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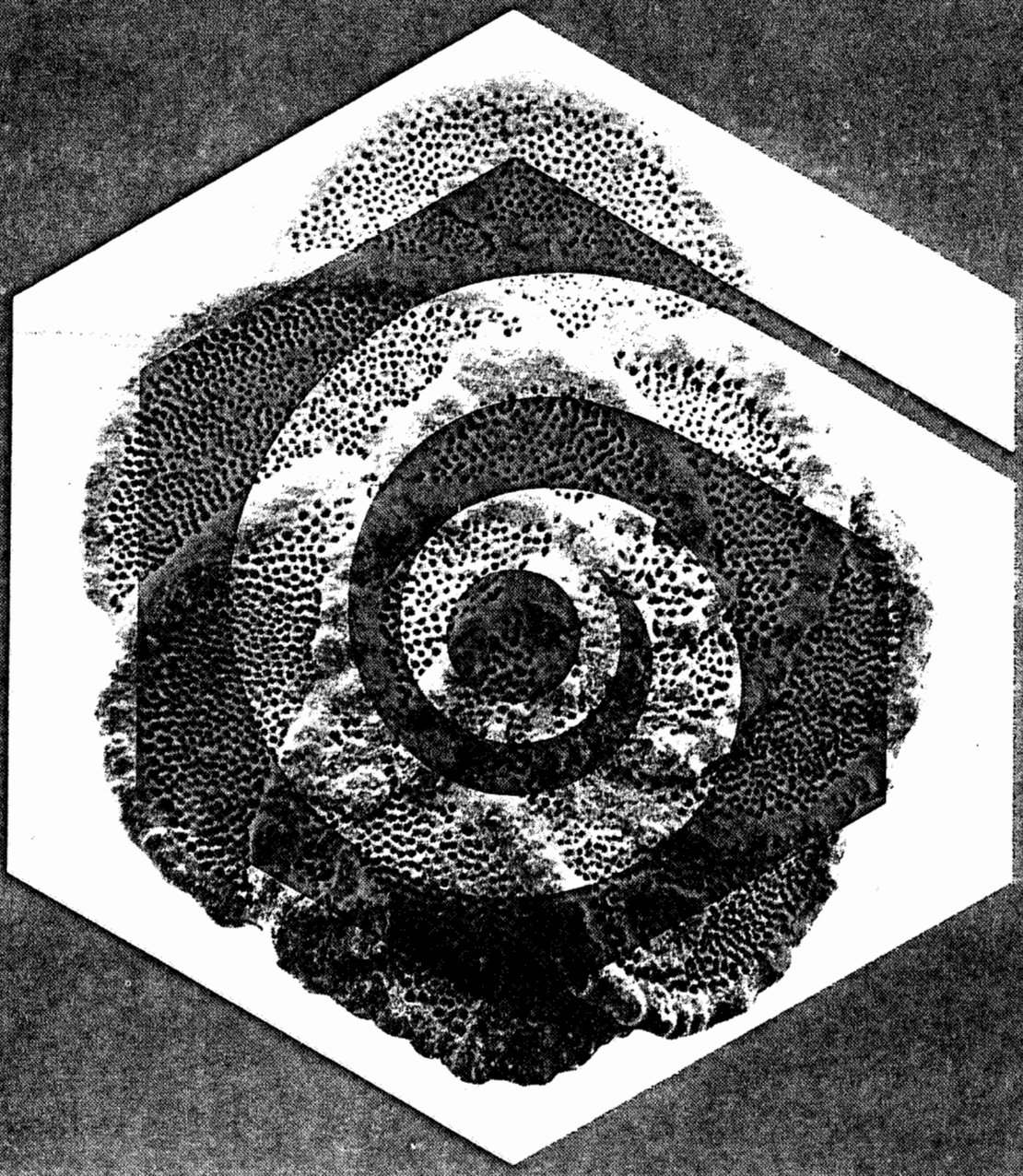

CLIENT COMPANY	*STATOIL*
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1. INTRODUCTION

This report presents the results of the stratigraphical and paleontological study of samples from Well 34/10-18, drilled by Statoil in the North Sea (Norwegian offshore) during 1983.

Material available

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

10m between 1,020m - 1,680m
2.5m between 1,680m - 1,780m
5m between 1,780m - 2,290m
2.5m between 2,290m - 2,395m
5m between 2,395m - 2,600m
2.5m between 2,600m - 3,025m

20 sidewall cores between 2,108m and 3,008m and 11 core chips between 2,343.93m and 2,394m were also received.

Analyses

Micropaleontological analyses on ditch cuttings were carried out at an average of 10m intervals with a greater sample density in the lower part of the well. Analyses were carried out on 7 core chips and 11 sidewall cores.

Calcareous nannoplankton analyses were carried out on two core chips and one sidewall core within the Early Cretaceous.

A total of one hundred and seven samples (11 cores, 19 SWCs and 77 ditch cuttings) has been analysed for palynology over the interval 1,695m to 3,025m.

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

Boundary definition

All boundaries defined in this report are based on sample depths and are taken at significant lithostratigraphic or biostratigraphic events. Petrophysical logs were available in the latter stage of the study but all boundaries are based on samples.

Lithostratigraphic terminology

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

2. SUMMARY

Cainozoic

1. The highest 20 metres studied (1,010m-1,030m) comprise fine glauconitic sands containing a microfauna of sponge spicules and calcareous foraminiferids (the latter are probably caved). This unit falls within an age range of Early Pliocene-Miocene and was deposited in a marine sublittoral environment.

2. The Early Pliocene-Miocene sands rest directly on siltstones of the Hordaland Group (from 1,030m-1,380m) dated as Oligocene on the basis of the diatom flora and sparse foraminiferid fauna. Marine, outer sublittoral conditions existed during the deposition of the section from 1,030m to 1,250m. Agglutinating foraminiferids become more common below 1,250m reflecting deeper water, probably bathyal conditions.

3. It is not possible to define the top of the Eocene interval precisely in this well and the section from 1,380m to 1,420m is dated as Oligocene/?Eocene. No restricted Late Eocene taxa were recorded and there may be an unconformity at the top of the Middle-Early Eocene section at 1,420m.

4. Middle-Early Eocene Hordaland Group claystones and rare dolomitic limestones are recorded from 1,420m to 1,670m, containing an agglutinating foraminiferid assemblage which indicates marine bathyal conditions. Rare tuffaceous deposits occur below 1,570m indicating occasional contemporaneous volcanic activity. A regionally persistent Early Eocene lithostratigraphic marker comprising red/brown claystone with planktic foraminiferids occurs at the base of the interval, below 1,660m.

5. Tuffaceous claystones of the Balder and Sele Formations are present from 1,670m to 1,745m in this well, and contain a characteristic diatom flora. This interval spans the basal Eocene-Late Paleocene boundary, and was deposited in a marine, outer sublittoral to bathyal environment.

6. Grey claystones and siltstones of the Lista Formation present from 1,745m to 1,885m are dated as Late Paleocene (1,745m-1,870m) and "Middle" Paleocene (1,870m-1,885m). The agglutinating foraminiferid fauna, together with radiolaria, indicates deposition in a marine, bathyal environment.

7. The "Middle" Paleocene interval rests unconformably on Late Maastrichtian sediments at 1.885m: there is no definite paleontological evidence for Early Paleocene deposits.

Cretaceous

8. Grey claystones and interbedded dolomitic limestones, typical of the Shetland Group, occur from 1,885m to 2,336m. The microfauna is dominated by long-ranging agglutinating taxa, but the rare occurrence of calcareous foraminiferids, radiolaria and pyritised diatoms, and microfloral content, indicates a dating of Maastrichtian, Campanian and ?Santonian. The whole of this interval was deposited in a marine, outer sublittoral to bathyal environment, the dominance of agglutinating taxa through much of the sequence reflecting periods of deeper water deposition.

9. Late Cretaceous (?Santonian) claystones of the Shetland Group rest unconformably at 2,336m on a very thin unit (2,336m-2,340m) of red/brown claystones of the Cromer Knoll Group, dated as Early Albian. These in turn rest unconformably at 2,340m on limestones dated on the basis of the foraminiferid content as Early Barremian-Hauterivian.

10. The Cromer Knoll Group limestones present from 2,340m to 2,351.6m are of marine sublittoral origin, and the microfaunal and nannoplankton content indicates a subdivision of Early Barremian-Hauterivian (2,340m-2,343.93m) and Early Hauterivian-?Valanginian (2,343.93m-2,351.6m). This limestone rests unconformably on the Kimmeridge Clay Formation at 2,351.6m.

Jurassic

11. Only part of the Kimmeridge Clay Formation is present in the well and it is represented by a thin sequence (2,351.6m-2,355m) of black claystones and siltstones dated by palynological analyses of core samples as Early

Portlandian/Late Kimmeridgian. Deposition took place in a marine, sublittoral, environment with poorly oxygenated conditions at the sea bed.

12. The Kimmeridge Clay Formation rests unconformably on the Heather Formation at 2,355m.

13. Heather Formation claystones have been recorded in the samples, between 2,355m and 2,370m. The sediments between 2,361m and 2,770m, using core samples, have been accurately dated as Early Bathonian, but the overlying six metres are only tentatively dated as Bathonian as no core samples were available. Deposition took place in a marine, sublittoral environment.

14. The five members of the Brent Formation are present in this well between 2,370m and 2,605m and have been tentatively differentiated by samples. Dating of the sequence indicates an age range of Early Bathonian to Early Bajocian (=Aalenian). The downhole appearance of the dinoflagellate Nannoceratopsis gracilis is a significant regional event in the middle part of the Ness Member although its occurrence at 2,475m in this well may not be the top of its total range. Deposition of the formation was in a transitional to nearshore marine environment, the cyclic Ness sequence possibly represents deposition on a delta platform.

15. The Dunlin Formation 2,605m-2,975m is divided into four members which are apparently present in this well. The Formation ranges in age from Early Bajocian (=Aalenian) to Early Pliensbachian. Numerous faunal/floral events have been recognised in this area and these are indicated on the log for correlation and dating purposes.

    Deposition was mainly in a lower energy, marine, sublittoral environment, although the coarse clastics at the base of the Amundsen Member may be littoral deposits and shallower deposition is also indicated in the regressive Cook Sand between 2,740m and 2,765m.

16. Clean coarse sands between 2,975m and 3,025m indicate the penetration of the Statfjord Formation. Only the upper part of the sequence is present in this well and it has been dated as no older than Sinemurian. Deposition took place in a marine, littoral-sublittoral environment.

3. STRATIGRAPHICAL SUMMARY

Interval	Lithostratigraphic Unit	Age	Thickness
1,010m - 1,030m	Nordland?/Hordaland	Early Pliocene-Miocene	20m
1,030m - 1,380m	Hordaland	Oligocene	350m
1,380m - 1,420m	Hordaland	Oligocene/?Eocene	40m
----------POSSIBLE UNCONFORMITY----------			
1,420m - 1,670m	Hordaland	Middle-Early Eocene	250m
1,670m - 1,745m	Rogaland:Balder & Sele	Basal Eocene-Late Paleocene	75m
1,745m - 1,870m	Rogaland:Lista	Late Paleocene	125m
1,870m - 1,885m	Rogaland:Lista	"Middle" Paleocene	15m
----------UNCONFORMITY----------			
1,885m - 1,940m	Shetland	Late Cretaceous (Late Maastrichtian)	55m
1,940m - 2,100m	Shetland	Late Cretaceous (Maastrichtian)	160m
2,100m - 2,310m	Shetland	Late Cretaceous (Campanian)	210m
2,310m - 2,336m	Shetland	Late Cretaceous (?Santonian)	26m
----------UNCONFORMITY----------			
2,336m - 2,340m	Cromer Knoll	Early Cretaceous (Early Albian)	4m
----------UNCONFORMITY----------			
2,340m - 2,343.93m	Cromer Knoll	Early Cretaceous (Early Barremian-Hauterivian)	3.93m
2,343.93m- 2,351.6m	Cromer Knoll	Early Cretaceous (Early Hauterivian-?Valanginian)	7.67m
----------UNCONFORMITY----------			
2,351.6m - 2,355m	Humber:Kimmeridge Clay	Late Jurassic (Early Portlandian/Late Kimmeridgian)	3.4m
----------UNCONFORMITY----------			
2,355m - 2,361m	Humber:Heather	Middle Jurassic (?Bathonian)	6m
2,361m - 2,370m	Humber:Heather	Middle Jurassic (Early Bathonian)	9m
2,370m - 2,475m	Brent: Tarbert-Ness	Middle Jurassic (Early Bathonian-?earliest Bathonian/Bajocian)	105m

2,475m	- 2,595m	Brent: Ness-Rannoch	Middle Jurassic (?earliest Bathonian/Bajocian-Early Bajocian (=Aalenian))	120m
2,595m	- 2,605m	Brent: Broom	Middle Jurassic (Early Bajocian (=Aalenian))	10m
2,605m	- 2,675m	Dunlin: Drake	Middle-Early Jurassic (Early Bajocian (=Aalenian)-Toarcian)	70m
2,675m	- 2,740m	Dunlin: Drake-Cook	Early Jurassic (Early Toarcian)	65m
2,740m	-c.2,900m	Dunlin: Cook-Amundsen	Early Jurassic (Late Pliensbachian)	c.160m
c.2,900m	-c.2,975m	Dunlin: Amundsen	Early Jurassic (Early Pliensbachian)	c.75m
c.2,975m	- 3,025m L.S.R.	Statfjord	Early Jurassic (Sinemurian)	c.50m

4. STRATIGRAPHY

4.1 1,010m-1,030m EARLY PLIOCENE-MIOCENE

Lithostratigraphy:

Nordland (pars)/?Hordaland (pars)

1,010m-1,030m Sand, fine grained, angular, friable, with abundant glauconite and pyrite throughout. Rare fragments of grey calcareous limestone are present below 1,015m.

Biostratigraphy:

1,010m-1,030m Early Pliocene-Miocene

The age of this interval is suggested by the common occurrence of siliceous sponge spicules, including Geodia sp. These have been dated elsewhere in the area, in association with age restricted taxa, as Early Pliocene-Miocene. Foraminiferids present in this well are generally long-ranging Pliocene-Miocene forms although specimens of the Late Pliocene form Cibicides lobatulus grossa were also recorded. These are thought to be caving from the overlying section which Paleoservices Ltd. was not requested to examine.

Environment:

Marine, sublittoral.

Notes:

This interval rests directly on siltstones of Oligocene age and as the precise age of this interval is uncertain the nature of the lower boundary is itself not defined. There could be a possible unconformity at 1,030m, but this cannot be proved on the basis of the present available data.

4.2 1,030m-1,420m OLIGOCENE-?EOCENE

Lithostratigraphy:

Hordaland Groups (pars)

1,030m-1,160m Siltstone, brown-grey/brown, hard, argillaceous, pyritic throughout, with rare traces of lignite below 1,100m.

1,160m-1,310m Claystone, dark brown-grey/brown, firm-moderately hard, silty, with rare pyrite and glauconite throughout. Sand, medium-coarse, rounded, occurs throughout, but may be caved.

1,310m-1,420m Claystone, dark green-dark grey, moderately hard, subfissile, pyritic, also with rare traces of limestone, brown, sideritic, below 1,375m. Sand, medium-coarse, rounded, occurs sporadically but is probably the result of caving.

Biostratigraphy:

1,030m-1,380m Oligocene

The top of the Oligocene is defined at 1,030m by the highest occurrence of Diatom sp.3. (King, 1983), an index species for the Oligocene in the North Sea region. The Oligocene foraminiferid Turrilina alsatica also occurs below 1,040m. With the exception of these two taxa the microfauna and microflora between 1,030m and 1,250m is impoverished, and limited to sponge spicules and pyritised diatoms.

Below 1,250m agglutinating foraminiferids dominate the microfauna including Cyclammina gr. placenta, Recurvoides ex. gr. walteri and Rhabdammina gr. discreta. The Early Miocene-Oligocene species Silicosigmoilina sp. is also present below 1,260m, and continues to occur in cuttings samples down to 1,380m. If in-place this would indicate an age of Oligocene down to this depth.

1,380m-1,420m Oligocene/?Eocene

The microfauna recorded through this interval comprises only long-ranging agglutinating foraminiferids, which are known to range from the Oligocene through the Eocene (e.g. Glomospira charoides,

Ammodiscus incertus and Haplophragmoides walteri). It is not possible on the basis of this insufficient data to define the precise depth of the Oligocene-Eocene boundary although it may lie at the base of the interval which is marked by a preservation change in the microfauna.

Environment:

1,030m-1,250m Marine, outer sublittoral.

1,250m-1,420m The occurrence of a dominantly agglutinating foraminiferid assemblage of the "Rhabdammina-fauna" type suggests a marine, bathyal environment.

Note:

As no restricted Late Eocene taxa were recorded in this well, there may be an unconformity at the top of the definite Middle-Early Eocene sediments, i.e. at 1,420m.

4.3 1,420m-1,670m MIDDLE-EARLY EOCENE

Lithostratigraphy:

Hordaland Group (pars)

1,420m-1,570m Claystone, dark green to green/grey, firm, slightly shaly, with pyrite present throughout, and traces of siderite below 1,450m.

1,570m-1,660m Claystone, grey/green, firm, occasionally white speckled-tuffaceous.

1,660m-1,670m Claystone, red/brown, moderately hard, slightly shaly, sideritic.

Biostratigraphy:

The highest occurrence of the agglutinating foraminiferid Bolivinopsis spectabilis indicates the penetration of definite Middle-Early Eocene sediments. The rest of the microfauna is the same as that recorded in the interval above, with the exception of Cyclammina amplectens (below 1,470m); this species is known not to range above the Middle Eocene.

Common to abundant spherical reticulate radiolaria occur below 1,580m. These are characteristic of other Middle-Early Eocene sections in the North Sea region.

The red/brown claystone below 1,660m contains a characteristic planktic microfauna (Globigerina gr. linaperta). This horizon is a regional marker in the lower part of the Early Eocene.

Environment:

Marine, bathyal; indicated by the consistent occurrence of the agglutinating "Rhabdammina-fauna".

4.4 1,670m-1,885m BASAL EOCENE-PALEOCENE

Lithostratigraphy:

Rogaland Group (Balder and Sele Formations)

1,670m-1,745m Claystone, green-dark green, moderately hard, subblocky, waxy, tuffaceous.

Rogaland Group (Lista Formation)

1,745m-1,800m Siltstone, green/brown to light grey/green, moderately hard, subblocky, pyritic throughout.

1,800m-1,830m Claystone, light grey/green, moderately hard, pyritic, glauconitic.

1,830m-1,885m Siltstone, light grey/green-green/brown, moderately hard, pyritic, with traces of tuffaceous claystone below 1,860m.

Biostratigraphy:

1,670m-1,745m Basal Eocene-Late Paleocene

Microfauna: The microfaunal assemblage is very poor through this interval and the top of the basal Eocene-Late Paleocene section is defined by the lithological break to tuffaceous claystones at 1,670m. Pyritised and siliceous centric diatoms (Coscinodiscus sp.1 and C. sp.2) occur consistently below 1,680m; these are characteristic of the Balder and Sele Formations.

Microflora: The assemblages from this interval contain the following association of taxa, Cordosphaeridium gracilis, Glaphyrocysta ordinata, Deflandrea phosphoritica, Palaeocystodinium golzowense and abundant Triporate pollen. This association is regionally characteristic of sediments of Early Eocene to Late Paleocene age.

The Jurassic dinoflagellate cyst Nannoceratopsis gracilis is found reworked in this interval.

1,745m-1,870m Late Paleocene

Microfauna: There is a distinct change in the microfauna below 1,745m, associated with the highest siltstones and claystones occurring below the tuffs. This is marked by the incoming of a diverse agglutinating assemblage which includes consistent Bolivinopsis spectabilis. The consistent occurrence of this species below the Balder and Sele Formations is typical of Late Paleocene sediments in the North Sea. A further diagnostic Paleocene marker, Trochammina aff. albertensis, occurs below 1,820m.

Microflora: The first sample examined from this interval at 1,755m contains the downhole appearance of the dinoflagellate cyst Apectodinium augustum. Even though this taxon is thought to range up into the earliest Eocene it is most characteristic of the Late Paleocene and its occurrence here is consistent with a Late Paleocene age at 1,755m.

Alisocysta margarita appears downhole at 1,770m. This is a paleoevent which regionally occurs within the Late Paleocene.

Extensive reworking occurs within this interval including the Mesozoic miospores Cerebropollenites mesozoicus and Classopollis torosus and the Early Paleocene-Late Cretaceous dinoflagellate cyst Palaeoperidinium pyrophorum.

1,870m-1,885m "Middle" Paleocene

Microfauna: The occurrence of common spherical reticulate radiolaria below 1,870m is used to indicate a "Middle" Paleocene age for this interval. This radiolaria-rich horizon occurs widely in the North Sea region, often associated with age diagnostic planktic foraminiferids. In this well however only long-ranging Paleogene agglutinants were recorded.

Microflora: All the in-situ taxa present in the one sample examined from this interval at 1,880m, continue through from higher up the well.

The Early Paleocene-Late Cretaceous dinoflagellate cysts Ceratiopsis striata and Palaeoperidinium pyrophorum are found reworked in this sample.

Notes:

There is no paleontological evidence for the presence of Early Paleocene (Danian) sediments in this well and an unconformity between the "Middle" Paleocene and Late Cretaceous (Late Maastrichtian) is indicated at 1,885m.

Environment:

1,670m-1,745m Marine, sublittoral or bathyal, the precise water depth being uncertain, contemporaneous volcanic activity.

1,745m-1,885m Marine, outer sublittoral to bathyal, the latter being more likely in view of the large numbers of agglutinating foraminiferids ("Rhabdammina-fauna") recorded. The rare tuffaceous sediments noted below 1,860m indicate sporadic volcanic activity during the Late Paleocene, and the occurrence of radiolaria below 1,870m reflects more open oceanic current circulation in this area.

4.5 1,885m-2,336m LATE CRETACEOUS, Maastrichtian-?Santonian

Lithostratigraphy:

Shetland Group

1,885m-1,910m Claystone, grey, firm to moderately hard, calcareous, slightly silty, with rare traces of pyrite and glauconite present.

1,910m-2,000m Claystone, grey, moderately hard, shaly, pyritic, with limestone, cream/brown, hard, micritic, pyritic.

2,000m-2,060m Claystone, grey, moderately hard, calcareous, slightly silty, pyritic, sample quality is poor between 2,020m and 2,050m because of contamination by cement.

2,060m-2,100m Claystone, grey, shaly, interbedded with limestone, dark brown, dolomitic, microcrystalline.

2,100m-2,120m Claystone, grey, with traces red/brown, particularly below 2,110m. Rare limestone, dark brown, dolomitic.

2,120m-2,300m Claystone, grey, hard, subfissile, slightly shaly, with pyrite and grey sphaeroidal siderite, limestone, dark brown, dolomitic, interbedded with sandstone, fine, angular, glauconitic, laminated with claystone, sandstone particularly common below 2,220m.

2,300m-2,336m Claystone, grey-grey/green, hard, subfissile, pyritic with limestone, mid brown, hard, dolomitic, microcrystalline.

Biostratigraphy:

1,885m-1,940m Late Maastrichtian

Microfauna: The top of the Late Maastrichtian is marked at 1,885m by a major change in the microfauna. There is an age-diagnostic calcareous planktic foraminiferid assemblage below this depth which includes Pseudotextularia elegans and Racemiguembelina fructicosa and below 1,890m Abathomphalus mayaroensis and Globotruncana

contusa. These taxa are present throughout the unit together with the longer-ranging Maastrichtian-Campanian species Rugoglobigerina rugosa and Globigerinelloides messinae.

Benthic foraminiferids recorded include both calcareous and agglutinating taxa, Trochamminoides irregularis being a useful marker within the Maastrichtian of the northern North Sea area.

Microflora: The downhole appearance of the dinoflagellate cysts Spongodinium delitiense (1,905m), Chatangiella spp. (1,920m), and Palaeoperidinium pyrophorum (1,905m), where it is considered to be in place, all indicate penetration of sediments of Late Cretaceous, Maastrichtian or older age.

1,940m-2,100m Maastrichtian

Microfauna: The highest occurrence of the benthic foraminiferid Reussella szajnochae szajnochae is used to define the top of this interval. This subspecies ranges up into the Late Maastrichtian and is commonly found in the early part of the stage. It is associated here with the planktic species Globotruncanella havanensis which has a similar range, but does not occur below the Maastrichtian.

The upper part of this interval is characterised by the abundance of the planktic Rugoglobigerina rugosa, and common prismatic fragments of the bivalve Inoceramus sp. Below 2,020m the microfauna shows a gradual increase in the agglutinating taxa. (e.g. Rhabdamina gr. discreta, Recurvoides sp. and Ammodiscus cf. cretaceus).

Microflora: A number of characteristic Late Cretaceous palynomorphs appear downhole within this interval including the dinoflagellate cysts Trithyrodinium suspectum (1,950m), Odontochitina operculata (1,965m), Spinidinium clavum (1,995m) and Leberidocysta chlamydata (2,025m) and the pollen Aquilapollenites spp. (1,980m).

2,100m-2,310m Campanian

Microfauna: The red claystone at the top of this interval contains a characteristic microfauna comprising Globotruncana aff. arca and Pseudogaudryinella capitosa. This horizon is used to define the top of the Campanian in the northern North Sea.

There is a relatively impoverished microfauna of long-ranging agglutinating taxa through the rest of the Campanian with only rare calcareous benthic species present. The only stratigraphically significant taxa recorded are the small pyritised diatoms present below 2,250m which are characteristic of the laminated sandstone/ claystone facies in the early part of the Campanian in this area.

Microflora: Most of the taxa recorded higher up the well continue through this interval. A number of dinoflagellate cysts which top within the Campanian in nearby wells appear downhole in this interval including Odontochitina costata (2,115m), Raphidodinium fucatum (2,145m), Palaeohystrichophora infusorioides (2,160m) and Chatangiella niiga (2,220m).

2,310m-2,336m ?Santonian

Microfauna: The top of this interval has been taken at the highest occurrence of spherical radiolaria at 2,310m. In the northern North Sea these are normally associated with common inoceramid prisms and a distinctive calcareous benthic assemblage. In this well the radiolaria occur with only rare calcareous benthic foraminiferids (Eponides concinnus, Globorotalites michelinianus) down to the sidewall core at 2,336m and the inoceramid content is also low. For this reason the Santonian dating is only tentative. The planktic foraminiferid level also known to occur within Santonian sediments elsewhere in this region may not be preserved here as this unit rests unconformably on Early Cretaceous claystones at 2,336m.

Microflora: All the taxa recorded in this interval continue through from the overlying interval. No definite Santonian palynomorphs were recorded in the samples examined. However, the SWC at 2,336m

contains the following association of taxa, Chatangiella spp., Palaeoperidinium pyrophorum and Trithyrodinium suspectum, which regionally indicate an age not older than Late Turonian.

Note:

Early Cretaceous (Middle-Early Albian) taxa occur in the 5 metre ditch sample ranging from 2,335m-2,340m. However, as noted above Late Cretaceous (?Santonian) foraminiferids occur in the sidewall core at 2,336m, therefore the unconformity between the two intervals must lie at or below this depth.

Environment:

The whole of the Late Cretaceous succession was deposited in a marine, outer sublittoral to bathyal environment. The dominance of agglutinating taxa through much of the sequence reflects periods of deeper water deposition.

4.6 2,336m-2,351.6m EARLY CRETACEOUS, Albian and Early Barremian-?Valanginian

Lithostratigraphy:

Cromer Knoll Group

2,336m-2,340m Claystone, red/brown, occasionally grey, firm, shaly.

2,340m-2,351.6m Limestone, light brown-buff coloured, oil stained, bioclastic, with common bivalve debris and stylolites (see Appendix 1 for lithological description of sidewall core at 2,341m and core at 2,343.93m-2,344m). The lower part of the unit is light green, marly and nodular, with abundant pyrite (see core sample description at 2,350.55m).

Biostratigraphy:

2,336m-2,340m Early Albian

Microfauna: The ditch sample between 2,335m and 2,340m contains a diagnostic Early Albian foraminiferid assemblage including Globigerinelloides "gyroidinaeformis", Uvigerinammina bulimoides (int. sp.), Hedbergella planispira and Gavelinella intermedia. As discussed in the Late Cretaceous section of this report, Late Cretaceous (?Santonian) foraminiferids are present in the sidewall core at 2,336m and the top of the Early Albian must occur at or below this depth.

Microflora: No sample examined from this interval.

Notes:

The Early Albian red claystone rests directly on light brown limestone dated as Early Barremian to Hauterivian. There is no paleontological evidence for Aptian-Late Barremian sediments in this well and an unconformity is indicated at the top of the limestone unit at 2,340m.

2,340m-2,343.93m Early Barremian-Hauterivian

Microfauna: The top of this unit is defined by an age diagnostic microfauna, including Uvigerinammina moesiana and Lenticulina schreiteri, present in the limestone below 2,340m. Spherical radiolaria are also common in the ditch sample from 2,340.45m. The sidewall core at 2,341m contains abundant inoceramid prismatic fragments and only rare foraminiferids including the Early Barremian marker Uvigerinammina sp.1 (int. sp.).

Nannoflora: The sidewall core at 2,341m was examined but this yielded only rare long-ranging Cretaceous taxa.

Microflora: No samples examined from this interval.

2,343.93m-2,351.6m Early Hauterivian-?Valanginian

Microfauna: Only rare long-ranging foraminiferids were recorded from the ditch samples between 2,345m and 2,350m and the core sample at 2,343.93m-2,344m. The core sample at 2,351.60m however yielded a diverse benthic foraminiferid assemblage including abundant Trocholina infragranulata. This species, although facies controlled, is known to occur in Early Hauterivian to Valanginian carbonates in the northern North Sea.

Nannoflora: The top of the interval is defined by the occurrence of the Early Hauterivian taxon Truncatoscaphus delftensis in the core sample at 2,343.93m-2,344m. The accompanying microflora includes long-ranging forms such as Micrantholithus hoschulzi (Aptian-Valanginian), Watznaueria barnesae (Maastrichtian-Ryazanian) and Ellipsagelosphaera britannica (Albian-Oxfordian).

Only long-ranging species were recorded in the core sample from 2,351.6m with the exception of Nannoconus steinmanni (Barremian-Valanginian).

Microflora: Only long-ranging Mesozoic pollen and spores were recorded from the two core samples processed for palynology.

Environment:

2,336m-2,340m Marine, sublittoral.

2,340m-2,351.6m Marine, sublittoral, carbonate rich shelf deposition.

Notes:

The whole of the Early Barremian to ?Valanginian succession is very condensed and stratigraphic breaks may occur within the succession. For example there is no definite paleontological evidence of Late Hauterivian sediments between the sidewall core at 2,341m and the core sample at 2,343.93m-2,344m.

The Early Hauterivian-?Valanginian limestone rests directly on Late Jurassic (Early Portlandian/Late Kimmeridgian) claystones at 2,351.6m and an unconformable boundary is indicated at this depth.

4.7 2,351.6m-2,355m LATE JURASSIC, Early Portlandian/Late Kimmeridgian

Lithostratigraphy:

(see Appendix 1 - Lithological description of sidewall cores and core samples)

Humber Group

Kimmeridge Clay Formation

Ditch cuttings heavily contaminated by caving. Core samples at 2,351.6m, 2,353m, 2,354m and 2,354.75m claystone and occasionally siltstone, black, organic rich, micaceous, non calcareous, with trace glauconite and pyrite.

Biostratigraphy:

Microfauna: No in place microfauna was recorded in the ditch cuttings and core samples.

Microflora: The four core chips from this interval contain moderately diverse assemblages of microplankton, in miospore dominated samples, together with common/abundant amorphous sapropel. The presence of Millioudodinium gigas, at 2,351.6m indicates an age within the range Early Portlandian to Kimmeridgian. Hystrichogonyaulax cladophora first appears downhole at 2,353m. This taxon indicates penetration of sediments of Kimmeridgian or older age.

Pareodinia mutabilis and Pterospermella aureolata occur downhole at 2,354m. P. mutabilis has a stratigraphic range of Early Portlandian to Late Kimmeridgian. The core at 2,354.75m-2,354.80m also contains P. aureolata which, in the northern North Sea, does not range below the Late Kimmeridgian.

Environment:

Marine, sublittoral with anaerobic conditions at the sea bed.

Note:

The Late Jurassic (Early Portlandian/Late Kimmeridgian) sediments of the Kimmeridge Clay Formation rest unconformably on the Middle Jurassic (?Bathonian) sediments of the Heather Formation at 2,355m.

4.8 2,355m-2,370m MIDDLE JURASSIC, Bathonian

Lithostratigraphy:

(see Appendix 1 - Lithological description of core samples and sidewall cores)

Humber Group

Heather Formation

2,355m-2,360m Ditch cuttings heavily contaminated by caving, no core samples available. Trace siltstone/claystone, black, organic, and dolomite, brown.

2,360m-2,370m Ditch cuttings heavily contaminated by caving, core samples at 2,361m, 2,363m and 2,364.65m claystone/siltstone, dark grey, black, micromicaceous, with fine organic debris, pyritic.

Biostratigraphy:

2,355m-2,361m ?Bathonian

Microfauna: It was not possible to identify any in place microfauna as core samples were not available and ditch cuttings are heavily contaminated by caving.

Microflora: The ditch cuttings, 2,355m-2,362.5m, contain no closely age restricted taxa within the Late-Middle Jurassic. The presence of Sirmiodinium grossii indicates an age not older than Bathonian, but as the assemblage is dominated by caved palynomorphs S. grossii may also be caved.

Notes:

The top of this interval is taken at the lithological break at 2,355m, but is poorly defined paleontologically, as ditch cuttings were of poor quality and no core samples were available. No definite Early Portlandian/Late Kimmeridgian or other Late Jurassic fossils are present. A tentative Bathonian age is assigned to the interval based on its lithostratigraphic relationship to the underlying Early Bathonian.

2,361m-2,370m Early Bathonian

Microfauna: Common agglutinating foraminiferids occur in this interval (ditch samples 2,360m-2,370m) including Haplophragmoides sp. (int. sp. AH1), Ammodiscus sp. and Verneuilinoides sp.2 (int. sp.). Haphophragmoides sp. (AH1) dominates the fauna of the lower part of the Heather Formation (Early Oxfordian-Bathonian) in this area. The presence of V. sp.2 (int. sp.) is more typical of the Bathonian part of this formation.

Microflora: The top of this interval is defined on the highest occurrence at 2,361m of an association of miospores characteristic of the Early Bathonian.

Three core chips were examined from this interval. Two of the samples, 2,361m and 2,364.65m, contain abundant spores and pollen and rare acritarchs. The miospores include common/abundant bisaccate pollen, Cerebropollenites mesozoicus and Cyathidites spp. The core chip at 2,363m contains abundant Sentusidinium verrucosum and S. ringnessii. This is a paleoevent which is regionally dated as Early Bathonian. This sample also contains abundant Cyathidites spp. However, this is not the paleoevent which occurs at the top of the Brent Formation where Cyathidites spp. is both abundant and the dominant palynomorph present.

Environment:

Marine, sublittoral. It is difficult to relate present day criteria to depth of deposition of sediments, between 2,361m-2,370m, based on the abundance, but low diversity, of agglutinating foraminiferids. A restricted shelf environment would explain the widespread nature of the fauna at this level. Lofaldi and Nagy (1983) recorded similar assemblages in the Jurassic and Cretaceous of southern Spitzbergen where they relate high total organic carbon associated with a similar faunal association to oxygen depletion of the bottom waters.

The presence of abundant miospores suggests a depositional environment close to a terrestrial source, the presence of dinoflagellate cysts indicates more marine conditions.

Note:

A more precise dating would have been achieved for the interval 2,355m-2,361m if core samples had been available for study.

4.9 2,370m-2,605m MIDDLE JURASSIC, Early Bathonian-Early Bajocian (=Aalenian)

Lithostratigraphy:

(see Appendix 1 - Lithological descriptions of core samples and sidewall cores)

Brent Formation

Tarbert to ?Ness Members

2,370m-2,400m Dominantly sand, fine to coarse grained, angular to subangular, occasionally pyritic and trace organic debris. Core samples at 2,383.40m and 2,393.94m coal, black.

Ness Member

2,400m-2,450m Sand, as above; with sand/sandstone, fine, angular, calcareous and occasional ?sideritic cement; occasional lignite/coal, black and claystone, grey and brown with organic debris.

2,450m-2,495m Sand, fine to medium and coarse grained, angular to subrounded, occasional claystone/siltstone, brown with organic debris as in sidewall cores at 2,451m and 2,492m.

Etive Member

2,495m-2,565m Sand, fine to medium grained and fine to coarse grained, angular to subrounded. Trace lignitic debris.

Rannoch Member

2,565m-2,595m Sand, as above, together with sandstone, fine and occasionally medium grained, micaceous, with trace lignitic debris. At 2,580m trace brown dolomitic or sideritic matrix.

Broom Member

2,595m-2,605m Sand, coarse grained and gravel, subrounded and at 2,600m sandstone, fine to medium grained, angular. Sidewall core at 2,602m limestone, light grey, with fine organic debris.

The assignment of members of the Brent Formation is based on samples examined, not petrophysical log data.

Biostratigraphy:

2,370m-2,475m Early Bathonian-?earliest Bathonian/Bajocian

Microfauna: No in place microfauna recorded through this interval.

Microflora: Moderately diverse assemblages of spores and pollen occur in the samples from this interval, dominated by bisaccate pollen and Cyathidites spp.

The ditch cuttings examined between 2,432.5m and 2,465m and the SWC at 2,451m contain abundant Perinopollenites elatoides. In the northern North Sea this is a feature which is most characteristic of the middle to upper Ness Formation at approximately the same level as the incoming of Nannoceratopsis gracilis. However, N. gracilis was not found until 2,475m in this well.

The megaspore, ?Paxillitriletes sp., occurs in the same SWC as abundant P. elatoides at 2,451m. In an adjacent well megaspores occurred at the level of top N. gracilis, which supports the idea that the top occurrence of N. gracilis in this well may not be its true stratigraphic top; for this reason the base of this interval is dated as ?earliest Bathonian/Bajocian.

Note:

The top of this interval is defined by the penetration at 2,370m of sandstones assigned to the Brent Formation.

2,475m-2,595m ?Earliest Bathonian/Bajocian-Early Bajocian (=Aalenian)

Microfauna: No microfauna recorded through this interval.

Microflora: The top of this interval is taken at the downhole appearance of Nannoceratopsis gracilis, at 2,475m. This normally indicates penetration of sediments of earliest Bathonian age. However, as discussed above this may not be the true top of the range of N. gracilis.

The remainder of the samples examined contain long-ranging Jurassic miospores with bissacate pollen, Cyathidites spp. and Classopollis torosus the dominant forms. Rare N. gracilis occur within this interval.

2,595m-2,605m Early Bajocian (=Aalenian)

Microfauna: No microfauna recorded through this interval.

Microflora: The top of this interval is taken at the incoming downhole of common Nannoceratopsis gracilis at 2,595m. This is a paleoevent which regionally indicates an Early Bajocian (=Aalenian) age.

The SWC at 2,602m from near the base of this interval is devoid of palynomorphs.

Environment:

Transitional; deposition of the Broom, Rannoch and Etive Members was in a high energy marginal marine environment, while the interbedded clays, coal and sands of the Ness Member indicate a cyclic sequence. The return to a dominantly high energy marine regime of the Tarbert Sands may reflect a return to marginal marine deposition.

The regressive nature of the Broom through to Ness Members is reflected in the upward disappearance of the marine dinoflagellate cyst Nannoceratopsis gracilis, and the presence of land derived megaspores in the SWC at 2,451m.

Note:

The Early Bajocian (=Aalenian) dating of the Broom Member and the topmost Dunlin in this well suggests that there is no significant stratigraphic break between these units.

4.10 2,605m-c.2,975m MIDDLE-EARLY JURASSIC, Early Bajocian (=Aalenian)-Early Pliensbachian

Lithostratigraphy:

(see Appendix 1 - Lithological descriptions of sidewall cores)

Dunlin Formation

Drake Member

2,605m-2,680m Claystone and siltstone, grey, micromicaceous, pyritic, with trace glauconite; occasional sandstone, fine grained, angular and dolomite, brown. Ditch cuttings contaminated by caving in the upper part.

Cook Member

2,680m-2,690m Sand, fine to medium grained, occasionally coarse, angular to subrounded. Claystone and siltstone as above. Some sand grains coated with a calcareous matrix.

2,690m-2,730m Sand, fine to medium and occasionally coarse grained and at 2,710m very coarse grained, angular to subrounded, pyritic and lignitic. Claystone, grey, is present throughout but is probably caved.

2,730m-2,765m Sand, as above, together with sandstone, fine and occasionally medium grained, angular, calcareous.

Cook-Burton-Amundsen Members (undifferentiated)

2,765m-2,785m Sandstone, fine grained, calcareous, interbedded with claystone, grey and limestone, brown.

2,785m-2,805m As above, but dominantly claystone and limestone.

2,805m-2,825m Dominantly claystone, grey, with fine organic debris, occasional sand and limestone, brown.

2,825m-2,840m Claystone, grey, micromicaceous, with loose and floating sand, fine to coarse grained, angular to subrounded.

2,840m-2,850m Sandstone, fine grained, angular, calcareous, with claystone, grey and limestone, brown.

Amundsen Member

2,850m-2,915m Interbedded claystone, grey and limestone, brown, with occasional sand, fine grained, angular, pyritic and glauconitic. At 2,850m rare pseudoolites, calcareous, possibly chamositic.

2,915m-c.2,945m As above, but with more common sand.

c.2,945m-2,975m Dominantly sand, fine to medium in the upper part and coarse grained and gravel in the lower, angular to subrounded; interbedded claystone, grey, pyritic. Calcareous pseudoolites/peloids occur below 2,960m.

Biostratigraphy:

2,605m-2,675m Early Bajocian (=Aalenian)-Toarcian

Microfauna: This interval is identified by the downhole appearance of a common and diverse fauna of ostracods, foraminiferids and echinoid debris below 2,605m which indicates an Early Bajocian (=Aalenian) age in the upper part but ranging down into the Toarcian in the lower part. The diagnostic ostracods include Camptocythere foveolata gr. (below 2,615m) and C. aff. parvula (below 2,620m), while the foraminiferid association includes Nodosaria regularis, Trochammina squamata and Ammodiscus 'incertus'.

Microflora: The first sample examined from this interval, the SWC at 2,607m, contains an assemblage of palynomorphs dominated by long-ranging miospores, all of which continue through from higher up the well.

The presence of abundant Nannoceratopsis gracilis and rare Parvocysta sp. B. Bjaerke at 2,612.5m indicates penetration of Early Bajocian (=Aalenian) aged sediments.

A distinctive group of dinoflagellate cysts occurs downhole within this interval including Plankton Type 2 Schultz and Mai (2,627.5m), Facetodinium inflatum and Parvocysta nasuta (2,657.5m) and Phallocysta eumekes (2,672.5m). This association of taxa indicates an age within the range Early Bajocian (=Aalenian) to Late Toarcian.

2,675m-2,740m Early Toarcian

Microfauna: The downhole appearance of the ostracod Kinkelinella intrepida is a marker in this area of Early Toarcian age. The Early Toarcian age for this interval is based on the range of this taxon in onshore sequences in England and its floral association in similar sequences in the northern North Sea.

The fauna logged in the Cook Member, below 2,680m, may be caved.

Microflora: The assemblage from the SWC at 2,682m is dominated by long-ranging miospores, and also contains common Nannoceratopsis gracilis and rare Parvocysta nasuta. The presence of P. nasuta would suggest an age not older than Late Toarcian for the assemblage, however, P. nasuta and other "small" dinoflagellate cysts occur as drilling mud contaminants in the SWCs lower down the well so its occurrence at 2,682m may be the result of mud contamination.

The ditch cuttings sample at 2,702.5m contains common Sphaeromorph clusters and Spheripollenites spp. This is a paleoevent which regionally occurs within the Early Toarcian.

2,740m-c.2,900m Late Pliensbachian

Microfauna: The top of this interval is recognised by the downhole appearance of Ogmoconchella gr. adenticulata which is a regional and correlatable marker. The top occurrence of Ogmoconchella has been taken conventionally as Late Pliensbachian although there are an increasing number of records of this genus from onshore sequences in the basal Toarcian (D. tenuicostatum

ammonite zone). The conventional dating is used in this report so that consistent correlation can be drawn with other wells in the area.

Other significant local markers within the Late Pliensbachian are the top occurrence of Gastropods (below 2,770m),Ogmoconchella aequalis (large) (below 2,780m) with brown limestone at 2,785m, and large Ogmoconchas, including O. contractula and O. amalthei intercedens (below 2,825m) together with claystone with loose sand.

Two other events present which are of regional significance are marked by taxa which do not range elsewhere above the A. margaritatus ammonite zone (lower part of the Late Pliensbachian). These are i) the Ogmoconchella transversa level at 2,845m which is just below the downhole appearance of Dentalina matutina and an influx of Lenticulina muensteri and just above a level with pseudoolites, and ii) the Wicherella semiora level which occurs at 2,865m. This the lowest recognised event in the Late Pliensbachian of this area.

Microflora: Most of the taxa recorded higher up the well continue through this interval. Nannoceratopsis gracilis occurs consistently through this interval and this would indicate an age not older than Late Pliensbachian. However, this taxon occurs in the ditch cuttings to the base of the well and as a drilling mud contaminant in some of the deeper SWCs. This makes the use of the base of the range of N. gracilis unreliable in this well.

The dinoflagellate cyst Leuhndea spinosa appears downhole at 2,777.5m. This taxon which occasionally ranges up into the Early Toarcian is most characteristic of the Late Pliensbachian.

The presence of rare Dapcodinium semitabulatum in the SWC at 2,787m would be consistent with a Late Pliensbachian age.

The pollen Cerebropollenites thiergartii occurs downhole at 2,867.5m; this taxon is most characteristic of Early Jurassic, Pliensbachian or older, sediments.

c.2,900m-c.2,975m Early Pliensbachian

Microfauna: The downhole appearance of the ostracod Gammacythere ubiquita is a regional event which occurs at c.2,900m in this well. This taxon is restricted to the Early Pliensbachian throughout northern Europe.

The sandy lower part of the Amundsen Member in this area also contains two events which are correlatable regionally. These are the occurrence of common Ogmoconcha amalthei gr. at 2,925m and the Kinkelinella spp. event at 2,955m. The latter has been shown in this and one other well in the area to include taxa which do not range below the Pliensbachian, e.g. Kinkelinella cf. elongata.

Microflora: Nannoceratopsis gracilis occurs in all the samples examined through this interval including the SWC at 2,916m, but as explained above the base of its range in this well cannot be used for age dating.

Most of the taxa present continue through from the overlying intervals. Lycopodiacidites rugulatus which appears downhole at 2,927.5m is a characteristic Early Jurassic taxon. A strong fresh/brackish water influence is indicated in the SWC (2,916m) where common Botryococcus sp. occurs.

Note:

Previously Paleoservices Ltd. reported that the base Amundsen in this area may be as old as Sinemurian, but it is now suggested that the Dunlin-Statfjord boundary is approximately coincident with the Pliensbachian-Sinemurian boundary.

Environment:

2,605m-2,680m Marine, sublittoral. The diverse fauna is typical of a well oxygenated shelf "environment" and may be regarded a "pro deltaic" on the regional evidence.

2,680m-c.2,765m Marine, littoral-sublittoral. High energy deposition of sands took place throughout this interval. The presence of a marine fauna only in the lower part and the upward increase of lignitic debris highlights the regressive nature of the unit.

c.2,765m-c.2,975m Marine, sublittoral, possibly littoral in the lowest part. The diverse faunal assemblage suggests a well oxygenated "shelf" environment. The transgressive nature of the Amundsen Member is shown by the shallower water coarse sands which pass upwards into fine sands and subsequently into sequences dominated by deeper water lower energy shales and limestones. The level with pseudoolites at 2,550m correlates throughout much of the northern North Sea with a level of chamositic pseudoolites which probably indicates a period of extremely slow or non deposition.

The chamositic pseudoolite level mentioned above can be used in correlation as it probably reflects a time of eustatic readjustment or sea level change. Similarly the level of pseudoolites just above or at the top of the Cook Member can be correlated with a similar event in other areas of the northern North Sea. In block 34 it is also noted that sand grains coated with a calcareous matrix (calcareous peloids) are a prominent event near the base of the Amundsen (c.2,960m); this unusual sediment type may also represent another period of slower sedimentation.

A fresh/brackish water influence is indicated at 2,916m within the Amundsen Member.

Note:

The lower part of the Amundsen is obviously transgressive on the top Statfjord but there is no paleontological/palynological evidence for an unconformity at this level.

4.11 c.2,975m-3,025m EARLY JURASSIC, Sinemurian

Lithostratigraphy:

Statfjord Formation

(see Appendix 1 - Lithological description of sidewall cores)

2,975m-3,005m Sand, fine to coarse grained, dominantly angular, clean, trace pyrite and lignitic debris. Sidewall cores at 2,977m and 2,979m siltstone, grey and marl, grey.

3,005m-3,032m Sands, similar to those above together with more mica and beds of siltstone and claystone, grey and brown, with very fine organic debris.

Biostratigraphy:

Microfauna: The microfauna present in this interval is presumed to be caved.

Microflora: All the taxa present continue through from higher up the well. The pollen Cerebropollenites mesozoicus occurs in two of the four SWCs at 2,979m and 3,008m and in the last sample examined from this interval. Even though C. mesozoicus is reported to occur occasionally in the Hettangian its presence is much more characteristic of sediments of Sinemurian or younger age. The presence of C. mesozoicus combined with the absence of any definite Hettangian palynomorphs suggests an age not older than Sinemurian for this interval.

Environment:

Marine, littoral-sublittoral, 'near shore', high energy.

Note:

The combination of the microfloral and lithostratigraphical evidence suggests a Sinemurian age for this interval.

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

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

FIG. 2

5. REFERENCES

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APPENDIX 1

Lithological descriptions of core samples

Depth	Core No.	Sample Size	Quality	Analyses	Lithology
2,343.93m-2,344m	1	5x3cm	VG	M.N.P.	Limestone, light brown, oil stained, abundant fine shell debris: stylolites.
2,350.55m	1	5x1.5cm	VG	M.N.P.	Limestone and marl; light green marl with light brown nodular and in part pebbly limestone, abundant pyrite and trace glauconite. One large pebble appears to have sheath of crystalline calcite.
2,351.60m-2,351.65m	1	4x3cm	VG	M. P.	Claystone/siltstone, interlaminated; black, micaceous with "organic debris" and trace glauconite and pyrite, non calcareous.
2,353m	1	3x1cm	VG	M.P.	Claystone, silty in part, black, micaceous, fish debris with pyrite, non calcareous.

2,354m	1	5x1cm	VG	M. P.	Claystone, black, trace silt, micaceous, pyritic, non calcareous.
2,354.75m-2,354.80m	1	3x1cm	VG	M. P.	Claystone, black often silty, micaceous common fish debris including scales, pyritic, non calcareous.
2,361m	2		VG	P.	Claystone/siltstone, dark grey-black, micromicaceous, very fine organic debris, non calcareous, occasional pyrite.
2,363m	2		VG	M. P.	Claystone/Siltstone, as above.
2,364.65m-2,364.70m	2	5x1cm	VG	M. P.	Claystone/Siltstone, as above, very pyritic.
2,383.40m-2,383.47m	3	4x1cm	VG	P.	Coal, black and claystone, coal, pyritic.
2,393.95m-2,394m	3	4x1cm	VG	P.	Coal, as above.

Lithological descriptions of sidewall cores

Depth	Sample Size	Quality	Analyses	Lithology
2,108m	1.5cm	VG	M.P.	Claystone, green, trace mica, very fine organic debris.
2,177m	1.5cm	VG	M.P.	Claystone, as above.
2,210m	1.5m	VG	M.P.	Claystone, as above.
2,234m	1.0m	MP	M.P.	Claystone and siltstone, medium grey, non calcareous, very fine organic debris.
2,296m	0.5m	MP	M.P.	Claystone, as above.
2,336m	0.5m	MP	M.P.	Claystone, grey, calcareous in part.
2,341m	0.5m	M	M.N.	Limestone, very light buff, micritic, common bivalve debris.
2,400m	1.00m	M	M.P.	Sandstone, vfU, angular, clean, with laminae of black organic debris. Mud contamination.
2,451m	1.00m	G	M.P.	Claystone, dark brown and black, slickensided, abundant organic debris.

2,492m	0.75m	P	P.	Claystone/siltstone, medium brown, very fine mica and organic debris. Mud contamination.
2,602m	0.50m	G	P.	Limestone, very light grey, fine organic debris.
2,607m	0.70m	G	P.	Claystone, black, very organic.
2,682m	1.50m	VG	M.P.	Claystone, medium dark grey, non calcareous, occasional mica pyritic.
2,787m	0.75m	MG	M.P.	Claystone, silty, grey, micaceous, very fine organic debris, echinoid fragments.
2,847m	1.00m	MP	P.	Claystone, as above, mud contamination.
2,916m	1.00m	G	P.	Claystone, grey, non calcareous.
2,977m	0.50m	G	P.	Siltstone, grey clay matrix, slightly calcareous, micaceous. occasional floating sand grains.

2,979m	0.75m	G	P.	Marl, grey, fractured, trace organic debris.
3,006.5m	0.75m	MG	P.	Siltstone, grey, clay matrix, micaceous, very fine organic debris.
3,008m	0.75m	G	P.	Claystone, dark grey, non calcareous.

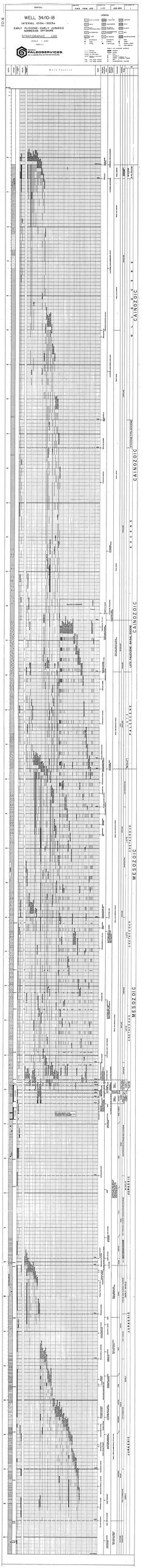
Key

Analyses type

M = Micropaleontology
N = Nannoplankton
P = Palynology

Sample quality

VG = Very good
G = Good
MG = Moderately good
MP = Moderately poor
P = Poor


STATOIL
WELL 34/10-18
INTERVAL 1018m - 3025m
EARLY PLIOCENE - EARLY JURASSIC
NORWEGIAN OFFSHORE
STRATIGRAPHIC LOG
SCALE 1 : 500
(1MM=0.5)
PALEOSERVICES.
LEGEND
CENOZOIC
MESOZOIC
EOCENE
PALEOCENE
CRETACEOUS
JURASSIC
TERTIARY
QUATERNARY

SEDIMENTARY HISTORY

CLIENT: STATOIL

WELL NO: 34/10-18
NORWEGIAN OFFSHORE

FIGURE: 1

DATE: JANUARY 1984

PROJECT NO: 1177

ANALYSTS: R.W.M., H.W.B, J.B.K.

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

KEY:
- Missing section
- Open marine circulation
- Restricted circulation
- Mainly coarse clastics (sand)
- Mainly fine clastics (silt, clay)
- Carbonates
- Evaporites
- Volcanics
- Regression
- Transgression

AGE M.Y | RELATIVE CHANGES OF SEA LEVEL* (Rise / Fall) | SERIES / STAGE | PALEO MARKERS: MICROFLORAL, MICROFAUNAL | ENVIRONMENT: CONTINENTAL, TRANSITIONAL, MARINE (SUBLITTORAL: INNER, OUTER; BATHYAL: UPPER, LOWER) | WELL DEPTH (METRES)

0 PLEISTOCENE
5 PLIOCENE
10 MIOCENE (LATE, MIDDLE, EARLY)
30 OLIGOCENE (LATE, EARLY)
40 EOCENE (LATE, MIDDLE, EARLY)
55 PALEOCENE (LATE, EARLY)
65 MAASTRICHTIAN
70 CAMPANIAN
80 SANTONIAN
85 CONIACIAN
90 TURONIAN
95 CENOMANIAN
100 ALBIAN
110 APTIAN
115 BARREMIAN
120 HAUTERIVIAN
125 VALANGINIAN
130 BERRIASIAN / RYAZAN
135 PORTLANDIAN
140 KIMMERIDGIAN
145 OXFORDIAN
150 CALLOVIAN
155 BATHONIAN
165 BAJOCIAN
170 AALENIAN
175 TOARCIAN
180 PLIENSBACHIAN
185 SINEMURIAN
190 HETTANGIAN
196 RHAETIAN
200 NORIAN

Present sea level.

Microfloral markers: Alisocysta margarita; Coccinodiscus spp.; Spongodinium delitianne; Odontochitina costata; Chatangiella niga; Paroxypermella aureolata; Paraedinia mutabilis; Hystrichogonyaulax cladophora; Abundant Sentusidinium spp. & S. ringnesii; Milioudodinium giga; Nannoceratopsis gracilis; Perinopollenites elatoides (abundant); Common N. gracilis; Abundant N. gracilis & Parvocysta sp. B.; Common sphaermorph clusters & Spheripollenites spp.

Microfaunal markers: Diatom sp. 3.; Sponge spicules; Geodia sp.; Siliconigmolina sp.; Spherical radiolaria; Bolivinopsis spectabilis (consistent); Cyclammina amplectens; Globigerina gr. limaperta; Bolivinopsis spectabilis; Pseudotextularia elegans; Pseudogaudryinella capitosa; Radiolaria; Globigerinelloides gyroidinaeformis; Trocholina infragranulata; Uvigerinammina moesiana; Haplophragmoides sp. (AHI); Camptocythere cf. foveolata; Nodosaria regularis; Gammacythere ubiquita; Ogmoconchella gr. adenticulata

SECTION ABOVE 1010m NOT STUDIED

AGE OF SANDS ABOVE 1030m MAY EXTEND FROM MIOCENE – EARLY PLIOCENE

1010
1030
1420 — Possible unconformity
1420
Ash marker ?
LISTA
1885
1885
2 - 5 m.y.
SHETLAND
2336
25 m.y. ±
2336
CROMER KNOLL
2340
12 m.y. ±
2340
CROMER KNOLL
2351.6
c. 10 m.y. ±
2351.6
KIMMERIDGE CLAY
2355
15 - 20 m.y. ±
2355
HEATHER
2370
TARBERT
NESS
ETIVE
RANNOCH
BROOM
BRENT
2605
DRAKE
2740
COOK
BURTON
AMUNDSEN
DUNLIN
c. 2975
STATFJORD
3025

STATOIL	ANALYSTS	PROJECT No.	DATE	ENCLOSURE No.
	J.B.K. R.W.M.	1177	JAN.1984	2

WELL 34/10-18

INTERVAL 2351.6m - 3025m

LATE-EARLY JURASSIC

PALYNOSTRATIGRAPHIC LOG

SCALE 1:500

(Metric)

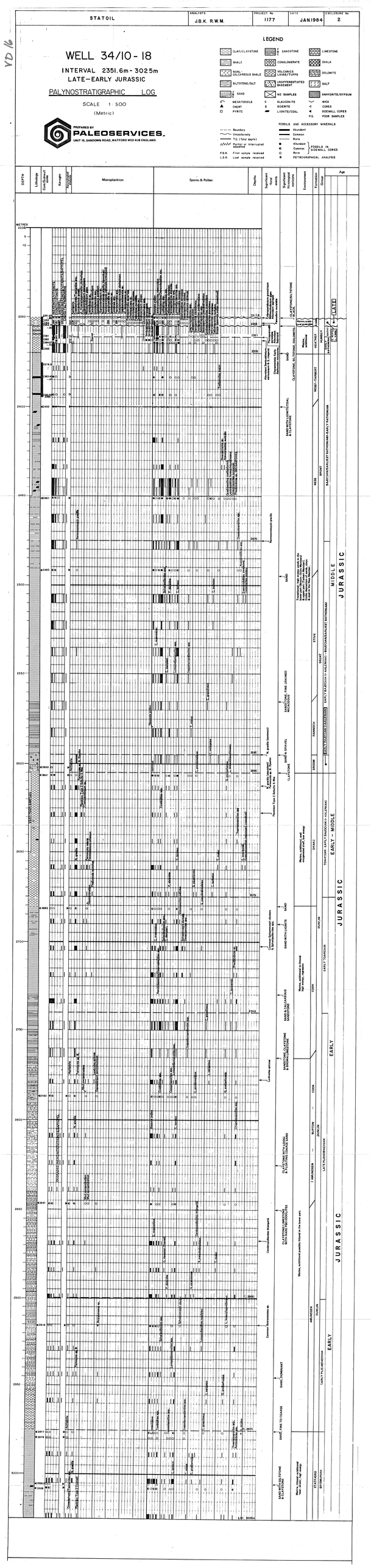
PREPARED BY
PALEOSERVICES
UNIT 15, SANDOWN ROAD, WATFORD WD2 4UB ENGLAND.

LEGEND

CLAY/CLAYSTONE
SILT/SILTSTONE
SHALE
MARL/CALCAREOUS SHALE
BILTSTONE/SILT
SAND
MEGAFOSSILS
CHERT
PYRITE
SANDSTONE
CONGLOMERATE
VOLCANICS LAVAS/TUFFS
UNDIFFERENTIATED BASEMENT
NO SAMPLES
GLAUCONITE
SIDERITE
LIGNITE/COAL
LIMESTONE
CHALK
DOLOMITE
SALT
ANHYDRITE/GYPSUM
MICA
CORES
SIDEWALL CORES
POOR SAMPLES

Boundary
Unconformity
T.D. (Total depth)
Partial or interrupted sequence
F.S.R. First sample received
L.S.R. Last sample received

FOSSILS AND ACCESSORY MINERALS
Abundant
Common
Rare
Abundant
Common
Rare
FOSSILS IN SIDEWALL CORES
PETROGRAPHICAL ANALYSIS


DEPTH
Lithology
Core Sidewall Core
Kerogen
Thermal Alteration
Microplankton
Spores & Pollen
Depths
Significant Lithological events
Significant Biostratigraphic horizons
Environment
Formation
Group
Age
METRES
2350
2400
2450
2500
2550
2600
2650
2700
2750
2800
2850
2900
2950
3000
3025m
LATE
MIDDLE
EARLY
JURASSIC
HEATHER
BRENT
ETIVE
RANNOCH
DRAKE
TARBERT
HUMBER
ness
NESS
SANDSTONE
SILTSTONE
CLAYSTONE
SAND
GRAVEL
COAL
LIMESTONE
MARL
Sandstone, fine grained, micaceous
Sandstone, fine grained, micaceous, with carbonaceous laminae
Sandstone, fine grained, micaceous, with carbonaceous laminae and coal stringers