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Title

PALEONTOLOGICAL/STRATIGRAPHICAL REPORT.

WELL 34/10-3

NORWEGIAN OFFSHORE

(310m - 2802m T.D.)

Project No.

632

Stratigraphers

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CONTENTS

ENCLOSURES.

1. INTRODUCTION.

This report presents the results of the stratigraphical and paleontological study of samples from Well 34/10-3, 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 310m and 1700m, and 3m intervals between 1700m and 2802m (T.D.) 83 sidewall cores were analysed between 1820m and 2788.5m, and samples from cores 1-9.

Palynological analyses have been undertaken on 34 ditch samples, 31 sidewall cores and 23 core samples over the interval 1875m-2802m.

A 1:2000 study is presented for the interval with a stratigraphic log at this scale for the complete well (Encl.1). At the request of Statoil (Mr. E. Lie) the 1:500 study was undertaken from 1727-2802m (T.D.) rather than 1800-2802m (T.D.) as originally requested (Encl.2).

Interval tops are taken at sample depths although petrophysical logs were provided by Statoil.

2. CONCLUSIONS.

1. The highest sample received (310m) is Pleistocene in age. The Pleistocene comprises sandy clays with fragments of igneous and metamorphic rocks (310-370m) and was deposited in a marine inner sublittoral environment.

2. The Tertiary section (370-1745m), consists of clays, sandy clays and sands ranging in age from Pliocene to Paleocene. They were deposited in marine sublittoral to bathyal environments in which sands were periodically deposited by turbidity currents or mass-flow. Tuffaceous claystones were encountered at 1580-1640m. These are a prominent lithological marker in the North Sea and are of Early Eocene to Paleocene age.

3. There is a marked stratigraphical hiatus between the Pliocene and Oligocene at 890m; the paleontological evidence suggests that rocks of Early Pliocene, Miocene and topmost Oligocene age are missing.

4. The Late Cretaceous section (1745-1886m) is represented by a thin sequence of claystones and occasional limestones of Maastrichtian-Campanian age. These are consistently the two most geographically widespread Cretaceous stages within the North Sea Basin. Deposition was in a marine, outer sublittoral to bathyal, environment.

5. A prominent stratigraphical break exists at 1886m, between Late Cretaceous (Campanian) and Early Cretaceous (Early Albian - Aptian) sediments.

6. A very thin Early Cretaceous (1886m-1892m) sequence of predominantly red claystones is dated as Early Albian - Aptian, and was deposited in a marine outer sublittoral to bathyal environment.

7. The Early Cretaceous section rests unconformably on Middle Jurassic rocks at 1892m. Rocks of Late and late Middle Jurassic age, belonging to the Kimmeridge Clay, Heather Formation and topmost Brent Unit are missing.

8. The Middle Jurassic Brent Unit (1892-2095m) is represented by rocks deposited in deltaic and shallow marine environments and dated by palynomorphs as earliest Bathonian to Early Bajocian.

   There are four lithological and sedimentological divisions in this sequence: a cyclic sequence of sandstones, claystones and coals (1892-1982m), the Ness Sub-unit, two sequences of mainly fine-medium sands (1982-2084m), the Etive and Rannoch Sub-units and a basal transgressive fine to coarse sand (2084-2095m), the Broom Sub-unit.

9. Below the Middle Jurassic sands there is a thick sequence of claystones, sandstones and limestones (2095m-2496m), the Dunlin Unit, ranging in age from Aalenian or Toarcian to Sinemurian. There is a prominent lignitic sand which cannot be accurately dated but may be the regressive top Pliensbachian or transgressive basal Toarcian. There appear to be no breaks within this sequence, the age of the transgressive sands at the base (2486m-2496m), may be Sinemurian or earliest Pliensbachian.

10. Although paleontological evidence is not conclusive, it suggests there may be a stratigraphical break at 2496m within the Sinemurian, between the Dunlin Unit and the poorly sorted sands of the Statfjord Formation below.

11. The lower part of the Early Jurassic section (2496m-2660m) is represented by a sequence of sands, overlying sands and claystones at 2569m. Palynological evidence suggests that this interval is Sinemurian to Hettangian in age.

12. Palynological evidence suggests that the top Triassic is at 2660m,and that the sequence below to 2802m (T.D.) is of Rhaetian age. The rocks present comprise the lower part of the Statfjord Formation and the Cormorant Formation. The junction between them may be either at the highest occurrence of purple shales at 2676m or of red claystones at 2715m.

3. STRATIGRAPHICAL SUMMARY.

Interval	Age	Thickness
310 - 370m	Pleistocene	60m
370 - 890m	Pliocene	520m
	Unconformity	
890 -1000m	Oligocene	110m
1000 -1110m	?Eocene	110m
1110 -1580m	Eocene	470m
1580 -1640m	Early Eocene - Paleocene	60m
1640 -1745m	Paleocene	105m
1745 -1772m	Late Cretaceous, Late Maastrichtian	27m
1772 -1886m	" " Maastrichtian - Campanian	114m
	Unconformity	
1886 -1892m	Early Cretaceous, Early Albian - Aptian	6m
	Unconformity	
1892 -2075m	Middle Jurassic, Earliest Bathonian - Bajocian	183m
2075 -2095m	" " Early Bajocian (Aalenian)	20m
2095 -2147m	?Middle-Early Jurassic, ?Early Bajocian (Aalenian) - Toarcian	52m
2147 -2198m	Early Jurassic, Early Toarcian	51m
2198 -2216m	" " Early Toarcian/ Late Pliensbachian	18m
2216 -2240m	" " ?Late Pliensbachian	24m
2240 -2411m	" " Late Pliensbachian	171m
2411 -2450m	" " Early Pliensbachian	39m
2450 -2496m	" " Early Pliensbachian-Sinemurian	46m
	?------?------ Unconformity ------?-------?	
2496 -2660m	Early Jurassic, Sinemurian - Hettangian	164m
2660 -2802m T.D.	Late Triassic, Rhaetian	142m

Lithostratigraphical Summary

(based on Deegan & Scull 1977)

Interval	Lithostratigraphy	Age	Thickness
1745 - 1886m	Shetland Group	Late Cretaceous	141m
----------	Unconformity	----------	
1886 - 1892m	Cromer Knoll Group	Early Cretaceous	6m
----------	Unconformity	----------	
1892 - 2095m	Brent Unit	Middle Jurassic	203m
1892-1982m	Ness Sub-unit		
1982-2084m	Etive-Rannoch Sub-unit	Middle Jurassic	
2084-2095m	Broom Sub-unit		
2095 - 2496m	Dunlin Unit	?Middle-Early Jurassic	401m
---------?---------	?---------- Unconformity	---------?---------?	----------
2496 - 2802m T.D.	Statfjord-Cormorant Formations.	Early Jurassic - Late Triassic.	306m

N.B. The above data is based on information from cuttings, cores and sidewall cores analysed by Paleoservices Ltd., and not the petrophysical logs of Statoil.

4. STRATIGRAPHY.

This discussion supplements the information presented on the stratigraphic logs (Enclosures 1-2). The lithology and biota are described and the age and depositional environments interpreted. An attempt has been made to assign the litho-stratigraphical divisions of the Mesozoic to those of Deegan and Scull (1977).

4.1 310m - 370m PLEISTOCENE

Lithology:

Sandy clay, grey, with fine to coarse sand grains, and gravel-size fragments of igneous and metamorphic rocks. Reworked glauconite is common.

Biostratigraphy:

A diverse microfauna includes the benthic foraminiferids Cassidulina laevigata, Nonion labradoricum ("boueanum"), Elphidium spp., and Elphidiella arctica. The planktic foraminiferid Globigerina pachyderma is abundant at the top of the interval. Bivalve debris, echinoderm debris and ostracods are also common.

This interval is assigned to the Pleistocene because of its position above the highest occurrence of Cibicides lobatulus grossa. The presence of Elphidiella arctica near the base of the interval supports correlation with the Early Pleistocene (Icenian) or older beds.

Environment:

Marine, inner sublittoral. The poorly-sorted sand and gravel content is probably glacial debris.

4.2 370m - 890m PLIOCENE

Lithology:

Sandy and silty clay, grey, very poorly sorted, with fine to very coarse grains of quartz, quartzite, schist and other rock types. Pyrite occurs throughout and glauconite is abundant at 550m.

Biostratigraphy:

A diverse microfauna is present, except in the interval from 680-790m, where fossils are rare. The foraminiferid fauna includes most of the species occurring in the Pleistocene, together with Cibicides lobatulus grossa, Sigmoilina schlumbergeri, Cibicides pseudoungerianus and Cassidulina pliocarinata. The planktics Globigerina pachyderma, G. bulloides and Globorotalia gr. inflata are common below 790m.

Molluscs (bivalves, gastropods and scaphopods) occur throughout, and are particularly common in shell-rich beds at 370-380m and 550-560m, associated with bryozoa.

The top Pliocene is placed at the highest occurrence of Cibicides lobatulus grossa, to conform with standard practice in the central and southern North Sea Basin, but the beds down to about 630m still contain fossils which are more typically Early Pleistocene (Elphidiella arctica and the bivalve Acila cobboldiae) and are apparently in place and it is possible that the boundary should be placed at a lower level. No Early Pliocene or Miocene fossils have been seen, and the Late Pliocene probably rests unconformably on the Oligocene.

Environment:

Marine, inner sublittoral, the sand and gravel is probably largely glacial debris.

4.3 890m - 1,000m OLIGOCENE

Lithology:

Claystone, soft, light brown, occasionally micaceous. Abundant glauconite is present at the top of the interval (890-920m) and at 890m is a hard, highly glauconitic sandstone.

Biostratigraphy:

Abundant sponge spicules include the distinctive form Geodia sp. Minute siliceous diatoms are often abundant. The diagnostic Late - Middle Oligocene species Diatom sp.3 (internal species) occurs at 930m.

Foraminiferids are scarce, but at 930m Angulogerina gracilis occurs, associated with Nonion granosum and Turrilina alsatica. These indicate a position near the Middle/Late Oligocene boundary. At higher levels no diagnostic fossils are present.

In neighbouring wells, beds with abundant Geodia and sponge spicules (corresponding to this interval) are overlain by a level with Late Oligocene foraminiferids. This confirms that the entire interval is Oligocene in age.

Environment:

Marine, sublittoral.

4.4 1,000m - 1,1110m ?EOCENE.

Lithology:

Sand, fine, medium and coarse grained, subrounded, with several beds of claystone, silty.

Biostratigraphy:

No in place fossils have been seen, and there is no paleontological evidence for the age of this interval.

Environment:

Marine, probably outer sublittoral to bathyal, as the lithologies are similar to those in the underlying interval. The sands were probably derived from a shallow shelf environment, and subsequently emplaced in a deeper-water environment by turbidity currents or mass-flow.

4.5 1,110m - 1,580m EOCENE.

Lithology:

1,110m-1,425m Sand, loose, fine to coarse grained, in beds from 5m to 40m thick, interbedded with claystone, green and brown, pyritic. Phosphatic faecal pellets and ?siderite are present at several levels.

1,425m-1,560m Claystone grey and green, with abundant pyrite. Traces of degraded tuff at 1,540m. A bed of white limestone at 1,550m.

1,560m-1,580m Claystone, red and grey.

Biostratigraphy:

1,110m - 1,330m Eocene (undivided)

The top of the Eocene is taken at the highest occurrence of a microfauna comprising agglutinating foraminiferids and Radiolaria. The foraminiferids include species of Bathysiphon, Rhabdammina, Recurvoides, Glomospira and Silicosigmoilina. Although this fauna includes no age-diagnostic species, it is typical of the Eocene in this part of the North Sea Basin.

1,330m - 1,490m ?Early Eocene

A similar (though more diverse) microfauna is present in this interval, with the addition of Ammodiscus glabratus and Cyclammina acutidorsata. The top occurrence of C. acutidorsata is usually within the Early Eocene.

1,490m - 1,580m Early Eocene

Radiolaria become very abundant at 1,490m. This event is widespread in the North Sea Basin, and occurs within (or at the top of) the Early Eocene. Radiolaria continue abundantly to 1,550m. The agglutinating foraminiferids continue, and below 1,540m are joined by occasional calcareous benthic species. The highest occurrence of the planktic species Globigerina gr. triloculinoides (at 1,550m) is a regional marker within the Early Eocene.

Environment:

The foraminiferid fauna indicates a marine, outer sublittoral to bathyal environment, more probably bathyal. The sand beds above 1,425m do not show the characteristics of shallow-water sands and were probably emplaced by mass flow or by turbidity currents.

4.6 1,580m - 1,640m EARLY EOCENE - PALEOCENE.

Lithology:

Claystone and tuffaceous claystone, grey and green, with occasional thin limestone beds.

Biostratigraphy:

The microfauna is dominated by pyritised diatoms (Coscinodiscus spp.). The top of this interval is defined by the highest occurrence of the distinctive species Coscinodiscus sp.1, a regional marker, which coincides approximately with the top of the ash series. Foraminiferids are very rare and probably all caved.

Environment:

Marine, ?outer sublittoral to bathyal, with contemporaneous vulcanicity.

4.7 1,640m - 1,745m PALEOCENE.

Lithology:

1,640m-c.1,705m Claystone, fine, grey, pyritic, and limestone.

c.1,705m-1,745m As above, with interbedded fine sand and sandstone.

Biostratigraphy:

The top of this interval (1,640m) is defined by the return of abundant agglutinating foraminiferids, characterised by the consistent occurrence of Bolivinopsis spectabilis. Other genera include Plectina, Trochammina, Recurvoides, Rhabdammina and Bathysiphon.

Environment:

Marine, outer sublittoral - bathyal.

4.8 1,745m - 1,886m LATE CRETACEOUS, Maastrichtian - Campanian.

Lithostratigraphy:

Shetland Group

1,745m-1,820m Claystone, grey, calcareous. The samples through this interval are heavily contaminated by caved Paleocene and Eocene claystones and sands.

1,820-1,886m The ditch cuttings are heavily contaminated by cement and caved lithologies. Fourteen sidewall cores shot in this sequence are grey claystone with occasional silty laminations. Thin beds of grey limestone and brown dolomitic limestone are present in the cuttings below 1,874m.

Biostratigraphy:

1,745m-1,772m Late Maastrichtian.

There are abundant planktic and benthic foraminifers in this interval, including the diagnostic Late Maastrichtian markers Abathomphalus mayaroensis, Globotruncana contusa, Pseudotextularia elegans and Racemiguembelina fructicosa.

1,772m - 1,886m Maastrichtian - Campanian.

Microfauna:

The top of this interval is taken at the highest occurrence of Reussella szajnochae, which was considered in previous reports to indicate the top Early Maastrichtian regionally. Analysis of calcareous nannoplankton in this area now shows that this marker is within the Late Maastrichtian.

Sample quality is poor below 1,820m and no other regional Maastrichtian - Campanian markers have been recognised.

The presence of Rugoglobigerina spp. nearly to the base of the sequence suggests that there are no rocks older than Campanian in this interval.

Microflora:

Eight sidewall cores were analysed for calcareous nannoplankton, but only four contained age-diagnostic assemblages. At 1,820m and 1,829m the presence of Arkangelskiella cymbiformis without Reinhardtites levis and N. frequens suggests a "Middle" Maastrichtian age (A. cymbiformis zone, zone 25 of Sissingh (1977). At 1,837m and 1,856m the presence of R. levis together with the assemblage found in the previous two samples indicates an Early Maastrichtian age (Zone 24/23B Sissingh 1977).

Ditch samples at 1,871m, 1,877m, 1,886m and a sidewall core at 1,883m contained a dinoflagellate and pollen association characteristic of the Campanian. Significant taxa present include the dinoflagellates Diconodinium sp., Odontochitina costata, Gillinia hymenophora (1,886m) and the pollen Aquilapollenites attenuatus (1,883m) and Aquilapollenites spp.

Environment:

Marine, outer sublittoral - bathyal. The presence of abundant planktic foraminifers in the upper part indicates influence from oceanic watermasses. The abundant and diverse assemblage of agglutinating foraminifers throughout also indicates "deep water".

Remarks:

The boundary of the Maastrichtian and Campanian stages must lie between 1,856m and 1,886m based on microfloral evidence.

4.9 1,886m - 1,892m EARLY CRETACEOUS, Early Albian - Aptian.

Lithostratigraphy:

Cromer Knoll Group

Cuttings are heavily contaminated by caved lithologies. The top of the interval is based on sidewall cores, and the logged lithologies are inferred from the lithologies in the sidewall cores.

1,886m, 1,887m and 1,890m. Claystone, red, non-calcareous, abundant siderite.

1,888.5m Claystone, brown, "speckled", coal debris, oily.

1,891m Contaminated sample, probably claystone, grey, non-calcareous.

Biostratigraphy:

Microfauna:

The top four sidewall cores (1,886m, 1,887m, 1,888.5m and 1,890m) contained common agglutinating foraminifers including Verneuilinoides chapmani, Reophax minuta, Recurvoides sp., Ammodiscus sp. and Textularia aff. foeda. This association is typical of the Early Albian and Late Aptian in the Northern North Sea. The lowest sidewall core (1,891m) contained a more diverse fauna, including the planktic Hedbergella sp. but none of the taxa are age diagnostic.

Microflora:

Three of the sidewall cores (1,887m, 1,888.5m and 1,891m) were analysed for calcareous nannoplankton but they were either barren or contained only Late Cretaceous contaminants.

Two sidewall cores were analysed for palynology; that at 1,887m contained very rare humic and sapropelic kerogen but was barren of palynomorphs while a sparse assemblage was obtained from 1,888.5m, consisting of long-ranging Cretaceous to Jurassic pollen including Classopollis torosus and Cerebropollenites mesozoicus.

Environment:

Marine, outer sublittoral to bathyal.

4.10 1,892m - 2,095m MIDDLE JURASSIC, Earliest Bathonian - Early Bajocian (Aalenian).

Lithostratigraphy:

Brent Unit

Ditch samples are poor in the upper part of this interval; lithological description is based on sidewall cores (1,892m-1,903.5m), cores(1,904m-2,025m) and ditch samples (2,025 - 2,095m).

Ness Sub-Unit

Dominantly a cyclic sequence of sandstones, siltstones, claystones and coal.

1,892m-1,903.5m

Nine sidewall cores were shot through this interval

1,892m	Coal
1,893.5m-1,902m	(7 S.W.C.s) Sandstone, fine, angular, with carbonaceous debris.
1,903.5m	Claystone, with occasional fine angular sand, carbonaceous debris.

1,904m-1,918.7m (Core 1).

1,904m-1,905m.25m Alternating thin beds of fine sandstone, siltstone and grey claystone; the sandstones are cross bedded in the upper part and bioturbated below.

1,905.25m-1,906.3m Claystone, and siltstone, grey, with occasional beds of flaser-bedded fine sandstone, pyrite and lignitic debris.

1,906.3m-1,918.7m At least four coarsening upwards cycles comprising fine sandstone, siltstone and claystone, variably laminated, cross or flaser bedded. Each cycle is capped by a coal with seat earth containing rootlets.

1,919.4m-1,929.8m (Core 2).
Similar lithologies to the interval above, with a prominent coal at 1,923.1m and a thick seat earth between 1,923.5m-1,925m.

1,930.9m -1,933.35m (Core 3).
Sandstone, fine, with thin claystone beds and coaly debris; cross bedded or slumped.

1,936.1m -1,947.7m (Core 4).
Sandstone, (1,936.8m-1,938.4m, 1,942m-1,944.7m, 1,946.2m-1,947.7m) fine,occasionally cross bedded,variably flaser bedded, with occasional claystones grey, often lignitic, and coal at 1,936.2m.

1,953.2m-1,969m (Core 5).

Two prominent sandstones (1,953.2m-1,955m, 1,962m-1,965.9m), fine, light brown with occasional claystone bands, planar or cross bedded, interbedded with claystone, grey occasional woody debris, often planar or flaser bedded with fine sandstone. Coal at 1,868m.

1,971m - 1,982m (Core 6).

1,971m - 1,975.8m Sandstone, fine and medium grained,light brown, with occasional claystone laminations. Between 1,972.6m and 1,974.8m inter-laminated sandstone, siltstone and grey claystone.

1,975.8m-1,982m Coal, seat earth with rootlets, coaly claystone with thin beds of fine sandstone near the base.

Etive-Rannoch Sub-Units

Monotonous sands and occasional gravel.

1,982m - 1,989.2m Sandstone, light brown,fine to medium and fine to coarse, poorly sorted and cemented, with white ?kaolinitic matrix. Coal at 1,985.4m, no seat earth.

1,989.2m -2,007.3m (Core 7).

As 1,982m- 1,989.2m with occasional gravel, and lignitic debris.

2,007.3m-2,025m (Core 8).

Sandstone, light grey-green, fine-medium, poorly sorted, with white ?kaolinitic cement.

2,025m - 2,084m (Ditch Samples).

Sandstone, fine and medium grained with pyrite and coaly debris. Poor samples.

Broom Sub-Unit.

2,084m - 2,095m (Cuttings and sidewall cores).

Sand, fine-coarse, angular-subangular with pyrite and carbonaceous debris, some brown dolomite.

Biostratigraphy:

1,892m-2,075m Earliest Bathonian - Bajocian

Microfauna:

Barren.

Microflora:

Palynological analyses through this interval are based on core samples (above 2,025m) and sidewall cores.

The highest sample examined (sidewall core at 1,895m) contains a typical Early Bathonian association of spores and pollen, Neoraistrickia sp., abundant Cyathidites spp., and Quadraeculina anellaeformis. The latter, together with the dinoflagellate Nannoceratopsis gracilis sl., is characteristic of earliest Bathonian microfloras reported from this area.

The first downhole occurrence of Nannoceratopsis gracilis senex is at 1,920m. This association indicates that sediments below 1,895m are not younger than earliest Bathonian.

The palynomorph assemblages which characterise the Heather and upper part of the Brent Formations in this area are absent which suggests therefore that this part of the sequence is missing from this well.

Below 1,997m, to 2,075m, the microfloras are less rich and diverse but retain a general earliest Bathonian to Bajocian character. The core sample at 1,985.4m, an allochthonous coal without a seat earth, contains the dinoflagellate Ctenidodinium cf. pachydermum (common) which indicates deposition in a marine (nearshore) environment. This event may be of use in local correlation.

2,075m-2,095m Early Bajocian (=Aalenian)

Microfauna:

Barren.

Microflora:

The dinoflagellates Nannoceratopsis gracilis and N. gracilis senex reappear in the sidewall cores between 2,075m and 2,095m. Regionally their presence in this basal part of the Brent sequence is taken as indicating an Early Bajocian (Aalenian) age. In these samples they are associated with spore and pollen taxa which range through the Middle Jurassic (and higher) but do not extend below the Toarcian. These forms gradually disappear in the underlying intervals (see below).

They include Klukisporites variegatus, Ischyosporites spp., Tsugaepollenites dampieri, T. turbatus and Coronatispora valdensis.

Environment:

Deltaic and shallow marine.

1,892m-1,982m The coarsening upwards cycles of the cores indicate fluvio deltaic sedimentation with swamps resulting in the deposition of autochthonous coals. There is evidence of occasional nearshore marine influence in the presence of rare dinoflagellates (N. gracilis sl.) and acritarchs.

1,982m-2,095m This monotonous sequence of sands is typical of a shallow marine delta front environment. A coal in the upper-part shows no seat earth and the presence of common dinoflagellates suggests that it has been transported (i.e. allochthonous). The presence of common dinoflagellates suggests more marine (?transgressive) conditions prevailed during the deposition of the sand in the lower part (2,075m-2,095m).

4.11 2,095m-2,496m ?MIDDLE - EARLY JURASSIC,?Early Bajocian-Sinemurian.

Lithostratigraphy:

Dunlin Unit.

2,095m-2,112m Ditch samples through this interval are dominantly sands but they are interpreted as caved. The in place lithology is possibly grey claystone, as in SWC 2,095m, the level at which the top Dunlin is taken.

2,112m-2,198m Claystone and siltstone, grey, with occasional fine angular sandstone, between 2,114m and 2,147m thin beds of brown dolomitic limestone.

2,198m-2,216m Sand, fine-coarse, very poorly sorted, angular-subangular with abundant pyrite and carbonaceous debris. Side-wall cores also indicate occasional beds of grey claystone (2,200m) and fine-medium sandstone.

2,216m-2,294m Sandstone, fine, angular, calcareous matrix, in part approaching sandy limestone.

2,294m-2,330m Interbedded brown limestone, grey claystone and occasional fine sandstone.

2,330m-2,336m As above with more fine sand.

2,336m-2,345m Sand, fine-medium, subangular (possibly in part caved). Occasional beds of grey claystone.

2,345m-2,481m Interbedded, grey claystone, siltstone, fine sandstone and red-brown limestone.

2,481m-2,496m Sandstone, fine, with occasional beds of claystone, grey. ?Phosphatic/chamositic pellets are common at 2,496m.

Biostratigraphy:

2,095m-2,147m ?Early Bajocian (Aalenian) - Toarcian.

Microfauna:

Agglutinating foraminifers are common in this interval and form an association which is regionally dated as Toarcian. The presence of ostracods including Kinkelinella sermoisensis and Camptocythere spp.,together with the benthic calcareous foraminifer Nodosaria regularis,suggests that the interval may range up into the Aalenian.

The top of the interval has been tentatively taken at the sidewall core at 2,095m containing long ranging agglutinating foraminifers although common foraminifers do not appear in the cuttings till 2,102m.

Microflora:

Most taxa recorded above continue through this interval and are not age restricted, although several of the spore and pollen species do not range below the Toarcian (see below).

2,147m-2,198m Early Toarcian

Microfauna:

Foraminifers and ostracods are common. The top of the interval is taken at the highest occurrence of Trachycythere verrucosa but also present are Kinkelinella intrepida and K.cf. debilis. This association is typical of the Early Toarcian in onshore successions where it tops in the Hildoceras bifrons ammonite zone.

Microflora:

Nannoceratopsis gracilis senex is common, associated with several small dinoflagellate taxa which do not occur above, including cf. Tectatodinium gochti (at 2,150m), Fromea elongata, and Dinoflagellate sp.3 Thusu (both at 2,170m). The last two are recorded from the Toarcian (Wilhelmoya Formation) of Kong Karls Land (Thusu 1978). The presence of Mancodinium semitabulatum (a Pliensbachian form) in the sidewall core at 2,170m may be the result of reworking or possibly could be an extension of its range.

Spores and pollen which "bottom" in the Late Toarcian are rare and disappear (downhole) through this interval. These include Coronatispora valdensis (basal occurrence in S.W.C. at 2,150m), and Klukisporites variegatus, Tsugaepollenites dampieri and T. turbatus (all bottom in the sidewall core at 2,185m).

2,198m-2,216m Early Toarcian - Late Pliensbachian.

Microfauna:

The microfauna is restricted to rare long ranging non diagnostic agglutinating and calcareous foraminifers.

Microflora:

The microflora contains common bisaccate pollen and Chasmatosporites major with some Nannoceratopsis gracilis and N. gracilis senex. Typical Late Toarcian spores and pollen (see above) are absent. The dinoflagellate Mancodinium semitabulatum is present at 2,215m but may be reworked there. This assemblage is not age diagnostic but is consistent with an Early Toarcian - Late Pliensbachian age.

Remarks:

This interval is recognised by its distinctive lithology; faunas and floras are non age diagnostic and it is dated by the fossiliferous sequences above, and below 2,240m.

2,216m-2,240m ?Late Pliensbachian.

Microfauna:

There appears to be no in place microfauna in this interval.

Microflora:

The assemblage lacks diversity and is similar to those in the overlying interval.

Remarks:

The lithology of this interval is the same as in the well dated interval below; it appears to have been deposited in the same sedimentary episode, and is therefore probably of the same age.

2,240m-2,411m Late Pliensbachian.

Microfauna:

The top of this interval is taken at the highest occurrence of abundant Ogmochoncha, an ostracod which does not normally occur above the Late Pliensbachian.

At 2,363m a distinctive association of the ostracod Ogmoconcha contractula and Dentalina matutina may prove to be a regional marker. Wicherella semiora (below 2,387m) is a regional marker in onshore successions where it is restricted to the early part of the Late Pliensbachian (Amaltheus margaritatus ammonite zone).

Microflora:

The first downhole occurrence of Cerebropollenites cf. thiergarti, in the sidewall core at 2,240m, and its association with the dinoflagellate Mancodinium semitabulatum indicates the penetration of sediments of definite Pliensbachian age from that depth. Acritarchs occur throughout this interval although dinoflagellates only occur in the upper part, down to 2,363m. M. semitabulatum is present down to 2,275m (S.W.C.), N. gracilis and N. gracilis senex to the sidewall core at 2,300m and the former is also present in ditch cuttings to 2,363m, although it is rare below 2,336m and may be caved. The genus Nannoceratopsis shows greater morphological diversity here, with N. ambonis occurring between 2,240m and 2,275m. The presence of N. gracilis sl. indicates an age not older than Late Pliensbachian.

The spore and pollen assemblages are dominated by bisaccate pollen, with common Chasmatosporites major, Osmundacidites +Baculatisporites spp. and Classopollis torosus; all are long-ranging taxa. Reworked Carboniferous and Permo-Triassic taxa occur throughout.

2,411m - 2,450m Early Pliensbachian.

Microfauna:

Foraminifers and ostracods are common through this interval. The highest occurrence of Gammacythere ubiquita at 2,411m indicates an Early Pliensbachian age. An abundance level of Ogmoconcha amalthei amalthei at 2,441m may prove to be an important regional marker.

Microflora:

No age diagnostic taxa were recorded; spore and pollen assemblages are similar to those in the overlying interval. Reworked taxa recorded include the Rhaetian form Riccisporites tuberculatus.

2,450m-2,496m Early Pliensbachian - Sinemurian.

Microfauna:

Ostracods and foraminifers are sparse compared with the overlying interval. Some of the taxa typical of the Pliensbachian continue, including Ogmoconcha amalthei amalthei. The top of the interval is taken at the highest occurrence of poorly preserved Kinkelinella spp. which may be Late Sinemurian forms. No distinctive Early Sinemurian ostracods are present.

Microflora:

The assemblages lack age - diagnostic taxa. Reworked forms are common in the sidewall cores 2,467.2m, 2,471.1m and 2,476.1m and include Carboniferous spores Densosporites sp., Lycospora sp., Triquitrites sp., and Tripartites sp. as well as the Rhaetian species Riccisporites tuberculatus. A specimen of Kraeuselisporites reissingeri (Sinemurian - Rhaetian) from 2,471.1m is probably reworked.

Regionally an Early Sinemurian - Hettangian microflora has been reported at the base of the Dunlin Formation, but is not recognisable in this sequence. A stratigraphical hiatus may therefore occur at this level.

Environment:

2,095m-2,198m Marine, possibly outer sublittoral prodeltaic.

2,198m-2,216m Probably shallow marine , delta front.

2,216m-2,496m Marine, mainly inner sublittoral. Common ?phosphatic/chamositic pellets in the sand at 2,493.6m may indicate a period of non deposition. This is overlain by a transgressive, possibly littoral, sand unit (2,216m-2,294m) and a similar though regressive sand occurs at the top of the interval (2,481m-2,496m).

4.12 2,496m - 2,802m T.D. EARLY JURASSIC - LATE TRIASSIC, Sinemurian - Rhaetian.

Lithostratigraphy:

Statfjord - Cormorant Formations

2,496m-2,529m Sandstone/sand, fine-coarse and fine-medium, angular-subangular, poorly sorted, lignitic debris, occasional silty grey claystone. Possibly cyclic.

2,529m-2,569m Sandstone, as above but with calcareous cement, lignitic debris, occasional light grey claystone.

2,569m-2,601m Claystones, brown (occasionally green and red), sideritic with sand/sandstone, fine-medium as above.

2,601m-2,676m Claystone and siltstone, light grey, light brown with occasional red bands; occasional siderite; interbedded sandstone, fine-coarse, angular, poorly sorted, white non-calcareous matrix.

2,676m-2,715m As above but with more purple and green claystone.

2,715m-2,802m Claystone and siltstone, red; with calcareous concretions below 2,718m and anhydrite below 2,733m; below ca.2,748m beds of fine-medium white sandstone.

Biostratigraphy:

2,496m-2,660m Sinemurian - Hettangian.

The top of this unit is taken at the lithological junction marking the top of the Statfjord Formation. It is probable that this Formation is diachronous, see discussion below.

Microfauna:

Barren.

Microflora:

In this area the top of the Statfjord Formation has been dated as Hettangian (see Paleoservices report, Project No.600), on microfloras obtained from cores.

The pollen Cerebropollenites mesozoicus and C. cf. thiergartii occur together in the Sinemurian but the former is absent from the Hettangian. Both of these taxa are present in the sidewall cores at 2,522m and 2,564m; this suggests that the top of the Statfjord Formation in this well may be of Sinemurian age. However, since C. mesozoicus is present in ditch samples down to 2,609m (although it is probably caved), a definite Sinemurian - Hettangian boundary cannot be recognised here.

Kraeuselisporites reissingeri (in the ditch sample at c.2,575m) is assumed to be in place and not reworked; its presence supports a Sinemurian - Hettangian age.

2,660m-2,802m Triassic, Rhaetian.

Microfauna:

Barren.

Microflora:

Riccisporites tuberculatus occurs in the sidewall core at 2,660m and is associated below with other typical Rhaetian and Late Triassic taxa. It is therefore considered to be in place and not reworked at this depth, and is taken to mark the top of the Rhaetian. Other significant taxa are Aratrisporites sp. from 2,723.5m, Ovalipollis ovalis from 2,746m, and Rhaetipollis germanicus from 2,763m.

The top of the Rhaetian occurs above the upper limit of the red bed sequence. In other wells in the area it occurs at a greater distance above the red beds. This discrepancy may reflect the failure to recover Riccisporites tuberculatus from higher levels in this well.

There is no palynological evidence for the penetration of sediments older than Rhaetian.

Environment:

2,496m-2,569m Marine, littoral to inner sublittoral.

2,569m-2,715m Continental-marine, paralic, probably fluvial in part.

2,715m-2,802m Continental, alluvial.

5. REFERENCES:

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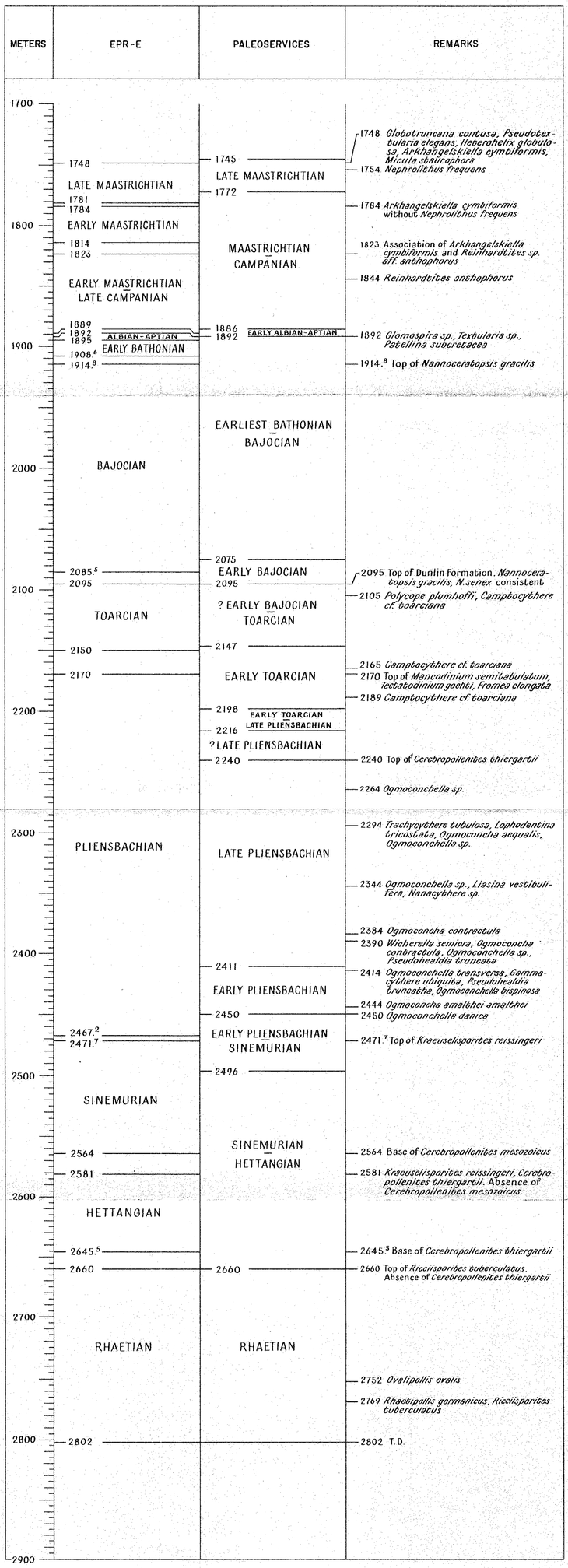
STATOIL 34/10-3

LOG I

SCALE: 1/2000

PREPARED BY J.P. VERDIER, M. PONS, J.P. COLIN

EPR-E (BORDEAUX) SEPTEMBER 1979



SEE STRATIGRAPHIC LOG ENCLOSURE 2
1:500 FOR INTERVAL 1727-2802 m
CALCAREOUS NANNOPLANKTON ANALYSIS
Depth
Lithology
Cores/Side-wall cores
Minerals
Palynological analyses
Main Fossils
Depths
Significant faunal/floral events
Significant lithological horizons
Environment
N.P.D./I.G.S Lithostratigraphic nomenclature
Stage
Epoch
Series
Era
Age
LATE
TRIASSIC
EARLY
JURASSIC
MIDDLE
LATE
CRETACEOUS
PALEOCENE
EOCENE
?EOCENE
OLIGOCENE
PLIOCENE
PLEISTOCENE
QUATERNARY
TERTIARY
MESOZOIC
CAINOZOIC
STATFJORD
DUNLIN
BRENT
SHETLAND
CORMORANT
RHAETIAN
HETTANGIAN - TSINEMURIAN
EARLY PLIENSBACHIAN
LATE PLIENSBACHIAN
BAJOCIAN - EARLIEST BATHONIAN
CAMPANIAN - MAASTRICHTIAN
Continental
Marine, inner sublittoral
Shallow marine delta front
Deltaic
Marine, outer sublittoral
Marine, sublittoral
CLAYSTONE, RED
CLAYSTONE, PURPLE & GREY
SANDSTONE
DOMINANTLY GREY CLAYSTONE
RED CLAYSTONE
TUFFACEOUS CLAYSTONE
MEDIUM - COARSE GRAINED SANDS
ABUNDANT GLAUCONITE
SIDERITE
GLAUCONITE
PHOSPHATIC PELLETS
WELL 34/10-3
NORWEGIAN OFFSHORE
STRATIGRAPHIC LOG
SCALE 1:2000
STATOIL
PALEOSERVICES
LEGEND
C.K./R.M.W./L.O.A.
632
JUNE 1979
1


STATOIL
WELL 34/10-3
NORWEGIAN OFFSHORE
STRATIGRAPHIC LOG
PALEOSERVICES LIMITED,
UNIT 15, SANDOWN ROAD,
WATFORD
ANALYSTS: R.W.M, L.O.A
PROJECT No: 632
DATE: JUNE 1979
ENCLOSURE No: 2
SCALE 1:500
LEGEND
CLAY/CLAYSTONE
SHALE
MARL-CALCAREOUS SHALE
SILTSTONE/SILT
F M C SAND
F M C SANDSTONE
CONGLOMERATE
VOLCANICS LAVAS/TUFFS
UNDIFFERENTIATED BASEMENT
NO SAMPLES
LIMESTONE
CHALK
DOLOMITE
SALT
ANHYDRITE
MEGAFOSSILS
CHERT
PYRITE
GLAUCONITE
SIDERITE
LIGNITE/COAL
PETROGRAPHICAL ANALYSIS
MICA
CORES
SIDEWALL CORES
P.S. POOR SAMPLES
Abundant
Common
Rare
PALYNOMORPHS IN CORES AND SIDEWALL CORES
BOUNDARIES
Definite
Uncertain
Unconformity
T.D. (Total depth)
Partial or interrupted sequence
FOSSILS AND ACCESSORY MINERALS
F.S.E. First sample examined
L.S.R. Last sample received
Depth
Lithology
Cores and Sidewall Cores
METRES
1600
Accessory Minerals
Microfauna
Fossils
Microflora
Kerogen
Palynological analyses
Significant faunal/floral events
Significant lithological horizons
Environment
N.P.D./I.G.S. Lithostratigraphic nomenclature
Stage
Epoch
Series
Era
Age
SEE STRATIGRAPHIC LOG ENCLOSURE 1
1:2000 FOR INTERVAL 310-1727 m
RHAETIAN
HETTANGIAN
SINEMURIAN-EARLY PLIENSBACHIAN
EARLY PLIENSBACHIAN
LATE PLIENSBACHIAN
EARLY TOARCIAN
EARLY-?MIDDLE
CAMPANIAN-MAASTRICHTIAN
LATE MAASTRICHTIAN
PALEOCENE
LATE
EARLY
MIDDLE
TRIASSIC
JURASSIC
CRETACEOUS
TERTIARY
MESOZOIC
CAINOZOIC
CLAYSTONE AND SANDSTONE

WELL 34/10-3
NORWEGIAN OFFSHORE
STRATIGRAPHIC LOG
SCALE 1:2000
STATOIL
PALEOSERVICES
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Lithology
Cores/Side-wall cores
Minerals
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Significant fauna/floral events
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CRETACEOUS
PALEOCENE
EOCENE
OLIGOCENE
PLIOCENE
PLEISTOCENE
QUATERNARY
TERTIARY
MESOZOIC
CAINOZOIC
LEGEND
JUNE 1979
632
1


STATOIL
WELL 34/10-3
NORWEGIAN OFFSHORE
STRATIGRAPHIC LOG
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SILTSTONE/SILT
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CHERT
PYRITE
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CHALK
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SALT
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SIDEWALL CORES
P.S. POOR SAMPLES
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Age
SEE STRATIGRAPHIC LOG ENCLOSURE 1
1:2000 FOR INTERVAL 310 - 1727 m
SINEMURIAN-EARLY PLIENSBACHIAN
EARLY PLIENSBACHIAN
LATE PLIENSBACHIAN
EARLY TOARCIAN
TOARCIAN-?EARLY BAJOCIAN (AALENIAN)
BAJOCIAN-EARLIEST BATHONIAN
CAMPANIAN-MAASTRICHTIAN
LATE MAASTRICHTIAN
PALEOCENE
TERTIARY
CAINOZOIC
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EARLY-?MIDDLE
MIDDLE
LATE
JURASSIC
CRETACEOUS
MESOZOIC