:
Humber Group (part);
Heather Formation (part).

Environment: marine, inner shelf with aerobic/dysaerobic bottom conditions.

The upper limit and age of the interval are based upon the following palynological criteria:

- the appearance of Scriniodinium crystallinum and the occurrence of numerous specimens of Gonyaulacysta jurassica at 2782.50m.
- the subsequent occurrence of Leptodinium mirabile between 2812.50m and 2842.50m.
- the appearance of Nannoceratopsis pellucida at 2842.50m.

MICROPALAEONTOLOGY

The microfaunas of this interval are essentially as seen above. There is, however, a change near the base where Lenticulina varians appears suggesting that the bottom waters were more oxygenated in the lower part of this interval. The appearance of this species is consistent with an early Kimmeridgian - middle Oxfordian age.

PALYNOLOGY

The ditch cuttings and single sidewall core samples analysed from this interval yielded palynofloras dominated by gymnosperm pollen, including common to abundant undifferentiated bisaccates, Cerebropollenites mesozoicus and Callialasporites dampieri. Pteridophyte miospores are less numerous and less diverse. The microplankton assemblages are moderately diverse and are characterised by Gonyaulacysta jurassica, microforaminiferal test linings and Sirmiodinium grossii (which becomes numerous to common below 2812.50m).

Scriniodinium crystallinum makes its first downhole appearance at 2782.50m, indicating an age no younger than the early Kimmeridgian/late Oxfordian Scriniodinium crystallinum Zone (XI). The simultaneous increase in numbers of Gonaulacysta jurassica is also characteristic of this age.

Nannoceratopsis pellucida is present in the deepest sample in this interval (2842.50m). This dinocyst ranges no younger than middle Oxfordian in this area of the North Sea, and indicates that the basal part of this interval is no younger than the early part of the Compositosphaeridium costatum Subzone (XIIB). The presence of Leptodinium mirabile from 2812.50m to 2842.50m (its last downhole occurrence) supports this conclusion, since this dinocyst ranges no older than the middle Oxfordian, Acanthaulax spinosissima Zone (XIII).

INTERVAL 2855m(SWC)-2887.50m; LATE JURASSIC, EARLY OXFORDIAN

Lithostratigraphic Unit:
Humber Group (part);
Heather Formation (part).

Environment: marine, inner shelf with aerobic bottom conditions.

The age and top of the interval are defined upon the following palynological criteria:

- the appearance of abundant specimens of Adnatosphaeridium aemulum and Acanthaulax spinosissima at 2855m(SWC).
- the subsequent occurrence of Atopodinium prostatum at 2857.50m.
- the presence of Wanaea fimbriata, W. thysanota and Crussolia deflandrei at 2870m(SWC).

MICROPALAEONTOLOGY

Microfaunas from this interval are generally poor. The appearance of Haplophragmoides canui at 2880m could represent the top of the Haplophragmoides canui Assemblage, but a much better top is seen in the underlying interval with the influx of Haplophragmoides spp. and this has been preferred. The suggestion that this assemblage could be present in the base of this interval means the possibility that Callovian deposits are present from 2880m and should not be ignored.

PALYNOLOGY

Two sidewall core and two ditch cuttings samples were analysed from this interval. The sidewall core sample at 2855m yielded a very poorly preserved but diverse and numerous dinocyst palynoflora. Abundant Adnatosphaeridium aemulum and Acanthaulax spinosissima together with common Sirmiodinium grossii and Gonyaulacysta jurassica dominate.

From 2857.50m to 2870m(SWC) less diverse assemblages were recorded, characterised by numerous to common A. aemulum and S. grossii with rare to numerous Gonyaulacysta cladophera and consistently occurring G. jurassica.

Throughout the entire interval the miospore assemblages are dominated by gymnosperm pollen, particularly undifferentiated bisaccates and Cerebropollenites mesozoicus.

The occurrence of abundant specimens of A. aemulum and A. spinosissima at 2855m(SWC) is characteristic of an early Oxfordian age, no younger than the Gonyaulacysta areolata Subzone (XIVA) of the Wanaea digitata Zone (XIV). An early Oxfordian age is substantiated at 2857.50m by the occurrence of Atopodinium prostatum.

An age equivalent to the Wanaea fimbriata Subzone (XIVB) is indicated at 2870m(SWC) by the occurrence of the subzonal index taxon. Within the same assemblage specimens of Wanaea thysanota and Crussolia deflandrei are encountered substantiating an age no younger than early Oxfordian. The latter taxon has, to date, only been recorded from the Tethyan Province (Southern France). Its record in this well is considered to reflect the existence of open marine connections between this area of the Viking Graben and the Tethyan Province to the south.

INTERVAL 2887.50m-2917.50m; LATE JURASSIC, LATE CALLOVIAN

Lithostratigraphic Unit:
Humber Group (part);
Heather Formation (part).

Environment: marine, inner shelf with aerobic bottom conditions.

The upper limit and age of the interval are defined upon the following palynological and micropalaeontological criteria:

- the appearance of Mendicodinium groenlandicum at 2887.50m.
- an increase in agglutinating foraminifera at 2890m and the subsequent occurrence of abundant Haplophragmoides spp., including H. canui from 2900m.
- the appearance of common specimens of Pareodinia ceratophora at 2902.50m.

MICROPALAEONTOLOGY

There is a noticeable increase in agglutinating foraminifera at 2890m followed by an influx of Haplophragmoides spp., including H. canui at 2900m. Abundant Haplophragmoides spp. continue to occur through the remainder of the interval. This microfauna is characteristic of the Haplophragmoides canui Assemblage of Callovian age.

PALYNOLOGY

Miospore dominated palynofloras were recovered from the ditch cuttings samples at 2887.50m and 2902.50m, characterised by common undifferentiated bisaccates. Relative to the overlying early Oxfordian interval, a marked change in the preservation of kerogen and reduction in both diversity and numbers of microplankton is encountered.

Specimens of Mendicodinium groenlandicum appear at 2887.50m, tentatively suggesting an age no younger than the late Callovian, M. groenlandicum Subzone (XIVC) of the Wanaea digitata Zone (XIV). Although this taxon possesses a total stratigraphic range of Ryazanian - Callovian, it usually achieves its numerical acme within the late Callovian. The appearance of specimens of M. groenlandicum at 2887.50m is, therefore, considered to probably reflect this event. Within the same assemblage, a specimen of Pareodinia evittii is recorded tentatively substantiating an age no younger than Callovian.

A feature of potential correlative value is the presence, at 2902.50m, of common Pareodinia ceratophora, a well documented intra-Callovian palynoevent.

INTERVAL 2917.50m-2970m; LATE JURASSIC, MIDDLE CALLOVIAN

Lithostratigraphic Unit:
Humber Group (part);
Heather Formation (part).

Environment: marine, inner shelf with aerobic bottom conditions.

The age and upper limit of the interval are based upon the following palynological criteria:

- the appearance of the Lithodinia cristulata/caytonensis plexus at 2917.50m.
- the presence of common specimens of Chytroeisphaeridia hyalina at 2932.50m.
- the occurrence, at 2932.50m, of Stephanelytron scarburghense.
- the subsequent presence of Chytroeisphaeridia cerastes at 2947.50m.

MICROPALAEONTOLOGY

Abundant Haplophragmoides spp. including H. canui, continue to occur in this interval with a further increase in the numbers recorded at 2950m. The Haplophragmoides canui Assemblage is, therefore, represented again and continues to indicate a Callovian age.

PALYNOLOGY

Three ditch cuttings samples and one sidewall core sample were analysed for palynology from this interval.

Gymnosperm pollen grains were the most common elements of the palynofloras and became increasingly abundant towards the base of the section. Microplankton assemblages recovered were moderately diverse. Pareodinia ceratophora is common at 2917.50m but only rare below this depth. Chytroeisphaetridia hyalina is common at 2932.50m becoming increasingly rare below this depth. Gonyaulacysta jurassica, G. cladophora and Lithodinia spp. occurred consistently throughout the interval.

The appearance of members of the Lithodinia cristulata/caytonensis plexus at 2917.50m indicates an age no younger than the middle Callovian, Polystephanephorus paracalathus Zone (XV).

The subsequent occurrence of common specimens of Chytroeisphaeridia hyalina at 2932.50m indicates the penetration of sediments no younger than the Nannoceratopsis pellucida Subzone (XVB). The last downhole occurrence of Stephanelytron scarburghense at the same horizon and Chytroeisphaeridia cerastes at 2947.50m supports this age assignment, as these dinocysts range no older than middle Callovian, N. pellucida Subzone (XVB) of the Polystephanephorus paracalathus Zone (XV).

INTERVAL 2970m-2977.50m(log); LATE JURASSIC, EARLY CALLOVIAN.

Lithostratigraphic Unit:
Humber Group;
Heather Formation (part).

Environment: marine, inner shelf with aerobic bottom conditions.

The upper limit and age of the interval are defined upon the following palynological criteria:

- the appearance of Sentusidinium varispinosum at 2970m.
- the occurrence of ?caved specimens of Hystrichogonyaulax pectinigerum at 2977.50m.

An unconformity is considered to be present at the base of this interval, resulting in the absence of deposits of late - middle Bathonian age.

MICROPALAEONTOLOGY

The single sample analysed from this interval shows a significant decline in the number of foraminifera recorded when compared to the middle Callovian. No new age diagnostic forms were seen.

PALYNOLOGY

The palynoflora recovered from the single ditch cuttings sample analysed from this interval (2970m) was dominated by abundant gymnosperm pollen, such as Callialasporites spp., Cerebropollenites mesozoicus and undifferentiated bisaccates. The microplankton assemblage is characterised by numerous specimens of Sirmiodinium grossii, Sentusidinium varispinosum and Lithodinia spp..

The appearance of S. varispinosum at 2970m indicates the penetration of early Callovian sediments, equivalent to the Dichadogonyaulax gochtii Subzone (XVIA) and lowest part of the Nannoceratopsis pellucida Subzone (XVB). The presence of numerous specimens of this taxon is normally a feature encountered within the D. gochtii Subzone (XV1A) and may indicate an age no younger than this subzone at 2970m.

A specimen of Hystrichogonyaulax pectinigerum is present at 2977.50m (at thetop of the underlying interval) within a palynoflora significantly modified by caved Callovian palynomorphs. Although Hystrichogonyaulax pectinigerum may occur in sediments of pre-Callovian age in onshore Northwestern Europe, the good preservation of the specimen and its local restriction to sediments of early Callovian age in this area of the North Sea, strongly suggest derivation from this early Callovian interval.

INTERVAL 2977.50m(log)-2991m(log); MIDDLE JURASSIC, EARLY BATHONIAN - LATE BAJOCIAN

Lithostratigraphic Unit:
Brent Group (part):
Tarbert Formation.

Environment: marginal marine/inner shelf with strong terrestrial influences.

The upper limit is defined upon a log break. The age is based upon the following palynological criterion:

- the presence, at 2977.50m, of numerous specimens of Dissiliodinium? "granulatum".

Regional considerations suggest the possibility of an unconformity or stratigraphic hiatus at the base of the interval resulting in the absence of some deposits of late Bajocian and middle Bajocian ages.

MICROPALAEONTOLOGY

This interval is barren of in situ foraminifera.

PALYNOLOGY

A single ditch cuttings sample and two core samples were analysed for palynology from this interval. The palynoflora recovered from the ditch cuttings sample is strongly modified by caving from the overlying Callovian interval. The appearance of numerous specimens of Dissiliodinium? "granulatum" at 2977.50m is characteristic of the early Bathonian - late Bajocian in this area of the North Sea. A specimen of Hystrichogonyaulax pectinigerum present at the same horizon is considered to be derived, via caving, from the overlying early Callovian interval.

The core sample at 2980.70m yielded a palynoflora dominated by the abundant occurrence of indeterminate algal sacs. Rare gymnosperm pollen were also recorded.

The core sample at 2981.33m produced a more numerous palynoflora with abundant bisaccates and Perinopollenites elatodes present. The only examples of marine microplankton in the core pieces were a faintly granular specimen of Sentusidinium sp. and Caddasphaera halosa.

INTERVAL 2991m(log)-3070m; MIDDLE JURASSIC, MIDDLE - EARLY BAJOCIAN

Lithostratigraphic Units:
Brent Group (part);
Ness Formation: 2991m(log)-3034m(log).
Unassigned Unit: 3034m(log)-3070m.

Environment: initially marginal marine/inner shelf, becoming progressively marginal marine/deltaic with strong terrestrial influences towards the top.

The upper limit is defined upon a log break. The age is based upon the following palynological criteria:

- the presence of common specimens of Leiofusa "solida" at 2986.63m (uncorrected core depth).
- the simultaneous appearance of numerous specimens of Nannoceratopsis gracilis and N. senex, in association with Chasmatosporites spp.

MICROPALAEONTOLOGY

No in situ foraminifera occur in this interval reflecting the marginal marine environment indicated by palynological evidence.

PALYNOLOGY

Core pieces, sidewall cores and ditch cuttings samples were analysed from this interval. Gymnosperm pollen formed the dominant element of the palynofloras recovered, with numerous to abundant undifferentiated bisaccates, Callialasporites dampieri, Perinopollenites elatoides and Cerebropollenites mesozoicus occurring consistently. With the exception of the core sample at 2986.63m (uncorrected depth) microplankton assemblages are sparse, with sporadic occurrences of Nannoceratopsis sp. Tasmanites spp. and the freshwater alga Botryococcus spp.

At 2986.63m(core, uncorrected depth) the microplankton assemblage is essentially composed of three forms: the distinctive netromorph acritarch Leiofusa "solida", and the dinocysts Nannoceratopsis gracilis and N. senex. Leiofusa "solida" usually marks the penetration of sediments equivalent to the upper part of the Ness Formation in this region of the Oseberg Field complex. The simultaneous appearance of numerous specimens of N. senex indicates an age no

younger than middle Bajocian, as does the first appearance of Chasmatosporites spp. at this same depth: a miospore that is considered to range no younger than Bajocian.

The increased incidence of inertinitic and vitrinitic kerogen within this interval reflects the proximity of terrestrial, swamp-type macrofloras, an interpretation supported by the increased diversity of pteridophyte miospores recorded.

An impoverished palynoflora was recovered from the sidewall core at 3050.70m preventing accurate dating of the lower part of this interval. In addition, ditch cuttings samples yielded assemblages significantly modified by caved taxa from the Callovian intervals and the upper part of this interval (Ness Formation).

INTERVAL 3070m-3186m(SWC); MIDDLE - EARLY JURASSIC, EARLIEST BAJOCIAN - MIDDLE TOARCIAN

Lithostratigraphic Units:
Unassigned Unit: 3070m-3116m(log).
Dunlin Group (part);
Drake Formation: 3116m(log)-3186m(SWC).

Environment: initially marine, inner shelf with aerobic/dysaerobic bottom conditions, becoming progressively marginal marine/inner shelf.

The age and upper limit of the interval are defined upon the following palynological criteria:

- the occurrence of Mancodinium semitabulatum at 3070m.
- the presence of a questionable specimen of Scriniocassis weberi, at 3080m.
- the association of S. weberi, Nannoceratopsis ambonis and Comparodinium punctatum at 3117m(SWC).

MICROPALAEONTOLOGY

The microfaunas of this interval are extremely impoverished and it is suspected that the rare specimens of agglutinated foraminifera recorded are caved from the Late Jurassic. The occurrence of a single specimen of Trochammina sp. at 3120m may reflect the presence of late - middle Toarcian deposits at this depth.

PALYNOLOGY

Palynofloras recovered from the ditch cuttings samples within this interval are significantly modified by caved taxa from the overlying Late Jurassic, particularly Callovian, intervals, resulting in the recovery of impoverished in situ assemblages. In addition, apart from the sidewall core at 3117m, palynofloras recovered from the sidewall cores are also impoverished. As a result, the dating of this interval is based upon meagre evidence, hence the wide ranging age assigned.

Assemblages are dominated by miospores throughout, characterised by the common to abundant occurrences of undifferentiated bisaccates, Perinopollenites elatoides, the Baculatisporites/Osmundacidites group, Cerebropollenites mesozoicus, Deltoidospora spp., Callialasporites spp. and Chasmatosporites spp.

Common specimens of Nannoceratopsis senex are encountered at and below 3117m(SWC), becoming abundant at 3172.50m.

A single specimen of Mancodinium semitabulatum was recorded at 3070m and based upon regional considerations is considered to indicate an age no younger than the lower part of the early Bajocian or even a Toarcian age. This distinctive taxon, which can extend up into deposits of middle Bajocian age, normally, in the Oseberg Field complex, does not occur in sediments of post-earliest Bajocian age. This age assignment is tentatively supported by the presence of a questionable specimen of Scriniocassis weberi at 3080m, a species which does not extend into post-earliest Bajocian deposits.

The sidewall core at 3117m yielded a relatively rich assemblage containing the association of Scriniocassis weberi, Nannoceratopsis ambonis and Comparodinium punctatum, which on local correlation suggests a late - middle Toarcian age.

An age no younger than the "Sphaeromorphs" Subzone (XVIIIC) of the Nannoceratopsis gracilis Zone (XVIII) is indicated at 3172.50m by the appearance of numerous clusters of "sphaeromorph" acritarchs.

Of additional interest is the occurrence, at 3117m(SWC), of recycled miospores including striate bisaccates (Permo-Triassic) and Striatoabieites aytugii (Carnian - Scythian). Their occurrence at this horizon may be of local correlative value, reflecting a phase of introduction of reworked material from the source area.

INTERVAL 3186m(SWC)-3220m(SWC); EARLY JURASSIC, EARLY TOARCIAN

Lithostratigraphic Unit:
Dunlin Group (part);
Drake Formation (part).

Environment: marine, inner shelf with anaerobic/dysaerobic bottom conditions.

The upper limit and age of this interval are based upon the following palynofloral criterion:

- the occurrence of abundant specimens of "sphaeromorph" acritarchs at 3186m(SWC).

MICROPALAEONTOLOGY

Impoverished microfaunas, as seen in the overlying intreval, continue to be recorded.

PALYNOLOGY

One ditch cuttings and one sidewall core sample were analysed from this interval. Although gymnosperm pollen continue to be the dominant element of the palynofloras, a significant change in their composition was recorded with an influx of common specimens of Chasmatosporites spp. with Perinopollenites elatoides and Callialasporites dampieri becoming very rare.

The microplankton assemblage in the sidewall core at 3186m is characterised by the occurrence of abundant "sphaeromorph" acritarch clusters. This palynoevent is indicative of the penetration of sediments equivalent to the early Toarcian part of the "Sphaeromorphs" Subzone (XVIIIC).

INTERVAL 3220m(SWC)-3418m; EARLY JURASSIC, LATE PLIENSBACHIAN - SINEMURIAN

Lithostratigraphic Units:
Dunlin Group (part): 3220m(SWC)-3387m(log);
Drake Formation: 3220m(SWC)-3241m(log),
"Sand Unit": 3241m(log)-3288m(log),
"Shale Unit": 3288m(log)-3387m(log).
Statfjord Formation: 3387m(log)-3418m.

Environment: initially deltaic/marginal marine, becoming inner shelf with strong terrestrial influences.

The upper limit and age of this interval are defined upon the following palynological criteria:
- the occurrence of a latest Pliensbachian palynoflora at 3220m(SWC).
- the subsequent appearance of Cerebropollenites cf. thiergartii at 3232.50m.

MICROPALAEONTOLOGY

This interval is barren of in situ microfauna, probably as a result of its marginal marine environmental setting.

PALYNOLOGY

From 3220m(SWC) to 3265m (ditch cuttings) the palynofloras examined were dominated by gymnosperm pollen, particularly undifferentiated bisaccates, Chasmatosporites spp. and Cerebropollenites spp. Marine microplankton form a prominent part of the palynoflora in the sidewall core sample at 3220m. This is reduced to very rare acanthomorph acritarchs and prasinophycean algae in the ditch cuttings sample from 3265m, whilst in the sidewall core sample at the same depth an exclusively terrestrial derived assemblage was encountered. A single specimen of Tasmanites sp. was present at 3297.50m(SWC) indicating weak/fluctuating salinities.

No in situ marine microplankton were recorded from 3307.50m to 3418m. Within this interval pteridophyte miospores became more diverse and numerous, with Deltoidospora spp. and elements of the Baculatisporites/Osmundacidites group frequently numerous to common and Klukisporites spp., Verrucosisporites spp. and Dictyophyllidites spp. occurring consistently. Gymnosperm pollen still form the

dominant part of the palynofloras, however, characterised by numerous to common undifferentiated bisaccates and Cerebropollenites cf. thiergartii with consistently occurring Chasmatosporites spp.

At 3220m(SWC) the outgoing of common to abundant "sphaeromorph" acritarchs indicates a late Pliensbachian age. The base of the range of Nannoceratopsis triceras at the same depth indicates an age equivalent to the upper part of the Luehndea spinosa Subzone (XVIIID), an age assignment supported by the last downhole occurrence of N. senex and N. gracilis, neither of which range any older than late Pliensbachian. Further evidence for a late Pliensbachian age comes from the appearance of Cerebropollenites cf. thiergartii at 3232.50m and its common occurrence at 3265m(SWC), a feature characteristic of sediments of this age in this part of the North Sea.

Although no positive biostratigraphic evidence for a Sinemurian age was recovered from this interval the penetration of sands assigned to the Statfjord Formation suggests that, on regional grounds, the interval may be as old as Sinemurian in the lower part.

Rare occurrences of striate bisaccates (3297.50m(SWC) and 3376m(SWC)) indicate the recycling of Permo-Triassic sediments within this interval.

GEOLOGICAL HISTORY

SINEMURIAN TO TOARCIAN

The oldest sediments encountered are fine to coarse grained sandstones deposited within a fluvio-deltaic setting, with the possibility of minor marine influences. Sand deposition ceased abruptly, probably within the late Sinemurian, resulting in the accumulation of shales within a marginal marine to inner shelf setting. Within the Pliensbachian, a significant influx of arenaceous detritus occurred within a proximal, marine location. During the late Pliensbachian, shale deposition resumed and continued into the early Toarcian, during which time anoxic bottom conditions prevailed.

TOARCIAN TO LATE BAJOCIAN-EARLY BATHONIAN

Within the late - middle Toarcian period a major influx of sand occurred which continued into the early Bajocian. These deposits are considered to probably have been laid down within an inner shelf/marginal marine environment with strong terrestrial influence. Continued regression during the early Bajocian resulted in the progradation of the delta-top facies of the Ness Formation. This style of sedimentation continued into the middle Bajocian.

A late Bajocian transgressive phase subsequently inundated the delta-top, following a brief phase of non-deposition and/or erosion, and led to the accumulation of marine sands. This style of

	sedimentation continued to the early Bathonian.
MIDDLE - LATE BATHONIAN	ABSENT - due to either deposition with subsequent erosion or non-deposition.
CALLOVIAN TO LATE VOLGIAN-EARLY RYAZANIAN	Sedimentation resumed in response to the widespread early Callovian transgressive phase with the accumulation of shales and limestones in an inner shelf environment with aerobic bottom conditions. Deposition appears to have been continuous into the early Ryazanian with the accumulation of shales under progressively anaerobic/dysaerobic bottom conditions with the establishment of a stratified water column.
LATE RYAZANIAN TO HAUTERIVIAN	ABSENT - due to non-deposition or deposition with subsequent erosion.
BARREMIAN TO MIDDLE ALBIAN	Sedimentation resumed within the Barremian. Deposition was probably intermittent with very slow subsidence rates throughout the Aptian to middle Albian, within a shallow, oxygenated, inner shelf location.
LATE ALBIAN TO CONIACIAN	ABSENT - due to non-deposition or deposition with subsequent erosion.
SANTONIAN TO MAASTRICHTIAN-LATE MAASTRICHTIAN	Deposition resumed during the Late Cretaceous resulting in the accumulation of a predominantly argillaceous sequence within an inner to outer shelf location.

PALAEOCENE

Following a minor unconformity, probably due to the effects of North Atlantic rifting, sedimentation resumed within the Early Palaeocene, Danian. Deposition was continuous into the Late Palaeocene under outer shelf to upper bathyal depths. Towards the end of the Late Palaeocene a significant volcanic event, associated with further North Atlantic rifting, resulted in the deposition of tuffaceous shales.

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APPENDIX 1

LITHOLOGICAL DESCRIPTIONS OF SIDEWALL CORES

Depth (m)	Recovery (mm)	Quality	Type of Analysis	Lithology
2002	frags	fair	M	SANDY CLAYSTONE: moderately hard, medium dark grey, highly argillaceous with traces of mica and sands, weakly calcareous and ?tuffaceous.
2006	20	fair		SHALE: moderately hard, weakly fissile, finely laminated, medium dark grey.
2008	17	fair		SHALE: moderately hard, slightly waxy, weakly fissile, medium dark grey and slightly micromicaceous.
2023	20	fair	M	CLAYSTONE: moderately hard, slightly waxy, finely laminated and medium dark grey.
2165	frags	fair	M	CLAYSTONE: moderately hard, slightly waxy, olive black to greenish black, micromicaceous.
2225	10	fair	M	CLAYSTONE: moderately hard, slightly waxy, medium grey to olive grey, micromicaceous and strongly calcareous.
2432	15	fair	M	CALCAREOUS CLAYSTONE: moderately hard, slightly waxy, olive black, micromicaceous and moderately calcareous.
2580	10	fair	MP	CLAYSTONE: as 2432m, but weakly calcareous.
2640	10	fair	MP	CLAYSTONE: moderately hard, slightly waxy, olive black to brownish black and micromicaceous.

2665	frags	fair	MP	CALCAREOUS CLAYSTONE/ARGILLACEOUS LIMESTONE: hard, olive black, highly argillaceous and micromicaceous.
2703	frags	fair	MP	SHALE: hard, subfissile, olive black to brownish black, micaceous and very weakly to non-calcareous.
2727	frags	fair	P	SHALE: moderately hard, earthy, brownish black, micromicaceous, silty and weakly calcareous.
2770	10	fair	P	SHALE: moderately hard, fissile, brownish black, micromicaceous.
2815	frags	fair	P	SHALE: moderately hard, fissile, olive black to dark grey, micaceous.
2855	frags	poor	P	LIMESTONE: hard, coarsely crystalline, brownish grey and micaceous.
2870	frags	fair	P	SILTY SHALE: moderately soft, subfissile, dusky yellowish brown, silty with very fine sand, micromicaceous and weakly calcareous.
2955	frags	fair	P	SILTY SHALE: as 2870m, but non-calcareous.
2976.30	frags	poor		sample predominantly drilling mud with fragments of SHALE: brownish black with COAL: black.
2997.50	frags	poor	P	SHALE: waxy, subfissile, moderately hard, brownish grey.
3025	frags	poor	P	SHALE: as 2997.50m with carbonaceous fragments.
3050.70	12	fair	P	SANDSTONE: fairly friable, pinkish grey, very fine grained, micaceous and weakly calcareous.
3085	18	fair	P	SANDSTONE: fairly friable, white to pinkish grey, fine to medium grained, micaceous, ?kaolinitic and weakly calcareous.

3117	frags	fair	P	SANDSTONE: friable, light grey, very fine grained, slightly argillaceous, micaceous, finely laminated with SHALE: brownish grey and highly micaceous with carbonaceous fragments, and ARGILLACEOUS SANDSTONE: light brownish grey to medium light grey, very fine grained and micaceous.
3158.50	frags	fair	P	SANDSTONE: friable, light grey, very fine to medium grained, ?kaolinitic.
3186	frags	fair	P	SHALE: moderately hard, weakly fissile, olive black and micromicaceous.
3220	frags	fair	P	SHALE: moderately hard, subfissile, brownish grey to dusky yellowish brown, slightly silty, micaceous.
3265	frags	fair	P	ARGILLACEOUS SANDSTONE: fairly friable, very pale orange to dark yellowish brown, very fine grained, argillaceous and micaceous, laminated with SHALE: dusky yellowish brown and micaceous.
3297.50	10	poor	P	CLAYSTONE: moderately hard, olive black, micaceous and very weakly calcareous.
3346	frags	fair	P	SHALE: moderately hard, subfissile, dusky yellowish brown, micaceous, locally sandy grading to ARGILLACEOUS SANDSTONE.
3376	frags	fair	P	SHALE: with minor ARGILLACEOUS SANDSTONE: as 3346m.
3391	18	fair	P	SANDSTONE: fairly friable, pinkish grey, fine to medium grained, micaceous with rare carbonaceous fragments.
3406	15	fair	P	SANDSTONE: as 3391m but very fine to fine grained.

3416	frags	fair	P	SANDSTONE: friable, very light grey, fine to coarse grained, micaceous and slightly argillaceous, ?kaolinitic.

Key

P = Palynology
M = Micropalaeontology
frags = fragments

APPENDIX 2

LITHOLOGICAL DESCRIPTIONS OF CORE PIECES

Depth (m)	Core No.	Type of Analysis	Lithology
2980.70	1	P	ARGILLACEOUS SANDSTONE: well cemented, medium light grey, very fine grained, argillaceous and micaceous with carbonaceous fragments.
2981.33	1	P	MICACEOUS SHALE: moderately hard, fissile, medium dark grey to olive black and highly micaceous.
2986.63	1	P	SHALE: moderately hard, subfissile, medium dark grey and micromicaceous.
2991.85	1	P	CLAYSTONE: moderately hard, olive black to dark grey, micromicaceous with carbonaceous fragments.

Key

P : Palynology

APPENDIX 3

RHAETIAN–VOLGIAN DINOCYST ZONATION

GEOLOGICAL AGE			STANDARD AMMONITE ZONES	DINOCYST ZONATION	
				ZONES	SUBZONES
LATE JURASSIC	Volgian	late	*lamplughi*	*"Imbatodinium" villosum* VI	*Egmontodinium* sp. A VIA
			preplicomphalus		*Kleithriasphaeridium* sp. A VIB
			primitivus		*Systematophora* spp. VIC
			oppressus		
		middle	*giganteus*	*Muderongia* sp. A VII	*Dichadogonyaulax pannea* VIIA
			gorei		*Dichadogonyaulax culmula* VIIB
			albani		*Glossodinium dimorphum* VIIC
			Epipallasiceras sp.		
			rotunda		
			pallasioides		
			Pavlovia sp.	*Pareodinia mutabilis* VIII	*Gonyaulacysta pennata* VIIIA
		early	*pectinatus*		*Gonyaulacysta jurassica* VIIIB
			hudlestoni	*Gonyaulacysta longicornis* IX	*Egmontodinium polyplacophorum* IXA
			wheatleyensis		
			scitulus		*Scriniodinium luridum* IXB
			elegans		
	Kimmeridgian		*autissiodorensis*	*Gonyaulacysta cladophora* X	
			eudoxus		
			mutabilis		
			cymodoce		
			baylei	*Scriniodinium crystallinum* XI	*Leptodinium egemenii* XIA
	Oxfordian	late	*pseudocordata*		*Stephanelytron redcliffense* XIB
			decipiens	*Scriniodinium galeritum* XII	*Scriniodinium oxfordianum* XIIA
			cautisnigrae		*Compositosphaeridium costatum* XIIB
		middle	*transversarium*		
			plicatilis	*Acanthaulax spinosissima* XIII	
		early	*cordatum*	*Wanaea digitata* XIV	*Gonyaulacysta areolata* XIVA
			marlae		*Wanaea fimbriata* XIVB
	Callovian	late	*lamberti*		*Mendicodinium groenlandicum* XIVC
			athleta		
		middle	*coronatum*	*Polystephanephorus paracalathus* XV	*Kalyptea stegasta* XVA
			jason		*Nannoceratopsis pellucida* XVB
		early	*calloviense*		*Dichadogonyaulax gochtii* XVIA
			macrocephalus		
MIDDLE JURASSIC	Bathonian	late	*discus*	*Pareodinia ceratophora* XVI	*Wanaea acollaris* XVIB
			aspidoides		
			retrocostatum		*Gonyaulacysta filapicata* XVIC
		middle	*morrisi*		
			subcontractus		
			progracilis		
		early	*zigzag*		
	Bajocian	late	*parkinsoni*	*Nannoceratopsis spiculata* XVII	
			garantiana		
			subfurcatum		
		middle	*humphriesianum*		
			sauzei		*Polysphaeridium deflandrei* XVIIIA
			laeviuscula		
			discites		
		early	*concavum*		
			murchisonae		
			opalinum		
EARLY JURASSIC	Toarcian	late	*levesquei*	*Nannoceratopsis gracilis* XVIII	*Mancodinium semitabulatum* XVIIIB
			thouarsense		
		middle	*variabilis*		
			bifrons		"Sphaeromorphs" XVIIIC
		early	*falciferum*		
			tenuicostatum		
	Pliensbachian	late	*spinatum*		*Luehndea spinosa* XVIIID
			margaritatus		
		early	*davoei*	*Polysphaeridium langii* XIX	Unnamed subzone XIXA
			ibex		
			jamesoni		
	Sinemurian	late	*raricostatum*		*Liasidium variabile* XIXB
			oxynotum		
			obtusum		
		early	*turneri*		Unnamed subzone XIXC
			semicostatum		
			bucklandi		
	Hettangian		*angulata*		*Dapcodinium priscum* XIXD
			liasicus		
			planorbis		
LATE TRIASSIC	Rhaetian			*Rhaetogonyaulax rhaetica* XX	

LITHOLOGIES

Clay

Shale/mudstone

Siltstone

Sand/sandstone, very fine to medium grained

Sand/sandstone, coarse grained to granules

Conglomerate (with sand matrix)

Conglomerate (without sand matrix)

Coal/lignite

Breccia

Limestone (undifferentiated)

Chalky limestone

Dolomitic limestone

Calcareous dolomite

Dolomite

Chert

Anhydrite/gypsum

Salt (halite)

Potassium salts

Concretions/nodules

Igneous rocks, undifferentiated

Basement, undifferentiated

Granite

Qualifiers

Argillaceous

Silty/sandy

Pebbly

Carbonaceous

Calcareous

Dolomitic

Red sediments — red

Accessories

Calcite C

Ironstone/ferruginous deposits . . . . . Fe

Glauconite . . . . . Gl

Kaolinite . . . . . K

Phosphate . . . . . Ph

Pyrite . . . . . Py

Siderite/sphaerosiderite . . . . . S

Silica . . . . . Si

GRAIN TYPES

Oolith

Fossils in general

Bioclastic debris

Mudflakes

BIOSTRATIGRAPHIC SYMBOLS

Fossil Abundances:

- Present . . . . . o
- Common . . . . . ●
- Abundant . . . . . ■

Diagnostic forms . . . . . *

Caved forms C

Reworked forms . . . . . R

Incoming of

Outgoing of

Unconformity/stratigraphic hiatus

Faulted boundary . . . . . F—F

Late . . . . . LT., lt.

Middle . . . . . M., m.

Early . . . . . EY., ey.

Other symbols

Sample gap

Lost circulation material . . . . . lcm

Cement . . . . . cmt

Turbo drilling or diamond bit drilling . . . . . tu
(Samples unsuitable for good stratigraphic analysis)

Casing point

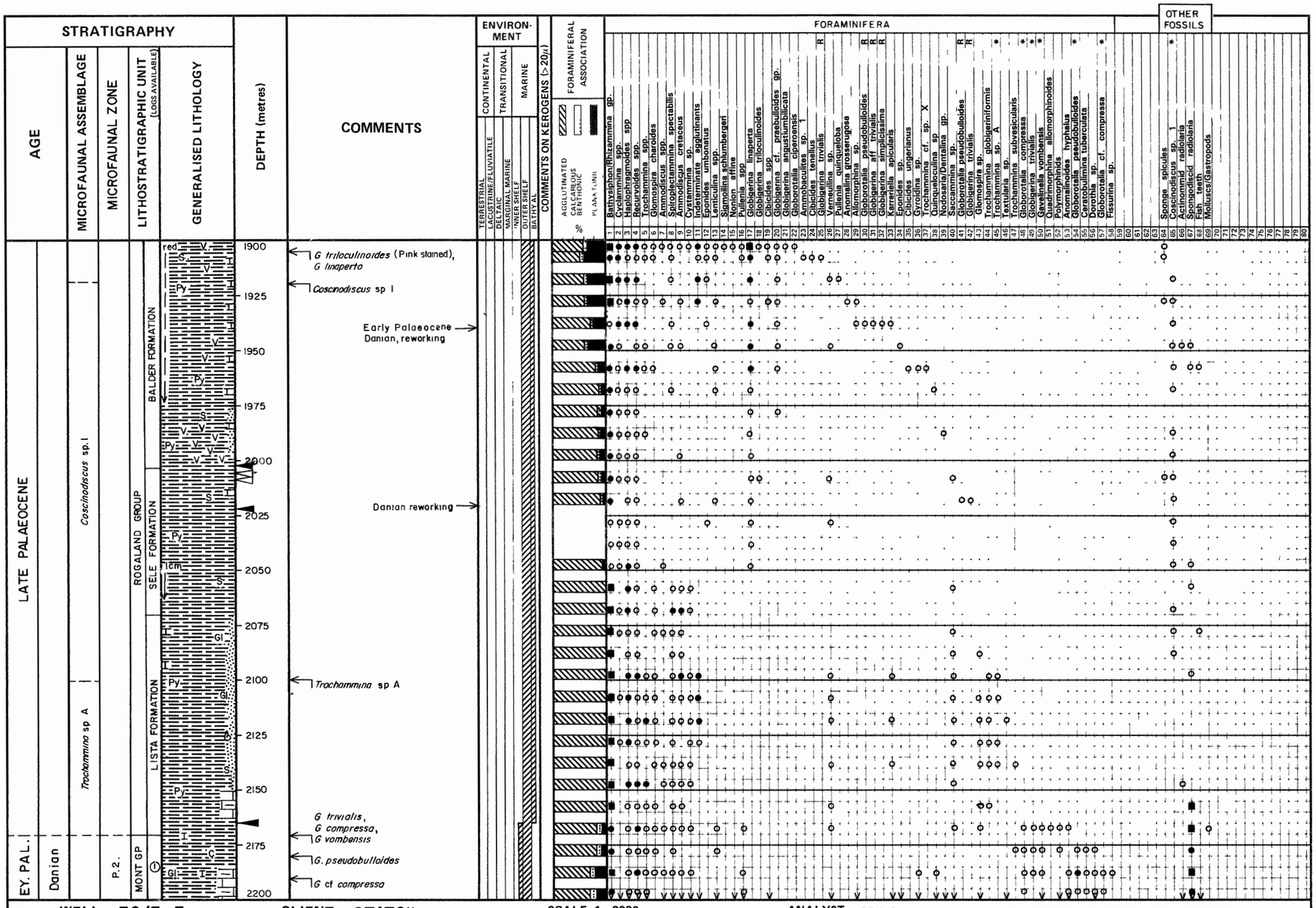
Core

Sidewall core

Sidewall core (analysed for biostratigraphy)

Sidewall core (no recovery)

FIGURE 1 – Legend (edited from Robertson Research Standard Legend).



WELL:– 30/3-3
CHART:– 1 of 5
FIGURE:– 2

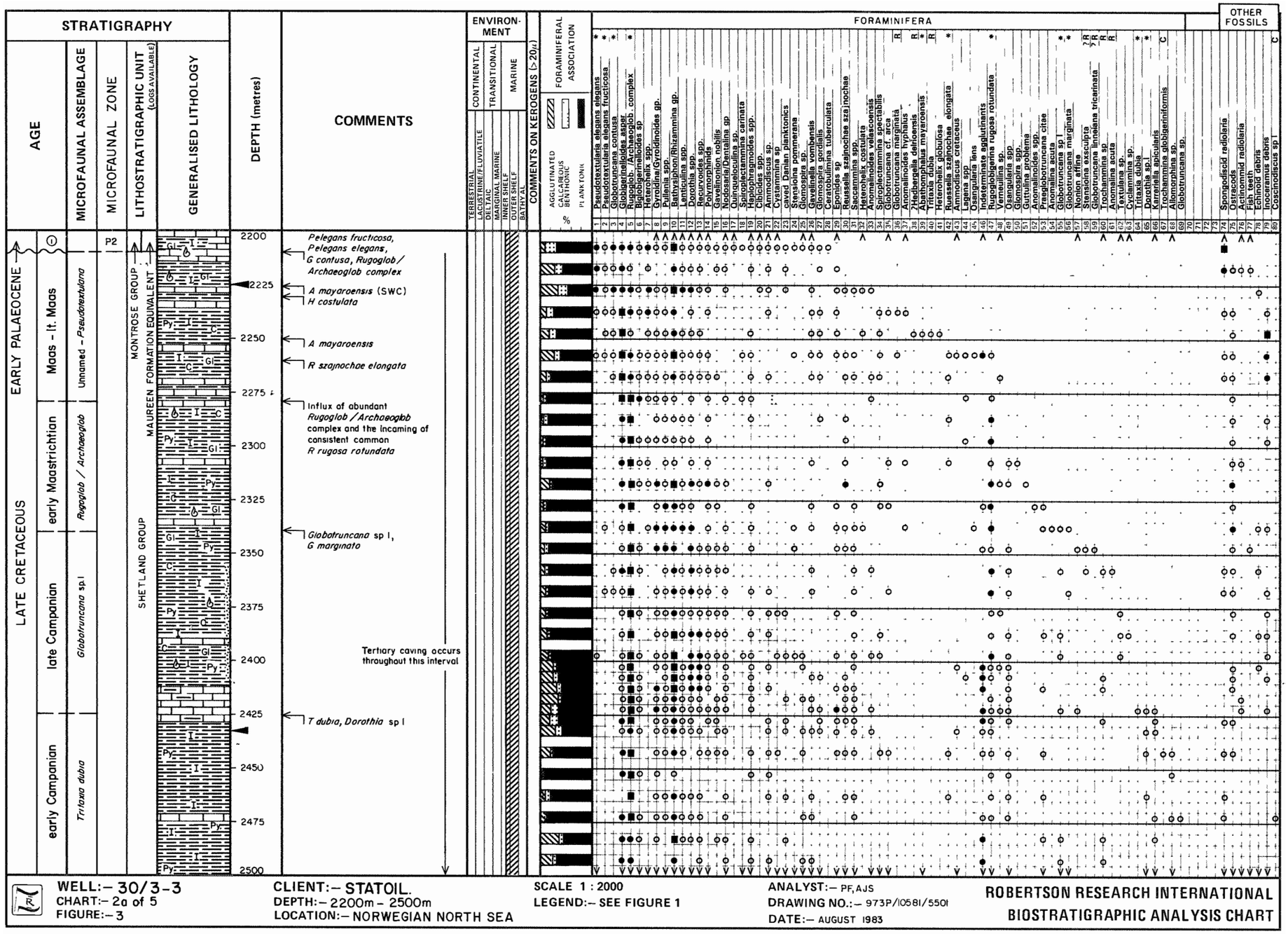
CLIENT:– STATOIL.
DEPTH:– 1900m-2200m
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

ANALYST:– PF, AJS
DRAWING NO.:– 973P/10581/5501
DATE:– AUGUST 1983

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART

① MAUREEN FORMATION EQUIVALENT


STRATIGRAPHY
AGE
MICROFAUNAL ASSEMBLAGE
MICROFAUNAL ZONE
LITHOSTRATIGRAPHIC UNIT (LOGS AVAILABLE)
GENERALISED LITHOLOGY
DEPTH (metres)
COMMENTS
ENVIRON-MENT
CONTINENTAL
TRANSITIONAL
MARINE
COMMENTS ON KEROGENS (>20µ)
FORAMINIFERAL ASSOCIATION
AGGLUTINATED
CALCAREOUS BENTHONIC
% PLANKTONIC
FORAMINIFERA
OTHER FOSSILS
EARLY PALAEOCENE
LATE CRETACEOUS
Maas - lt. Maas
early Maastrichtian
late Campanian
early Campanian
Unnamed - Pseudotextularia
Rugoglob / Archaeoglob
Globotruncana sp.1
Triloxia dubia
P2
MONTROSE GROUP
MAUREEN FORMATION EQUIVALENT
SHETLAND GROUP
2200
2225
2250
2275
2300
2325
2350
2375
2400
2425
2450
2475
2500
Pelegans fructicosa, Pelegans elegans, G contusa, Rugoglob / Archaeoglob complex
A mayaroensis (SWC)
H costulata
A mayaroensis
R szajnochae elongata
Influx of abundant Rugoglob / Archaeoglob complex and the incoming of consistent common R rugosa rotundata
Globotruncana sp 1, G marginata
Tertiary caving occurs throughout this interval
T dubia, Dorothia sp 1
Pseudotextularia elegans elegans
Pseudotextularia elegans fructicosa
Globotruncana contusa
Globigerinelloides asper
Rugoglob. /Archaeoglob. complex
Biglobigerinelloides sp.
Heterohelix spp.
Gyroidina/Gyroidinoides spp.
Dorothia spp.
Bathysiphon /Rhizammina gp.
Lenticulina spp.
Dorothia spp.
Recurvoides spp.
Polymorphinids
Gavelinonion nobilis
Nodosaria/Dentalina gp
Nuttallinella florealis
Spiroplectammina carinata
Haplophragmoides spp.
Cibicides spp.
Ammodiscus sp.
Cystammina sp.
caved Danian planktonics
Stensioina pommerana
Globigerina spp.
Gaudryina voltziana
Glomospira gordialis
Ceratobulimina tuberculata
Eponides sp
Reussella szajnochae szajnochae
Saccammina spp.
Heterohelix globulosa
Anomalinoides welleriensis
Spiroplectammina spectabilis
Globotruncana cf. arca
Globotruncana marginata
Anomalinoides hyphalus
?Hedbergella delrioensis
Abathomphalus mayaroensis
Triloxia dubia
Heterohelix globulosa
Reussella szajnochae elongata
Ammodiscus cretaceus
Lagena spp.
Osangularia lens
Indeterminate agglutinants
Rugoglobigerina rugosa rotundata
Vemeuilina spp.
Globigerina spp.
Guttulina problema
Anomalinoides spp.
Praeglobotruncana citae
Anomalina acuta
Globotruncana sp 1
Globotruncana marginata
Nuttallinella florealis
Stensioina exsculpta
Globotruncana linneiana tricarinata
Trochammina sp.
Anomalina acuta
Textularia sp.
Cyclammina sp.
Triloxia dubia
Dorothia sp.
Nuttallinella florealis
Trochammina globigeriniformis
Allomorphina sp.
Globotruncana sp.
Spongodiscid radiolaria
Ostracods
Actinommid radiolaria
Fish teeth
Echinoid debris
Inoceramus debris
Coscinodiscus sp1
WELL:- 30/3-3
CHART:- 2a of 5
FIGURE:- 3
CLIENT:- STATOIL
DEPTH:- 2200m - 2500m
LOCATION:- NORWEGIAN NORTH SEA
SCALE 1 : 2000
LEGEND:- SEE FIGURE 1
ANALYST:- PF, AJS
DRAWING NO.:- 973P/10581/5501
DATE:- AUGUST 1983
ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART

① DANIAN

DEPTH (metres) (LOGS AVAILABLE)

PALYNOFLORAL ZONE

COMMENTS

COMMENTS ON KEROGENS (> 20μ)

MICROPLANKTON

MIOSPORES

1	Areoligera spp.		
2	Spiniferites ramosus group		
3	Caretiopsis diebelii		
4	Palaeoperidinium pyrophorum		
5	Deflandrea phosphoritica complex		
6	Cyclonephelium spp.		
7	Palaeostomocysts fragilis		
8	Hystrichosphaeridium sp. 2 McKINTYRE		
9	Lejeunecysta hyalina	*	
10	Raphidodinium fucatum	*	
11	Palambages spp.		
12	Isabelidinium spp.		
13	Impagidinium spp.		
14	Hystrichosphaeridium tubiferum		
15	Spinidinium spp.		
16	Acanthomorph acritarchs		
17	Achomosphaera ramulifera		
18	Spongodinium delitiense	*	
19	Chlamydophorella nyei		
20	aff. Polysphaeridium subtile		
21	Chytroeisphaeridia granulifera		
22	Alterbia acutula	*	
23	Isabelidinium cooksonii		
24	Cribroperidinium spp.		
25	Botryococcus spp.		
26	Trithyrodinium suspectum		
27	Crassosphaera spp.		
28	Paralecaniella indentata		
29	Hystrichosphaeridium stellatum		
30	Leberidocysta chlamydata		
31	Odontochitina costata		
32	Chatangiella spp.		
33	Spiniferites "magnifica"	C	
34			
35			
36			
37			
38			
39	Bisaccates		R.
40	Callialasporites spp.		R.
41	Aquilapollenites spp		
42	Cerebropollenites mesozoicus		
43	Loranthacites spp.		
44	Striate bisaccate		R.
45	Baculatisporites/Osmundacidites group		
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2200
2225
2250
2275
2300
2325
2350
2375
2400
2425
2450
2475
2500

Palynological analysis starts at 2500m

A acutula,
R fucatum,
S delitiense

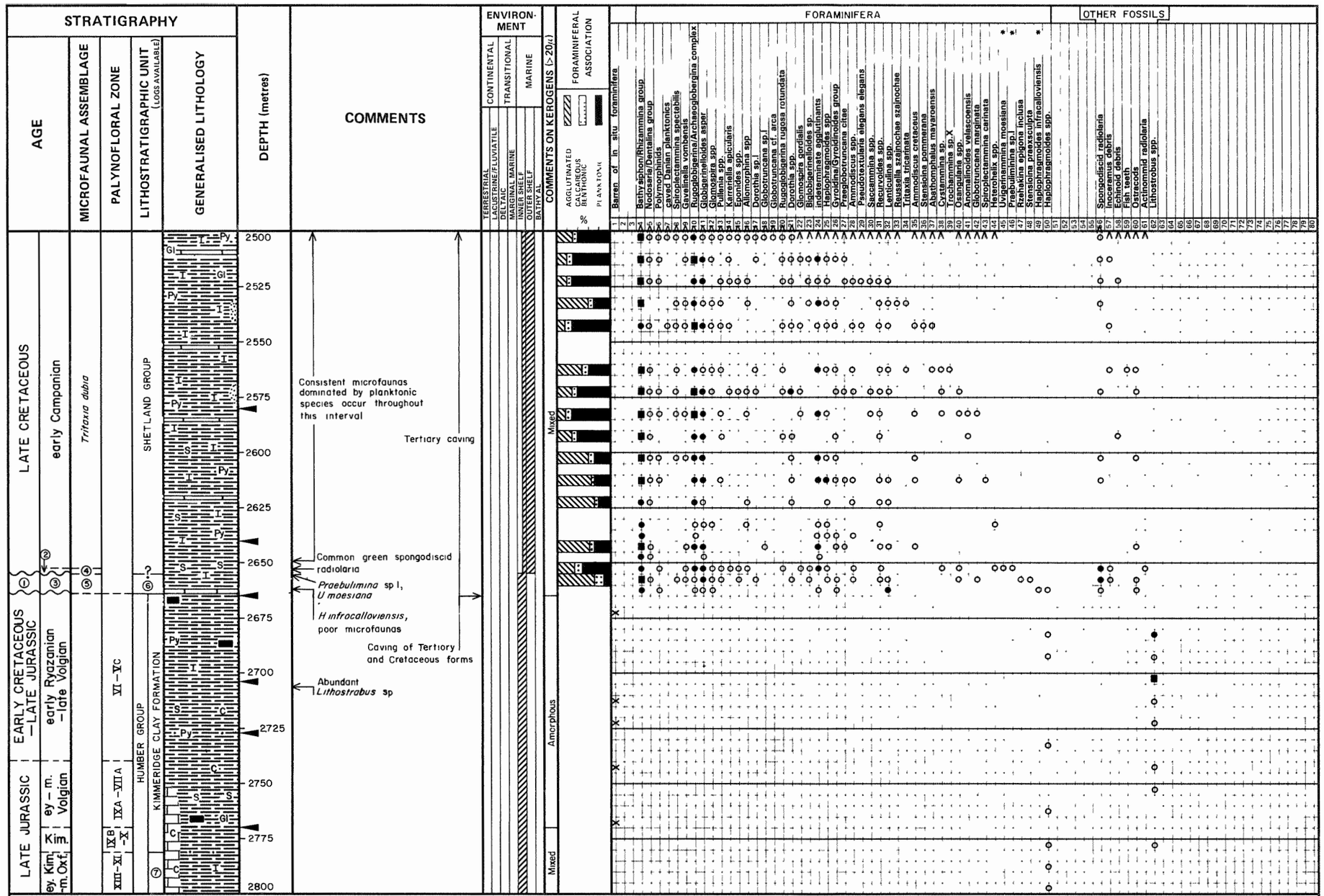
WELL:— 30/3-3
CHART:— 2b of 5
FIGURE:— 4

CLIENT:— STATOIL.
DEPTH:— 2200m - 2500m
LOCATION:— NORWEGIAN NORTH SEA

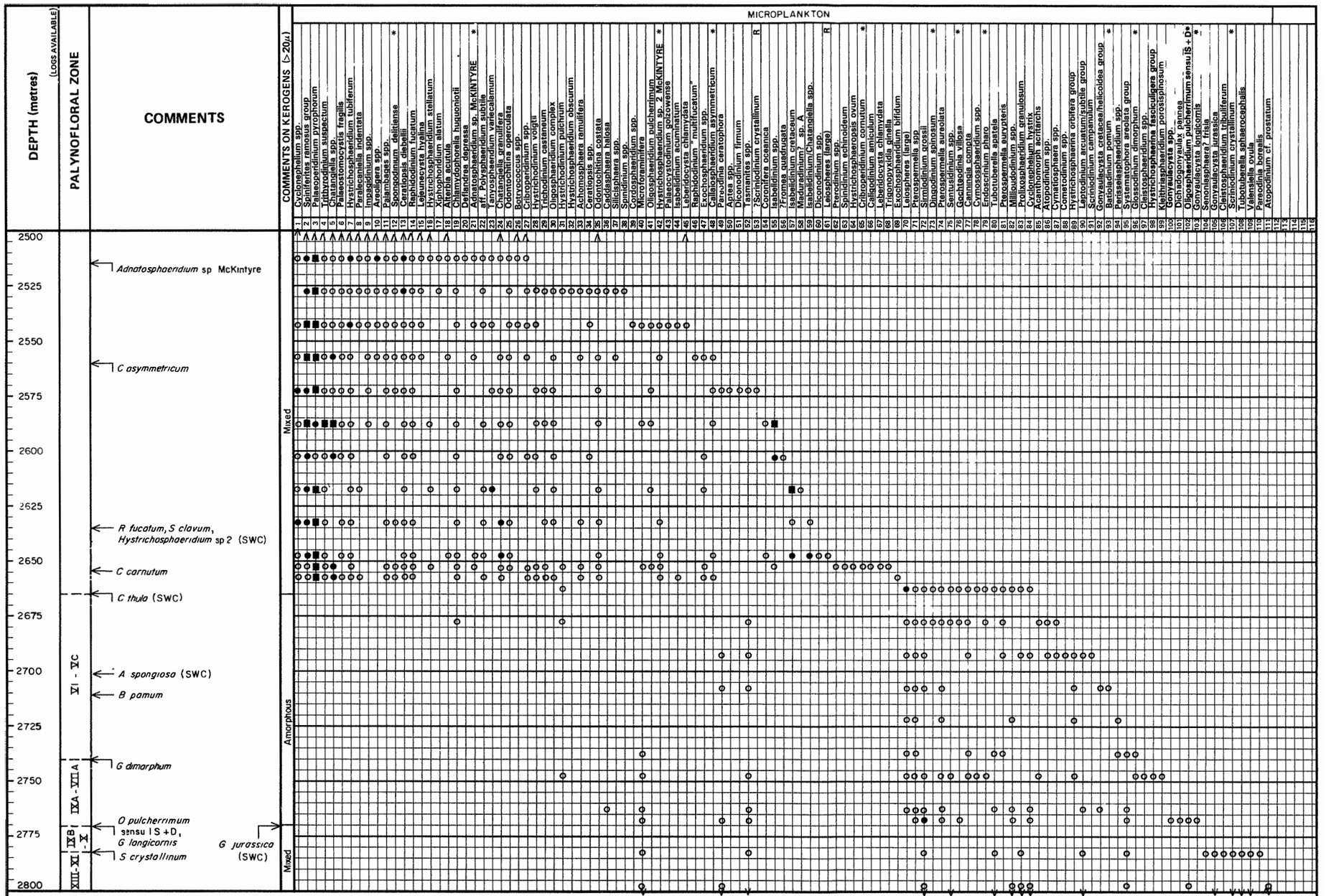
SCALE 1 : 2000
LEGEND:— SEE FIGURE 1

ANALYST:— JPGF, NHM
DRAWING NO.:— 973P/10581/5501
DATE:— AUGUST 1983

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART



① EARLY CRETACEOUS
② Santonian
③ middle Albian – Barremian
④ *Stensioina*
⑤ *Recurvoides / Glomospira* – Calcareous benthonics / Ostracods
⑥ CROMER KNOLL GROUP
⑦ HEATHER FORMATION



WELL:– 30/3-3
CHART:– 3b of 5
FIGURE:– 6

CLIENT:– STATOIL.
DEPTH:– 2500m - 2800m
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

ANALYST:– JPGF, NHM
DRAWING NO.:– 973P/10581/5581
DATE:– AUGUST 1983

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART

DEPTH (metres) (LOGS AVAILABLE)

PALYNOFLORAL ZONE

COMMENTS

COMMENTS ON KEROGENS (>20μ)

MIOSPORES

1 Bisaccates
2 Callialasporites spp. R
3 Deltoidospora spp.
4 Aquilapollenites spp.
5 Baculatisporites/Osmundacidites group
6 Densoisporites velatus R
7 Leptolepidites spp.
8 Lycopodiumsporites spp
9 Parvisaccites enigmatus R
10 Striate bisaccates R
11 Cicatricosisporites spp.
12 Araucariacites spp. R
13 Klukisporites spp.
14 Cerebropollenites mesozoicus
15 Lycopodiacidites spp.
16 Leptolepidites spp.
17 Perinopollenites elatoides
18 Callialasporites dampieri
19 Callialasporites triobatus
20 Circulina simplex
21 Dictyophyllidites spp.
22 Cerebropollenites cf. thiergartii R
23 Callialasporites trivalinus R
24 Chasmatosporites spp.
25 Densoisporites velatus
26 Araucariacites australis

2500
2525
2550
2575
2600
2625
2650
2675
2700
2725
2750
2775
2800

Adnatosphaeridium sp McKintyre
C asymmetricum
R fucatum, S clavum
Hystrichosphaeridium sp 2 (SWC)
C cornutum
C thula (SWC)
A spongiosa (SWC)
B pomum
G dimorphum
O pulcherrimum
sensu I S+D,
G longicornis
S crystallinum
G jurassica (SWC)

XI-YC
IXA-VIIIA
IX B
X
XIII-XI

Mixed
Amorphous
Mixed

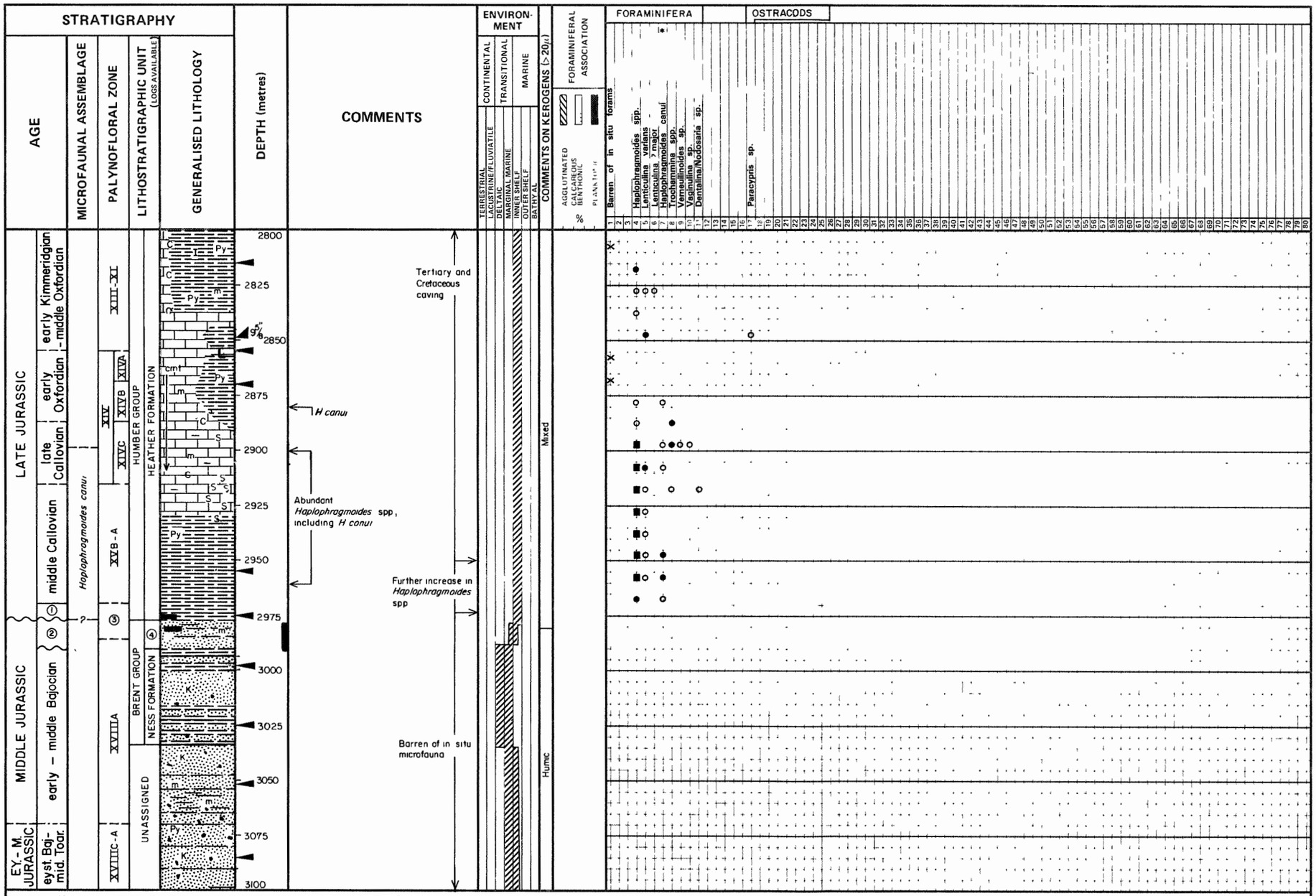
WELL:– 30/3-3
CHART:– 3c of 5
FIGURE:– 7

CLIENT:– STATOIL.
DEPTH:– 2500m-2800m
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

ANALYST:– JPGF, NHM
DRAWING NO.:– 973P/10581/5501
DATE:– AUGUST 1983

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART



WELL:– 30/3-3
CHART:– 4a of 5
FIGURE:– 8

CLIENT:– STATOIL.
DEPTH:– 2800m - 3100m
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

ANALYST:– AJS, DJS
DRAWING NO.:– 973P/10581/5501
DATE:– AUGUST 1983

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART

① early Callovian

② early Bathonian - late Bajocian

③ XVIA - XVIB

④ TARBERT FORMATION

DEPTH (metres) (LOGS AVAILABLE)

PALYNOFLORAL ZONE

COMMENTS

MICROPLANKTON

COMMENTS ON KEROGENS (>20µ)

MIOSPORES

2800
2825
2850
2875
2900
2925
2950
2975
3000
3025
3050
3075
3100

XIII - XI
XIV
XIV C
XIV B
XIV A
XV B - A
XV B
XV A
XVIII A
XVIII C - A

L mirabile
N pellucida
Abundant *A aemulum*, *A spinosissima* (SWC)
W thysanota, *W fimbriata*, *C. deflandrei* (SWC)
M groenlandicum
Common *P ceratophora*
L cristulota/caytonensis group
S scarburghense
C callomonii/decopitata group
C continuum, *C cerastes*
S varispinosum
H pectinigerum (caved), *D.? "granulatum"*
Core samples only analysed from this interval
N.gracilis, *N senex*, common *L "solida"*
Sidewall core samples only analysed from this interval
M semitabulatum
? Scriniocassis weberi

Mixed
Humic

1 *Simlodinium grossii*
2 *Microforaminifera*
3 *Leptodinium arcuatum/subtile group*
4 *Paraeodinia ceratophora* *
5 *Leptodinium mirabile*
6 *Gonyaulacysta jurassica* *
7 *Gonyaulacysta cladophora*
8 *Systematophora areolata group*
9 *Tubotuberella apatela*
10 *Gonyaulacysta nealei*
11 *Ctenidodinium spp.*
12 *Milloudodinium spp.*
13 *Prolixosphaeridium granulosum*
14 *Acanthomorph acritarchs* *
15 *Nannoceratopsis pellucida*
16 *Systematophora spp.*
17 *Scriniodinium spp.*
18 *Adnatosphaeridium aemulum* *
19 *Scriniodinium crystallinum*
20 *Tasmanites spp.*
21 *Atopodinium prostatum* *
22 *Escharisphaeridia pocockii*
23 *Sentusidinium spp.*
24 *Wanaea thysanota*
25 *Wanaea fimbriata*
26 *Mendicodinium groenlandicum* *
27 *Acanthaulax spinosissima*
28 *Tubotuberella sphaerocephalis*
29 *Paraeodinia evitrii*
30 *Lithodinia spp.*
31 *Valensiella ovula*
32 *Polysphaeridium paracalathus* *C
33 *Gonyaulacysta eisenackii*
34 *Lithodinia jurassica*
35 *Adnatosphaeridium cf. aemulum*
36 *Lithodinia cristulata/caytonensis gp* *
37 *Chytroeisphaeridia hyalina*
38 *Stephanelytron scarburghense*
39 *Adnatosphaeridium caulleryi*
40 *Adnatosphaeridium multispinosum/vittata group* *
41 *Chytroeisphaeridia dictyoda*
42 *Dichadogonyaulax stauromatos*
43 *Gonyaulacysta dangeardii*
44 *Ctenidodinium continuum* *
45 *Chytroeisphaeridia cerastes*
46 *Caddaspheara halosa*
47 *Sentusidinium varispinosum* *
48 *Dichadogonyaulax spp.*
49 *Chytroeisphaeridia chytroides*
50 *Wanaea acollaris*
51 *Hystrichogonyaulax pectinigerum* *
52 *Palaeostomocystis tornatilis*
53 *Dissilodinium? "granulatum"* *
54 *Atopodinium cf. prostatum*
55 *Nannoceratopsis senex* *
56 *Leptodina solida* C
57 *Nannoceratopsis gracilis* *
58 *"Sphaeromorph" acritarchs*
59 *Mancodinium semitabulatum* *
60 *?Scriniocassis weberi* *
61
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66
67 Bisaccates
68 *Cerebropollenites mesozoicus*
69 *Perinopollenites elatoides*
70 *Callialasporites dampieri*
71 *Deltoidospora spp.* R
72 *Araucariacites australis*
73 *Classopollis torosus*
74 *Basidiospores/Osmundacidites group*
75 *Lycopodiumsporites spp.*
76 *Sestrosporites pseudoalveolatus*
77 *Densoisporites velatus*
78 *Aratrisporites ?spinulosus*
79 *Todisporites spp.*
80 *Chasmatosporites spp.*
81 *Parvisaccites enigmatus*
82 *Kuylisporites waterbolkii*
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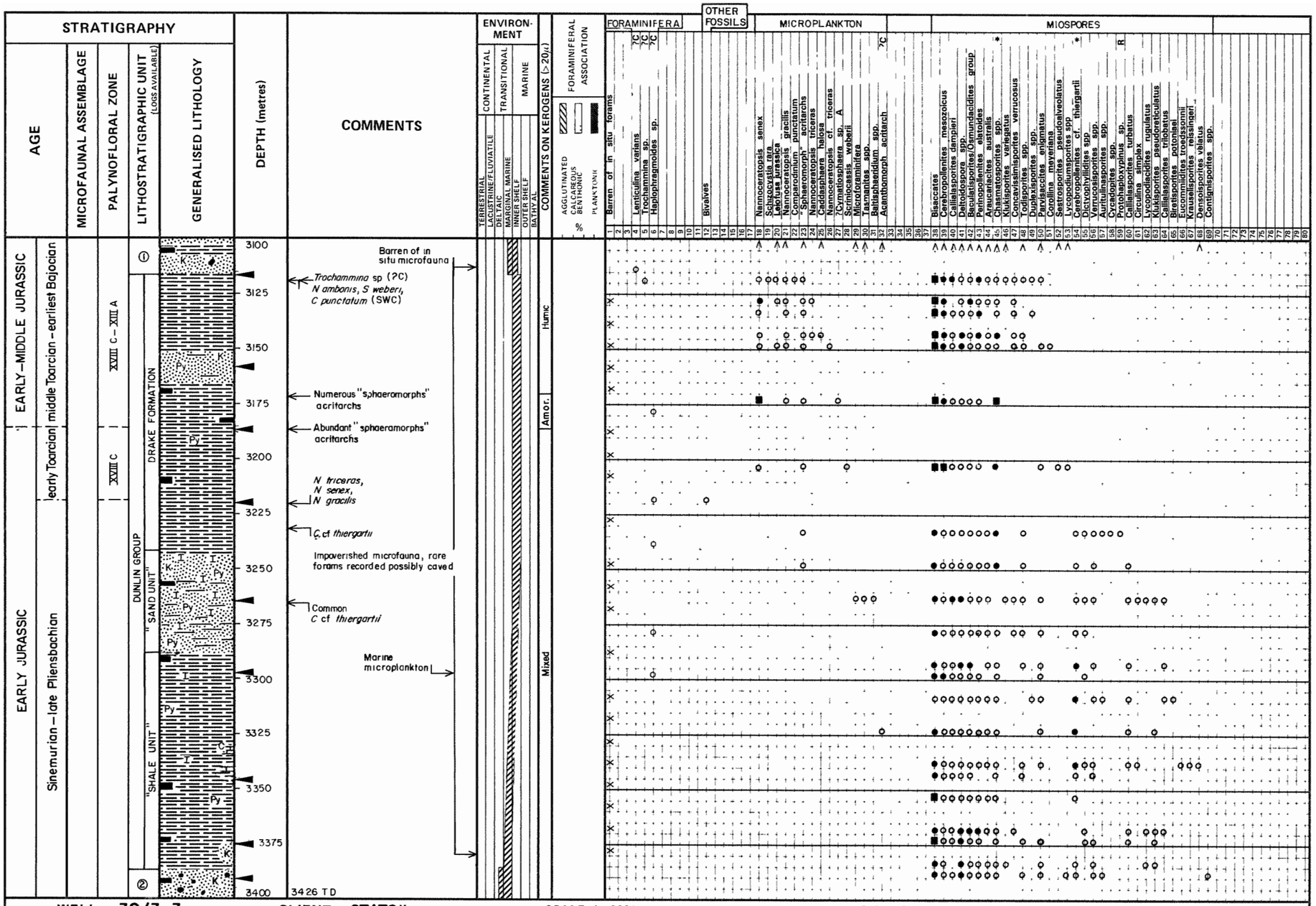
WELL:– 30/3-3
CHART:– 4b of 5
FIGURE:– 9

CLIENT:– STATOIL.
DEPTH:– 2800m - 3100m
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

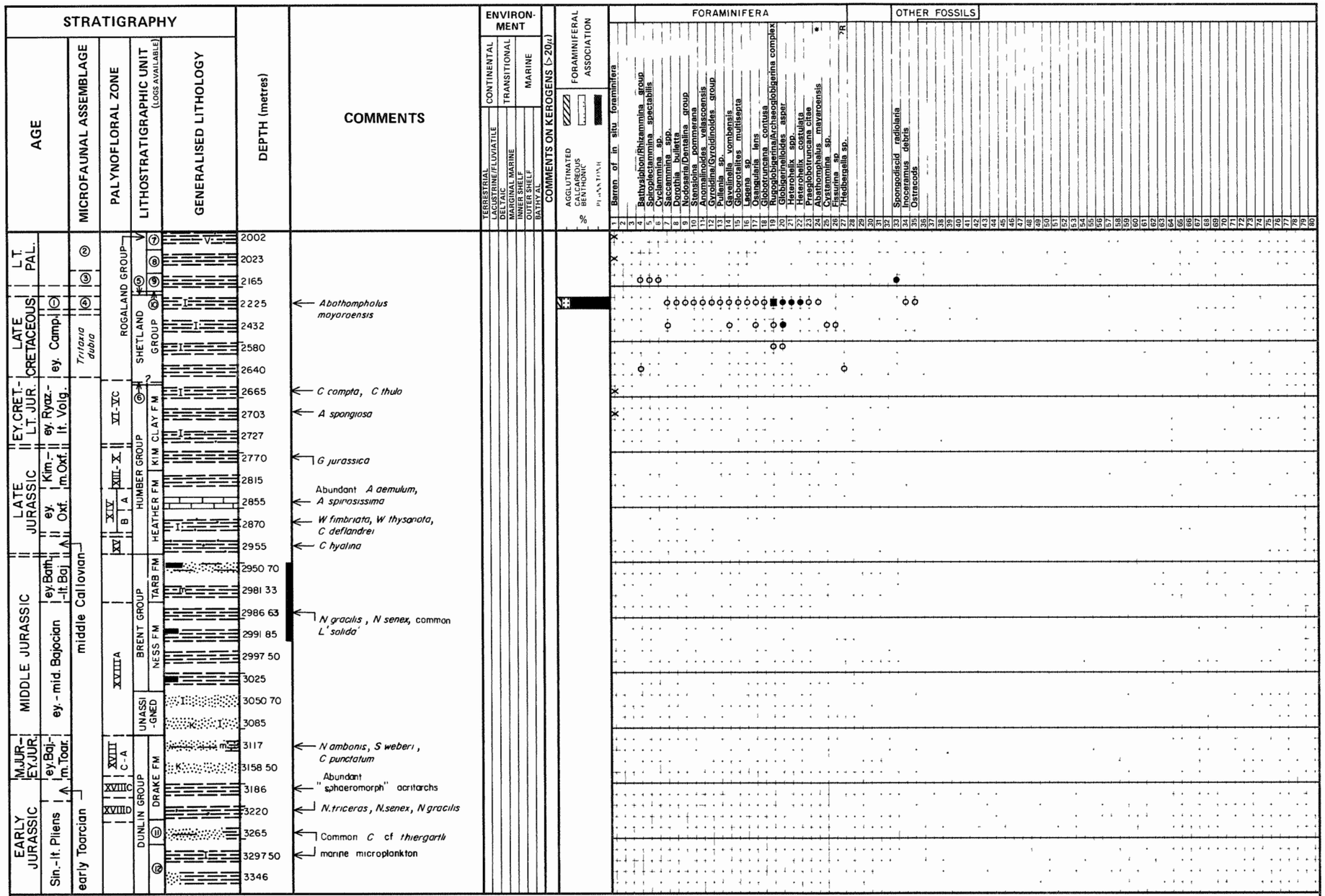
ANALYST:– J PGF, NHM
DRAWING NO.:– 973P/10581/5501
DATE:– AUGUST 1983

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART



① UNASSIGNED

② STATFJORD FORMATION



WELL:– 30/3-3
CHART:– Ia of 2
FIGURE:– 11

CLIENT:– STATOIL
SIDEWALL CORES AND CORE PIECES
LOCATION:– NORWEGIAN NORTH SEA

LEGEND:– SEE FIGURE 1

ANALYST:– PF, AJS
DRAWING NO.:– 973P/10581/5501
DATE:– AUGUST 1983

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART

① late Maastrichtian - Maastrichtian
② *Coscinodiscus* sp I
③ *Trochammina* sp A
④ *Psruddatextularia* - unnamed
⑤ MONTROSE GROUP
⑥ CROMER KNOLL GROUP
⑦ BALDER FORMATION
⑧ SELE FORMATION
⑨ LISTA FORMATION
⑩ MAUREEN FORMATION EQUIVALENT
⑪ "SAND UNIT"
⑫ "SHALE UNIT"

DEPTH (metres) (LOGS AVAILABLE)

PALYNOFLORAL ZONE

COMMENTS

COMMENTS ON KEROGENS (>20µ)

MICROPLANKTON

MIOSPORES

2002
2023
2165
2225
2432
2580
2640
2665 — C compta, C thula
2703 — A spongiosa
2727
2770 — G jurassica
2815
2855 — Abundant A aemulum, A spinosissima
2870 — W fimbriata, W thysanota, C deflandrei
2955 — C hyalina
2980 70
2981 33
2986 63 — N gracilis, N senex, common L "solida"
2991·85
2997 50
3025
3050 70
3085
3117 — N ambonis, S weberi, C punctatum
3158 50
3186 — Abundant "sphaeromorph" acritarchs
3220 — N triceras, N senex, N gracilis
3265 — Common C cf thiergarti
3297 50 — Marine microplankton
3346

1 Spiniferites ramosus group
2 Palaeoperidinium pyrophorum
3 Cyclonephelium spp.
4 Odontochitina operculata
5 Odontochitina costata
6 Impagidinium spp.
7 Chatangiella spp
8 Hystrichosphaeridium tubiferum
9 Trithyrodinium suspectum
10 Chatangiella granulifera
11 Acanthomorph acritarchs
12 Palaeohystrichophora infusorioides *
13 Palaeoperidinium cretaceum
14 Paralecaniella indentata
15 Isabelidinium microarmum
16 Hystrichodinium pulchrum
17 Cribroperidinium spp.
18 Chlamydophorella hyugoniorii
19 Botryococcus spp.
20 Deflandrea phosphoritica asymmetrica *
21 Deflandrea oebisfeldensis
22 Caddasphaera halosa
23 Hystrichosphaeridium stellatum
24 Hystrichodinium voigtii
25 Hystrichosphaeridium sp. 2 McKINTYRE
26 Alterbia acuminata
27 Palaeostomocystis fragilis
28 Callaiosphaeridium asymmetricum
29 Odontochitina porifera
30 Microforaminifera
31 Exochosphaeridium bifidum
32 Trigonopyxidiella pinella
33 Spinidinium clavum *
34 Cassiculosphaeridia reticulata
35 Sirmiodinium grossii
36 Large leiospheres
37 Pterodinium cingulatum *
38 Pterodinium spp.
39 Tasmanites spp.
40 Tubotuberella apatela
41 Pterospermella aureolata
42 Cannosphaeropsis thula * *
43 Aldoria spongiosa
44 Nyktericodinium spp.
45 Nyktericodinium kozlowskii
46 Glossodinium dimorphum
47 Prolixosphaeridium granulosum
48 Gonyaulacysta jurassica *
49 Atopodinium cf. prostatum
50 Chomotriletes sp.
51 Gonyaulacysta jurassica subsp. "minuta" *
52 Admixtosphaeridium aemulum * *
53 Scriniodinium spinosissima
54 Scriniodinium galeritum
55 Gonyaulacysta cladophora
56 Dichadogonyaulax sp.
57 Gonyaulacysta eisenackii
58 Nannoceratopsis pellucida
59 Chytroisphaeridia chytroeides
60 Compositosphaeridium costatum
61 Sentusidinium spp.
62 Sentusidinium rioultii
63 Stephanelytron redcliffense
64 Scriniodinium crystallinum
65 Pareodinia ceratophora
66 Cleistosphaeridium ehrenburgii *
67 Wanaea fimbriata
68 Surculosphaeridium vestitum
69 Valensiella spp. *
70 Valensiella ovulum *
71 Crussolia deflandrei *
72 Chytroisphaeridia hyalina *
73 Tubotuberella sphaerocephalis
74 Algal sacs
75 Sentusidinium "granulatum"
76 Leiofusa "solida" *
77 Leiofusa jurassica * *
78 Nannoceratopsis gracilis *
79 "Sphaeromorph" acritarchs
80 Schizophacus rugulatus
81 Thin walled leiospheres
82 Nannoceratopsis ambonis *
83 Comparodinium punctatum *
84 Polygonomorph acritarchs
85 Leiofusa jurassica *
86 Nannoceratopsis deflandrei
87 Micrhystridium semitabulatum
88 Nannoceratopsis triceras *
89
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93 Bisaccates
94 Deltoidospora spp.
95 Cicatricosisporites spp.
96 Baculatisporites/Osmundacidites group
97 Lycopodiumsporites spp.
98 Cerebropollenites mesozoicus
99 Callialasporites spp.
100 Classopollis spp.
101 Klukisporites variegatus
102 Perinopollenites elatoides
103 Araucariacites australis
104 Coronatispora valdensis
105 Cyathidites spp.
106 Concavissimisporites verrucosus
107 Densoisporites velatus
108 Todisporites spp.
109 Pinuspollenites minimus * *
110 Cerebropollenites thiergartii *
111 Lycopodiacidites rugulatus
112 Coniina meyeriana R
113 Striate bisaccates R
114 Striatoabieites aytugii
115 Skartsisporites pseudobalteolatus
116 Duplexisporites problematicus
117 Ginkgocycadophytus spp. R
118 Cerebropollenites cf thiergartii * R
119 Virtatina sp. R
120 Dictyophyllidites spp.

WELL:—30/3—3
CHART:— Ib of 2
FIGURE:— 12

CLIENT:— STATOIL
SIDEWALL CORES AND CORE PIECES
LOCATION:— NORWEGIAN NORTH SEA

LEGEND:— SEE FIGURE 1

ANALYST:— JPGF, NHM
DRAWING NO.:— 973P/10581/5501
DATE:— AUGUST 1983

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART

① XVIIIC
② XVIIID

WELL:- 30/3-3
CHART:- 2 of 2
FIGURE:- 13

CLIENT:- STATOIL.
SIDEWALL CORES
LOCATION:- NORWEGIAN NORTH SEA

LEGEND:- SEE FIGURE 1

STRATIGRAPHY

AGE: EARLY JURASSIC — late Pliensbachian - Sinemurian

MICROFAUNAL ASSEMBLAGE

PALYNOFLORAL ZONE

LITHOSTRATIGRAPHIC UNIT (LOGS AVAILABLE): STATFJORD FORMATION ①②

GENERALISED LITHOLOGY

DEPTH (metres): 3376, 3391, 3406, 3416

COMMENTS

ENVIRONMENT: TERRESTRIAL, LACUSTRINE/FLUVIATILE, DELTAIC, MARGINAL MARINE, INNER SHELF, OUTER SHELF, BATHYAL — CONTINENTAL, TRANSITIONAL, MARINE

COMMENTS ON KEROGENS (>20μ)

FORAMINIFERAL ASSOCIATION: % AGGLUTINATED, CALCAREOUS BENTHONIC, PLANKTONIC

MIOSPORES

1 Bisaccates
2 Parvisaccites enigmatus
3 Deltoidospora spp.
4 Chasmatosporites spp.
5 Baculatisporites/Osmundacidites group
6 Cerebropollenites cf. thiergartii
7 Perinopollenites elatoides
8 Lycopodiacidites rugulatus
9 Todisporites spp.
10 Dictyophyllidites spp.
11 Protohaploxypinus sp. R
12 Araucariacites australis
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ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART

ANALYST:- NHM, AJS, JPGF
DRAWING NO.:- 973P/10581/5501
DATE:- AUGUST 1983

① DUNLIN GROUP
② "SHALE UNIT"

ENCLOSURE 1

ROBERTSON RESEARCH INTERNATIONAL

SUMMARY LOG

STATOIL 30/3-3

SCALE 1 : 500

AREA: NORWEGIAN NORTH SEA

SPUD DATE: 2nd APRIL 1983

COMPANY: STATOIL

COMPLETION DATE: 31st MAY 1983

INTERVAL STUDIED: 1900m - 3418m

T.D.: 3426m

Drawing No 973P/10581/5501

ANALYST JPGF, PF, NHM, AJS, DJS.

Date September 1983

Cored Interval
Casing Shoe
Sidewall Core
Sidewall Core (no recovery)
Sidewall Core analysed for biostratigraphy *