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STATOIL

Title

WELL 34/10-5

(1,500m-2,780m T.D.)
NORWEGIAN OFFSHORE
PALAEONTOLOGICAL/STRATIGRAPHICAL FINAL REPORT.

Project No.

690

Stratigraphers

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CONTENTS

ENCLOSURES.

1. INTRODUCTION.

This report presents the results of the stratigraphical and palaeontological study of samples from Well 34/10-5, drilled by Statoil in the North Sea, Norwegian offshore, during 1979.

The information presented is based on the analysis of ditch samples collected at 10m intervals between 1,500m and 1,700m, at 6m intervals from 1,700m to 1,742m and on average 3m intervals from 1,742m-2,780m T.D. Ninety one sidewall cores were analysed between 1,783m and 2,773m: fourteen other sidewall core bottles received were either incorrectly labelled or contained no samples. Seven core chips from cores cut in the Brent Formation were also studied.

A total of 90 samples (6 cores, 51 SWC's and 33 ditch samples) have been examined for palynology from the interval 1,856m-2,780m T.D.

Interval tops are derived from sample depths although petrophysical logs were provided by Statoil.

A stratigraphical/palaeontological log (Scale 1:500) is presented with the report.

2. CONCLUSIONS.

1. The highest sample analysed (1,500m), is of Early Eocene age. Only the lower part of the Eocene was included in this study; this comprises mainly claystones (1,500m-1,550m) which were deposited in a marine, outer sublittoral to bathyal environment.

2. Claystones and tuffaceous claystones (1,550m-1,610m) characterise a regionally persistent interval of basal Eocene - Paleocene age.

3. The Paleocene (1,610m-1,730m) comprises claystones, sandy claystones and sands deposited in an outer sublittoral to bathyal environment. The absence of Middle and Early Paleocene markers possibly indicates that the Late Paleocene only is present.

4. The Late Cretaceous section (1,730m-1,857m) is represented by a sequence of claystones with occasional limestone beds of Maastrichtian and possibly Campanian age, which were deposited in a marine, outer sublittoral to upper bathyal environment.

5. No Cretaceous rocks older than Campanian are present in this well. The Late Cretaceous (Maastrichtian-?Campanian) rests unconformably on the Late Jurassic (Portlandian/ Kimmeridgian) at Ca.1,857m.

6. The very thin Late Jurassic section (Portlandian/ Kimmeridgian) is represented by the Kimmeridge Clay Formation (ca.1,857-1,858m) which unconformably overlies the Middle Jurassic (Heather Formation).

7. Rocks representing the Heather Formation (1,858m-1,895m) are dominantly claystones which have been dated by palynology as Middle Jurassic (Bathonian) and were deposited in a marine, sublittoral environment.

8. A relatively thick Brent Formation (1,895m-2,147m) contains all five lithological subunits which have been recognised regionally. Dating of the section, which is Middle Jurassic (Bathonian-Bajocian) in age, is based on palynological analyses. The Brent Formation represents a dominantly regressive, marine - ?deltaic, sequence which is partly reflected in the palaeontology by an upward decrease in marine floras and faunas.

9. The Dunlin Formation (2,147m-2,561m) is represented by claystones, siltstones, sandstones and limestones ranging in age from Middle Jurassic, Early Bajocian (=Aalenian) to possibly Sinemurian, which were deposited in a marine sublittoral environment.

   There are a number of faunal markers within the sequence which appear consistent over a wide area and may be used in accurate correlations.

10. The Dunlin Formation may unconformably overlie the Statfjord Formation at 2,561m but paleontological evidence is inconclusive.

11. The Statfjord and Cormorant Formations comprise a sand unit (2,561m-2,597m), claystones and sands with siderite (2,597m-2,762m), and red beds (2,762-2,780m). The lithologies and, to a lesser extent, the paleontology, suggests a progressively more marine depositional environment upwards from the continental "red beds" at the base. Dating which is based on palynology suggests an ?Early Sinemurian - Hettangian age for the interval 2,569m to 2,732m and a Rhaetian age for the interval 2,732m - 2,762m.

3. STRATIGRAPHICAL SUMMARY.

Interval	Age		Thickness
1,500 - 1,550m	Early Eocene		50m
1,550 - 1,610m	Early Eocene - Paleocene		60m
1,610 - 1,730m	Paleocene		120m
---- ? ---- ? -------- Unconformity -------- ? ---- ? ----------			
1,730 - 1,766m	Late Cretaceous,	Late Maastrichtian	36m
1,766 -ca.1,857m	" "	Maastrichtian - ?Campanian.	91m
---------- Unconformity ----------			
ca.1,857-ca.1,858m	Late Jurassic,	Portlandian/ Kimmeridgian	ca.1m
---------- Unconformity ----------			
ca.1,858- 1,895m	Middle Jurassic,	Bathonian (Heather Formation)	37m
1,895 -2,003.5m	" "	Bathonian	108.5m
2,003.5- 2,136m	" "	earliest Bathonian-Bajocian.	132.5m
2,136 - 2,147m	" "	Early Bajocian (=Aalenian)	11m
2,147 - 2,222m	Middle - Early Jurassic, Early Bajocian (=Aalenian) - Toarcian.		75m
2,222 - 2,237m	Early Jurassic,	Early Toarcian	15m
2,237 - 2,303m	" "	Early Toarcian - Late Pliensbachian	66m
2,303 - 2,468m	Early Jurassic,	Late Pliensbachian	165m
2,468 - 2,525m	" "	Early Pliensbachian	57m
2,525 - 2,561m	" "	Early Pliensbachian - Sinemurian.	36m
---- ? ---- ? ---- ? -- Unconformity -- ? ---- ? ---- ? ---------			
2,561 - 2,732m	Early Jurassic,	?Sinemurian-Hettangian	171m
2,732 - 2,762m	Late Triassic,	Rhaetian	30m
2,762 - 2,780m (T.D.)	" "	?Rhaetian	18m

4. STRATIGRAPHY.

This discussion supplements the information presented on the stratigraphic log (Enclosure 1). The lithology and biota are described and the age and depositional environments interpreted.

4.1 1,500m-1,550m EARLY EOCENE.

Lithology:

Claystone, grey, with occasional beds of sandstone, fine and occasionally medium grained; below ca.1,520m occasional beds of limestone, light grey.

Biostratigraphy:

The fauna is dominated by agglutinating foraminiferids, including the genera, Rhabdammina, Haplophragmoides Bathysiphon, Cyclammina and Glomospira. The association of this fauna with abundant Radiolaria at 1,500m and the planktic foraminiferid Globigerina gr. triloculinoides at 1,530m indicates an Early Eocene age.

Environment:

Marine, outer sublittoral to bathyal.

4.2 1,550m-1,610m EARLY EOCENE - PALEOCENE.

Lithology:

Claystone, and tuffaceous claystone, grey-black and green; sandy below 1,590m.

Biostratigraphy:

Agglutinating foraminiferids continue through this interval but they are probably in part caved. The diatom Coscinodiscus sp.1 appears at the top of the interval and continues throughout; its association with tuffaceous claystone is conventionally taken to indicate an Early Eocene to Paleocene age.

Environment:

Marine, outer sublittoral to bathyal with contemporaneous volcanic activity.

4.3 1,610m-1,730m PALEOCENE.

Lithology:

1,610m-1,690m Claystone, green, with occasional beds of sand, fine-medium grained; and limestone, brown. At 1,670m a white micritic limestone.

1,690m-1,730m Interbedded sand, fine-medium grained, subangular, sandy claystone and green claystone.

Siderite is common below 1,712m and abundant between 1,718m-1,730m.

Biostratigraphy:

The top of this interval is taken at the highest occurrence of common agglutinating foraminiferids which include Bolivinopsis spectabilis.

Regionally persistent Middle and Early Paleocene markers are absent in this section suggesting that possibly only the Late Paleocene is present.

Environment:

Marine, outer sublittoral to bathyal.

4.4 1,730m-Ca.1,857m LATE CRETACEOUS, Maastrichtian -?Campanian.

Lithostratigraphy:

Shetland Group.

1,730m-1,742m Claystone, grey; occasional white chalky limestone.

1,742m-1,857m Ditch samples are extremely small and consist mainly of drilling mud additives and cement. The 'in place' lithology, indicated by sidewall cores, is mainly grey claystone, with occasional thin beds of grey limestone. Siderite is common below 1,844m and in the deepest ditch sample, 1,856m-1,859m (which includes rocks of Jurassic age also) there is a white micro-crystalline limestone.

Biostratigraphy:

1,730m-1,766m Late Maastrichtian.

Foraminiferids are abundant throughout this interval, including taxa which are restricted to, or have their highest occurrences in, the Late Maastrichtian e.g. Pseudotextularia elegans, Globotruncana contusa, Racemguembelina fructicosa, Rugoglobigerina rugosa and Globigerinelloides messinae.

1,766m-Ca.1,857m Maastrichtian - ?Campanian.

The highest occurrence of Reussella szajnochae defines the top of this interval; from its association with more age-restricted fossils in other wells this is probably within the lower part of the Late Maastrichtian. Foraminiferids are abundant throughout this interval and include mainly the taxa which occurred above. Below 1,823m agglutinating foraminiferids dominate the fauna and although no age-restricted taxa are present, it is possible that the Campanian was penetrated.

Environment:

Marine, outer sublittoral to upper bathyal, abundance levels of planktic foraminiferids in the upper part suggest the periodic influence of oceanic watermasses.

4.5 Ca.1,857m-Ca.1,858m LATE JURASSIC, Portlandian/Kimmeridgian.

Lithostratigraphy:

Kimmeridge Clay Formation.

The interval is recognised in this case by its fauna. No typical Kimmeridge Clay Formation lithology remained after washing the ditch cutting 1,856m-1,859m.

Biostratigraphy:

Microflora:

No taxa restricted to the Portlandian and Kimmeridgian have been recorded in the ditch sample 1,856m-1,859m.

Microfauna:

The ditch cutting sample 1,856m-1,859m contains Late Cretaceous, Late Jurassic (Kimmeridgian/Portlandian), and Middle Jurassic (Bathonian) faunas. As the sidewall core at 1,856m contains a Late Cretaceous fauna and the sidewall core at 1,860m contains a Middle Jurassic fauna the Late Jurassic must lie below 1,856m and above 1,859m.

The Late Jurassic fauna includes spherical radiolaria and Dictyomitra sp., which occur in the Portlandian and Kimmeridgian in the Kimmeridge Clay Formation of this area.

Environment:

Marine, sublittoral, restricted.

4.6 Ca.1,858m-1,895m MIDDLE JURASSIC, Bathonian.

Lithostratigraphy:

Heather Formation.

1,858m-1,880m Claystone, occasionally silty, light brown and dark grey, pyrite and lignitic debris. Shell debris in SWC at 1,860m.

1,880m-1,895m As above together with beds of dolomitic limestone.

Biostratigraphy:

Microflora:

Rich and diverse assemblages of palynomorphs are present in the four sidewall cores and one ditch sample examined from this interval. Dinoflagellate cysts are present throughout, but occur most abundantly in the ditch sample 1,856'-59' and the SWC at 1,860'. The former contains abundant Pareodinia evitti, Canningia ringnesii and Tenua verrucosa, with rare specimens of Valensiella ovula and Chytroesphaeridia chytroeides. The SWC at 1,860', contains an abundance of dinoflagellates, but with little specific diversity; the assemblage being dominated by Tenua verrucosa and Chytroeisphaeridia "granulata". Lithodinia pococki occurs abundantly in the SWC at 1,888m.

The miospore assemblages are dominated by bisaccate pollen, Cerebropollenites mesozoicus and occasionally by Callialasporites spp. Quadraeculina anellaeformis is present throughout. Taxa present in small numbers include Chasmatosporites sp., Neoraistrickia truncata, Ischyosporites variegatus and Coronatispora valdensis.

The presence of Q. anellaeformis, considered to top within the Bathonian (Morbey & Dunay 1978) in association with Pareodinia evitti, Canningia ringnesii and Tenua verrucosa indicates a Bathonian age.

Microfauna:

The microfauna in this interval is dominated by abundant agglutinating foraminiferids, including Haplophragmoides sp. and Verneuilinoides sp. These taxa are not age diagnostic but their preservation is characteristic of the Heather Formation. Calcareous foraminiferids and ostracods occur in the lower part but are not forms useful for accurate dating of the section.

Environment:

Marine, sublittoral, with continental influence.

4.7 1,895m-2,147m MIDDLE JURASSIC, Bathonian-Early Bajocian.

Lithostratigraphy:

Brent Formation/Unit.

1,895m-1,910m Sandstone/sand, fine to coarse grained, angular to subrounded.

1,910m-1,943m Sandstone/sand, fine-medium grained, subrounded at 1,910m and angular to subangular below 1,913m, clean; some dolomitic matrix at 1,910m.

1,943m-1,955m Sandstone/sand, fine-medium grained, angular-subangular, light brown.

1,955m-1,973m No ditch cuttings.

1,973m-1,982m Sandstone,fine grained, angular, calcareous, micaceous, and claystone, silty, black.

1,982m-1,997m Sand, fine-medium grained, angular; brown dolomite; lignitic debris and pyrite.

1,997m-2,006m As above, also grey lignitic claystone.

2,006m-2,015m Sandstone, fine grained, angular, calcareous; dolomite brown.

2,015m-2,018m Sand, fine to coarse grained,angular-subrounded.

2,018m-2,024m Sand and sandstone, fine-medium grained, angular, calcareous, micaceous.

2,024m-2,072m Sand, fine grained, angular; fine medium grained at 2,036m, and coarse grains below 2,063m; siderite at 2,030m; some white calcareous matrix below 2,042m.

2,072m-2,144m Sand as above, and sandstone, fine grained, angular, calcareous, micaceous downwards; below 2,114m glauconite; below 2,135m some dolomite, brown.

2,144m-2,147m Sand/sandstone, fine-coarse grained, poorly sorted, subrounded to angular.

Only seven samples were studied from the cores and as they were specially selected by Statoil geologists for palynology they may not represent the overall cored lithologies and are described separately below.

1,912.5m (CORE 1). Sandstone, fine grained, angular, weakly cemented, little clay matrix, pyrite, lignite debris.

1,932.27m (CORE 2). Claystone and siltstone, grey micaceous, burrow filled by sandstone as above.

1,932.60m (CORE 2). Claystone and siltstone, dark grey, micaceous.

1,956.90m (CORE 3).As above.

1,958.80 (CORE 3). As above, more carbonaceous debris.

1,969.90m (CORE 4). Laminated black, micaceous and carbonaceous claystone and fine micaceous sandstone.

1,973.10m (CORE 4). Claystone and siltstone, micaceous.

The approximate tops of Subunits/Members of the Brent Formation based on petrophysical logs are:-

1,895m Top Tarbert Subunit/Member.

1,970m Top Ness Subunit/Member.

2,035m Top Etive Subunit/Member.

2,095m Top Rannoch Subunit/Member.

2,143m Top Broom Subunit/Member.

Biostratigraphy:

1,895m-2,003.5 (SWC) Bathonian.

Microflora:

Six core chips and four sidewall cores have been examined from this interval. In particular the core samples (1,912.5, 1,932.60, 1,956.9, 1,958.8m, 1,969.9m and 1,973.1m) have yielded rich and diverse palynomorph assemblages, which are dominated by land-derived spores and pollen, with relatively very rare dinoflagellate cysts.

The spore/pollen assemblages are dominated by Cerebropollenites mesozoicus, Callialasporites spp., bisaccate pollen, Lycopodiumsporites spp., Classopollis torosus and Cyathidites spp. The latter, occur abundantly from 1,912.5m and only occurred in small numbers within the Heather Formation. Accessory species present include Q. anellaeformis, Chasmatosporites sp., Neoraistrickia gristhorpensis (at 1,912.5m), Ischyosporites variegatus, Trilites minutus, Coronatispora valdensis, Leptolepidites rotundus, L. bossus/equatibossus and Sestrosporites pseudoalveolatus. The rare dinoflagellate cysts present are all assignable to the genus Pareodinia (Pareodinia sp. B (Bjaerke), P. ceratophora and Pareodinia sp.). The freshwater alga Botryococcus is also present in small amounts.

The spore/pollen assemblage present is composed of taxa which range throughout the Bathonian/Bajocian, with the exception of Q. anellaeformis. The dinoflagellates present are also not age-restricted. The palynofloras recorded from immediately above and below this interval, however, suggest that it is of Bathonian (probably Middle - Early) age.

Microfauna:

The fauna in this interval is restricted to a fragment of a belemnite at 1,985m.

2,003.5m-2,136m Earliest Bathonian-Bajocian.

Microflora:

The top of this interval is taken at the first down-hole appearance of the dinoflagellate cyst Nanno-ceratopsis gracilis, which indicates an age not younger than earliest Bathonian.

Ten sidewall cores and three ditch cutting samples have been examined. The assemblages between 2,003.5m and 2,040m are, with the exception of N. gracilis, composed of taxa also recorded in the overlying interval.

Below 2,040m, the total kerogen content of the samples decreases markedly (two of the sidewall cores at 2,093 and 2,115m were barren), and no palynomorphs have been recorded.

Microfauna:

The microfauna is restricted to a single specimen of the foraminiferid Nodosaria regularis at 2,126m. This is a species typical of the Early Bajocian (s.s), Aalenian and Toarcian.

2,136m-2,147m Early Bajocian (=Aalenian).

Microflora:

Two sidewall cores (2,136m, 2,142m) have been examined. The top of the interval is taken at the incoming of consistent N. gracilis at 2,136m. The sidewall core at 2,142m is characterised by the presence of Nannoceratopsis gracilis in overwhelming numbers. This is a palynoevent of widespread regional stratigraphical significance in the basal Brent Formation/Unit.

The equivalent interval in other wells in the area has been dated as being Early Bajocian (Aalenian) in age.

Microfauna:

The microfauna is sparse through this interval but includes the foraminiferids Nodosaria regularis and Dentalina sp. together with an ostracod which closely approaches Procytheridea gibbosa, a taxon restricted to the Early Bajocian (=Aalenian).

Environment:

Shallow marine - deltaic.

The palynological preparations between 1,895m and 2,031m contain an abundance of well preserved land derived material (both spores/pollen and plant debris). However relatively small numbers of dinoflagellate cysts are present, of restricted morphological variety. This suggests deposition in a paralic environment with limited (?brackish) marine influence which may at least in part be deltaic. The occurrence of a Belemnite at 1,895m also indicates marine influence. The incoming downhole of the dinoflagellate cyst N. gracilis (at 2,003.5) is a palynoevent commonly present in this area within the Ness Member and may indicate a period of widespread marine influence of time stratigraphic significance.

The appearance below 2,126m of foraminiferids and ostracods together with glauconite indicates an increasing marine influence in the lower part of the Brent Formation/Unit This is supported by the common presence of N. gracilis at 2,136m and its presence in overwhelming numbers at 2,146m.

2,147m-2,561m Middle-Early Jurassic, Early Bajocian (Aalenian) - Sinemurian.

Lithostratigraphy:

Dunlin Formation/Unit.

2,147m-2,153m Claystone, dark grey; laminated with sands, very fine grained, and possibly brown dolomitic limestone.

2,153m-2,209m Claystone and siltstone, grey, with interbedded brown and grey limestone and dolomitic limestone. At 2,153m abundant chamositic/phosphatic oolites. Present throughout are pyrite, glauconite, siderite and very fine lignitic debris.

2,209m-2,237m Cement. Sidewall cores at 2,215m and 2,230m are in dark grey silty claystones.

2,237m-2,249m Sand, fine to medium grained, angular.

2,249m-2,273m Sand, as above; together with sandstone, fine and medium grained, medium grains sometimes pyrite coated; some lignitic debris.

2,273m-2,288m Sand, fine and medium grained, often with pyrite coated grains.

2,288m-2,357m Sandstone and sand, mainly fine grained, angular, calcareous, with an increasing abundance of grey siltstone and occasional claystone towards the base.

2,357m-2,381m Limestone and marl, light brown - orange and occasional claystone, grey.

2,381m-2,402m Claystone, grey; some fine angular sand below 2,399m.

2,402m-2,432m Claystone, grey; and sandy grey claystone, medium grained, angular.

2,432m-2,486m Interbedded claystone, grey and brown limestone, with chamositic/phosphatic oolites common between 2,432m-2,444m.

2,486m-2,528m Siltstone and claystone, grey; rare sandstone, very fine grained angular below 2,516m.

2,528m-2,561m Sandstone, fine grained, angular, micaceous; occasional beds of claystone and siltstone. Glauconite below 2,549m and 2,558m. Calcite mud-coated sand grains.

Biostratigraphy:

2,147m-2,222m Early Bajocian (=Aalenian) - Toarcian.

Microflora:

Seven sidewall cores and two ditch samples have been examined from this interval. Varied assemblages of dinoflagellate cysts are present, including Nannoceratopsis gracilis, Dinoflagellate type C (internal species), Plankton Type 2 (Schulz and Mai in Doring et al. 1966),and Comparodinium aff. punctatum. Single specimens of the dinoflagellate cysts Mancodinium semitabulatum and Scriniocassis weberi are present in the SWC's at 2,195m and 2,215m respectively. This association of dinoflagellate cysts is characteristic of the interval dated as Early Bajocian (Aalenian) - Late Toarcian in other wells in the area.

The common occurrence of Dinoflagellate Type 3 (Thusu) in the SWC at 2,215m is a palynoevent of potential significance in local correlation. Its occurrence appears to be closely related to the incoming of the ostracod Kinkelinella intrepida, which is taken to indicate penetration of strata of Early Toarcian age.(See section below).

Microfauna:

The top of the Dunlin Formation is recognised by the association of a claystone-dominated sequence with agglutinating foraminiferids.

The interval is characterised by a diverse fauna including the foraminiferids Nodosaria regularis, Lenticulina spp., Haplophragmoides kingakensis, Lenticulina clathrata and Ammodiscus "incertus". Ostracods are less common but include Camptocythere parvula (at 2,165m) and C. gr. foveolata (both restricted to the Aalenian in onshore sections) and at 2,177m an ostracod closely approaching Camptocythere toarciana, which is characteristic of the Toarcian.

2,222m-2,237m Early Toarcian.

Microflora:

One sidewall core (2,230m) has been examined; it contains an assemblage of abundant, very pale palynomorphs, dominated by Classopollis torosus, bisaccate pollen, and acanthomorph acritarchs. No age restricted taxa are present.

Microfauna:

The highest occurrence of Kinkelinella intrepida at 2,222m, is a regional marker of Early Toarcian age.

2,237m-2,306m Early Toarcian-Late Pliensbachian.

Microflora:

Rich and diverse assemblages of palynomorphs are present in the six samples (four ditch cutting and SWC's) examined, dominated by bisaccate pollen, Cerebropollenites mesozoicus, Classopollis torosus and Chasmatosporites spp.; Nannoceratopsis gracilis occurs commonly throughout. Mancodinium semitabulatum becomes common in the SWC at 2,294m; this taxa is considered by Morbey (1978) to occur most abundantly in strata of Late Pliensbachian age.

Between 2,264m (ditch cutting) and 2,277m (SWC), abundant, small Inaperturopollenites spp. are present. This is a palynoevent considered by Morbey (1978) to be of regional significance in the recognition of the Early Toarcian. Small numbers of reworked striate bisaccates are also present in the SWC at 2,277m.

Microfauna:

This interval contains no age-diagnostic ostracods or foraminiferids.

2,303m-2,468m Late Pliensbachian.

Microflora:

A total of eleven samples (five SWCs and six ditch cuttings) have been studied. No age significant taxa appear downhole through this interval. The assemblages are dominated by miospores, principally bisaccate pollen, Classopollis torosus and Chasmatosporites spp.

The dinoflagellate cysts Nannoceratopsis gracilis and Mancodinium semitabulatum occur at the bases of their ranges in SWCs at 2,356m and 2,343m respectively. A precise base for the range of N. gracilis is not determined in this well since it continues to occur as caving in ditch cuttings to the bottom of the well. N. gracilis is not known to occur in strata older than Late Pliensbachian in age whilst M. semitabulatum has not been recorded from strata older than Pliensbachian in age. Cerebropollenites thiergartii occurs commonly-abundantly and consistently in the SWCs at and below 2,343m, which is consistent with an age not younger than Late Pliensbachian. Reworked Carboniferous taxa occur sporadically through this interval.

Microfauna:

The highest occurrence of the ostracod Ogmoconchella at 2,303m,is a regional marker which is conventionally taken as Late Pliensbachian although the genus ranges into the earliest Toarcian in some onshore sections.

The following are regionally persistent faunal markers within the Late Pliensbachian recognised in this well.

2,303m Top Ogmoconchella spp.
2,357m Top large Ogmoconchella aequalis and Gastropods.
2,402m Top Ogmoconcha amalthei amalthei (large forms).
2,432m Top Ogmoconchella transversa with consistent Dentalina matutina.
2,444m Top Wicherella semiora(base A. margaritatus ammonite zone).

2,468m-2,525m Early Pliensbachian.

Microflora:

Three SWCs and one ditch sample have been examined. No age-significant changes in the microflora occur within this interval. The assemblages are dominated by Classopollis torosus, Chasmatosporites spp., bisaccate pollen and acanthomorph acritarchs.

Reworked Carboniferous miospores are present sporadically throughout including Tripartites sp. (Late - Early Carboniferous, Namurian. A/Late Visean) at 2,500m.

Microfauna:

The top occurrence of Gammacythere ubiquita at 2,468m indicates the penetration of the Early Pliensbachian. The association of common large specimens of Ogmoconcha amalthei gr., O. contractula and Ogmoconchella danica within the interval 2,495-2,525m is a regional marker also within the Early Pliensbachian.

4.8 2,525m-2,561m Early Pliensbachian - Sinemurian.

Microflora:

Limited assemblages of palynomorphs are present in the two SWCs and two ditch samples examined. No age significant taxa appear downhole in this interval. The presence of specimens of Cerebropollenites mesozoicus in the SWCs indicates an age not older than Sinemurian.

Microfauna:

The species of Ogmoconcha present in the interval above continue, indicating that this interval ranges in age from Early Pliensbachian to possibly Late Sinemurian. The highest occurrence of Kinkelinella sp. at 2,525m is a regional marker, but due to poor preservation it has not been specifically identified, although it may be a Late Sinemurian taxon.

Environment:

Marine, sublittoral, mainly inner.

4.9 2,561m-2,780m EARLY JURASSIC - LATE TRIASSIC.

Lithostratigraphy:

Statfjord - Cormorant Formations.

2,561m-2,597m Sand, fine to medium and occasionally coarse grained, angular to subangular, clean.

2,597m-2,654m Sand as above, together with sandstone, calcareous.

2,654m-2,690m Interbedded sand and sandstone as above, together with claystone; brown and purple, occasionally sandy. Sphaerosiderite present below 2,666m and abundant below 2,672m.

2,690m-2,729m Sandstone, fine to medium grained, angular, with occasional claystone, light grey and limonite brown.

2,729m-2,762m Claystone, brown, purple and grey, occasionally sandy and waxy; some sand as above.

2,762m-2,780m Claystone, red, grey and green and sand as above.

Biostratigraphy:

2,561m-2,732m ?Sinemurian - Hettangian.

Microflora:

Although diverse assemblages of palynomorphs are present in ditch samples between 2,570m and 2,645m, the lithologies are predominantly unfavourable for the recovery of palynomorphs. Together with the fact that no new taxa appear, this suggests that all taxa present are probably the result of caving.

At 2,645m and below, small numbers of taxa appear which are not recorded higher in the well. These are Microreticulatisporites fuscus (2,645m, common at 2,666m), Conbaculatisporites mesozoicus (2,666m) and a single specimen of Ovalipollis ovalis at 2,666m. M. fuscus is considered to be characteristic of the Early Sinemurian - Hettangian (Lund 1977) although other workers have recorded it from the Rhaetian. The presence of O. ovalis indicates the penetration of Hettangian or older strata.

The sidewall cores examined from this interval yielded only small amounts of kerogen, and rare palynomorphs are present only at 2,677.4m; no age restricted taxa are present.

Microfauna:

No in place microfauna.

2,732m-2,762m Rhaetian.

Microflora:

The top of this interval is taken at the incoming of common specimens of Riccisporites tuberculatus in the ditch sample at 2,732m. In the other wells in the area this is considered to indicate a Rhaetian age. A marked increase in the numbers of Cyathidites spp., also occurs at this level, suggesting that they are part of the insitu flora.

Microfauna:

No in place microfauna.

2,762m-2,780m T.D. ?Rhaetian.

Microflora:

No taxa indicating an age older than Rhaetian have been observed. All of the taxa present have been previously recorded higher in the well and many of them are incompatible with a Rhaetian age. Taken together with the predominantly unfavourable lithologies for palynomorph preservation this suggests that the palynomorphs present in the ditch samples are the result of caving. Palynomorphs are present in two of the SWCs examined (2,763m and 2,773m) but some of them (i.e. C. mesozoicus) are not compatible with a Rhaetian age. They probably reflect drilling mud impregnation of the SWC. There is therefore probably no insitu microflora in this interval.

Microfauna:

No in place microfauna.

Environment:

2,561m-2,654m Marine, littoral to inner sublittoral.
2,654m-2,762m Continental - marine, paralic; alluvial flood plain and marine littoral to inner sublittoral.
2,762m-2,780m Continental, alluvial.

T.D.

5. REFERENCES.

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S T A T O I L	ANALYSTS: R.W.M., K.J.G.	PROJECT No: 690	DATE: FEB. 1980	ENCLOSURE No: 1

WELL 34/10-5

1500 m. — 2780 m.

NORWEGIAN OFFSHORE

STRATIGRAPHIC LOG

SCALE 1:500

19 JK

PALEOSERVICES
UNIT 15, PARAMOUNT INDUSTRIAL ESTATE, SANDOWN ROAD, WATFORD WD2 4XA, ENGLAND

LEGEND

CLAY/CLAYSTONE; SANDSTONE (F M C); LIMESTONE; SHALE; CONGLOMERATE; CHALK; MARL - CALCAREOUS SHALE; VOLCANICS LAVAS/TUFFS; DOLOMITE; SILTSTONE/SILT; UNDIFFERENTIATED BASEMENT; CEMENT; SAND (F M C); NO SAMPLES; ANHYDRITE/GYPSUM

MEGAFOSSILS; G GLAUCONITE; MICA; CHERT; S SIDERITE; CORES; PYRITE; LIGNITE/COAL; SIDEWALL CORES; P.S. POOR SAMPLES

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

FOSSILS AND ACCESSORY MINERALS: Abundant; Common; Rare

FOSSILS IN SIDEWALL CORES/CORES: Abundant; Common; Rare

PALYNOLOGICAL ANALYSES: Ditch cuttings; Core; S.W.C.

S T A T O I L	ANALYSTS: R.W.M., K.J.G.	PROJECT No: 690	DATE: FEB. 1980	ENCLOSURE No: 1

WELL 34/10-5

1500 m. — 2780 m.

NORWEGIAN OFFSHORE

STRATIGRAPHIC LOG

SCALE 1:500

PALEOSERVICES
UNIT 15, PARAMOUNT INDUSTRIAL ESTATE, SANDOWN ROAD, WATFORD. WD2 4XA. ENGLAND

LEGEND

CLAY/CLAYSTONE — F M C SANDSTONE — LIMESTONE
SHALE — CONGLOMERATE — CHALK
MARL – CALCAREOUS SHALE — VOLCANICS LAVAS/TUFFS — DOLOMITE
SILTSTONE/SILT — UNDIFFERENTIATED BASEMENT — CEMENT
F M C SAND — NO SAMPLES — ANHYDRITE/GYPSUM
MEGAFOSSILS — G GLAUCONITE — MICA
CHERT — S SIDERITE — CORES
PYRITE — LIGNITE/COAL — SIDEWALL CORES
P.S. POOR SAMPLES

FOSSILS AND ACCESSORY MINERALS

Boundary — Abundant
Unconformity — Common
T.D. (Total depth) — Rare
Partial or interrupted sequence — Abundant / Common / Rare: FOSSILS IN SIDEWALL CORES/CORES
F.S.E. First sample examined
L.S.R. Last sample received
Ditch cuttings. / Core / S.W.C. } PALYNOLOGICAL ANALYSES

S T A T O I L	ANALYSTS: R.W.M., K.J.G.	PROJECT No: 690	DATE: FEB. 1980	ENCLOSURE No: 1

WELL 34/10-5

1500 m. — 2780 m.

NORWEGIAN OFFSHORE

STRATIGRAPHIC LOG

SCALE 1:500

PALEOSERVICES

UNIT 15, PARAMOUNT INDUSTRIAL ESTATE, SANDOWN ROAD, WATFORD. WD2 4XA. ENGLAND.

LEGEND

CLAY/CLAYSTONE — SHALE — MARL – CALCAREOUS SHALE — SILTSTONE/SILT — SAND (F M C)
SANDSTONE (F M C) — CONGLOMERATE — VOLCANICS LAVAS/TUFFS — UNDIFFERENTIATED BASEMENT — NO SAMPLES
LIMESTONE — CHALK — DOLOMITE — CEMENT — ANHYDRITE/GYPSUM

MEGAFOSSILS — CHERT — PYRITE
G GLAUCONITE — S SIDERITE — LIGNITE/COAL
MICA — CORES — SIDEWALL CORES — P.S. POOR SAMPLES

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

FOSSILS AND ACCESSORY MINERALS
Abundant
Common
Rare

FOSSILS IN SIDEWALL CORES/CORES: Abundant, Common, Rare

PALYNOLOGICAL ANALYSES: Ditch cuttings, Core, S.W.C.