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STATOIL
WELL 34/10-13
(INTERVAL 1,500m-3,395m T.D.)
NORWEGIAN OFFSHORE
PALEONTOLOGICAL/
STRATIGRAPHICAL FINAL REPORT.

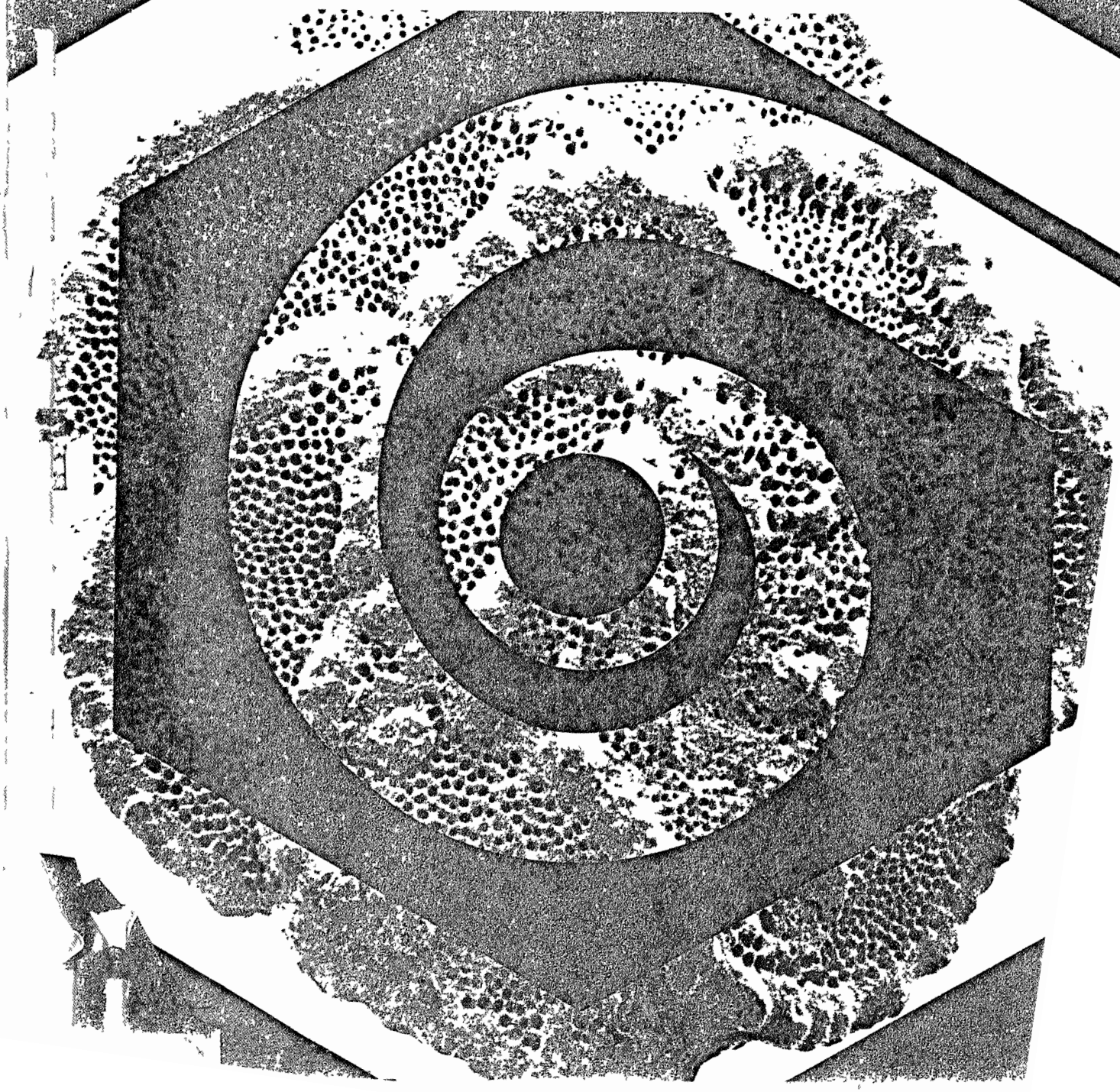

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Figure 1. Sedimentary History

Appendix: Lithological descriptions of core samples

Enclosure 1 Stratigraphic Log; 1,500m (F.S.E.) - 3,395m (T.D.) (Scale 1:500)

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STRATIGRAPHICAL CONSULTANTS

Client Company

STATOIL

Title

WELL 34/10-13

(INTERVAL 1,500m-3,395m T.D.)

NORWEGIAN OFFSHORE

PALEONTOLOGICAL/STRATIGRAPHICAL FINAL REPORT.

Project No

900

Stratigraphers

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R.W. MEYRICK.

MANAGING DIRECTOR DR V L ROVEDA (IT)

Date

March, 1982.

1. INTRODUCTION

This report presents the results of the stratigraphical and paleontological study of samples from Well 34/10-13, drilled by Statoil in the North Sea (Norwegian offshore) during 1981.

Conventional microfaunal and lithological analyses were carried out on ditch samples, collected at an average interval of 3m, from 1,500m-2,001m (total 158 samples). Lithological analysis of 75 samples between ca.2,046m and ca.3,381m have been carried out.

Twenty five core chips were received from cores 4-16 (1,945m-3,388m), and have been incorporated into this study.

Palynological analyses have been carried out on 109 samples between 1,797m and 3,395m (T.D.). These comprise 15 core samples and 94 ditch samples.

Petrophysical logs were provided by Statoil for the interval from 300m-3,391m, but in all cases the boundaries defined in this report are based solely on the samples examined.

The Stratigraphical Log (scale 1:500) is presented with this report (Encl.1) and a Sedimentary History diagram (Fig.1) is also included in the report.

2. CONCLUSIONS

1. The shallowest sample included in this study (1,500m-1,503m) is an Eocene claystone.

2. The Eocene section studied (1,500m-1,539m) comprises mainly claystone with agglutinating foraminiferids, deposited in a marine, outer sublittoral to bathyal environment.

3. The interval 1,539m-1,599m comprises tuffaceous claystone and is the North Sea 'Ash Marker' which is Early Eocene-Late Paleocene in age.

4. The Late-?Middle Paleocene comprises mainly claystone with occasional limestone beds (1,599m-1,713m). They contain common agglutinating foraminiferids typical of a marine, outer sublittoral to bathyal environment.

5. A sample gap exists between 1,713m-1,725m and as a consequence the exact Paleocene/Cretaceous boundary cannot be defined.

6. The Late-?Middle Paleocene sediments probably rest unconformably on those of Late Cretaceous (Maastrichtian-Campanian) age. There is no paleontological evidence for the presence of definite Middle or Early Paleocene sediments in this sequence and the topmost Late Cretaceous (Top Late Maastrichtian) is also possibly absent.

7. Only the upper part of the Late Cretaceous is present in this well and this comprises mainly claystone of Maastrichtian-Campanian age. Deposition was in a marine, outer sublittoral to bathyal environment. The faunas recorded suggest an environment influenced by oceanic circulation in the upper part of the section (1,725m-ca.1,755m) and a more restricted environment lower in the sequence is indicated by the sparser fauna (ca.1,755m-1,905m).

8. Late Cretaceous (Maastrichtian-Campanian) sediments unconformably overlie those of Early Jurassic (Pliensbachian-?Late Sinemurian) age at 1,905m.

   The lower part of the Shetland Group, the Cromer Knoll and Humber Groups, the Brent Formation and upper part of the Dunlin Formation are absent.

9. The Dunlin Formation (1,905m-1,926m) in this well comprises part of the Amundsen Member, consisting of claystone, siltstone and sand of Pliensbachian to possibly Late Sinemurian age. The absence of many of the fossils typical of the lower part of the Dunlin Formation suggests a possible hiatus between the Dunlin and Statfjord Formations. The Dunlin Formation was deposited in a marine, mainly inner sublittoral environment.

10. Undifferentiated Statfjord/Cormorant Formations occur between 1,926m and 3,395m (T.D.). They range in age from Early Jurassic to Late Triassic (Sinemurian-?Norian), with the top of the Rhaetian probably occurring within the Statfjord Formation. Regionally the Statfjord Formation is interpreted as representing deposition in marine and transitional (marine-continental) environments. Deposition of the "red bed" sequence, below ca.2,157m, took place in a continental, alluvial and fluvial, environment.

3. STRATIGRAPHICAL SUMMARY

Interval (F.S.E.)	Age	Thickness
1,500m - 1,539m	Eocene	39m
1,539m - 1,599m	Early Eocene-Late Paleocene	60m
1,599m - 1,713m	Late-?Middle Paleocene	114m
	UNCONFORMITY	
	(NOTE SAMPLE GAP 1,713m-1,725m)	
1,725m - 1,905m	Late Cretaceous; Maastrichtian-Campanian	180m
	UNCONFORMITY	
1,905m - 1,926m	Early Jurassic; Pliensbachian-?Late Sinemurian	21m
1,926m - 1,995.45m	Early Jurassic; Sinemurian-?Hettangian	69.45m
1,995.45m-2,811m	Early Jurassic-Late Triassic; Hettangian-Rhaetian	815.55m
2,811m - 3,395m (T.D.)	Late Triassic; Rhaetian-?Norian	584m

4. STRATIGRAPHY

This discussion supplements the information presented on the Stratigraphical Log (Encl. 1). The litho-stratigraphy and biostratigraphy are described and age and depositional environments interpreted.

4.1 1,500m (F.S.E.)-1,713m EOCENE-PALEOCENE

Lithostratigraphy:

1,500m-1,539m Claystone, green and pale grey; rare tuffaceous debris.

1,539m-1,599m Claystone and tuffaceous claystone, grey.

1,599m-ca.1,701m Claystone, light grey; occasional tuffaceous claystone is present in the upper part of this interval but it is probably caved from the overlying unit; siderite is common; below 1,675m beds of sand, fine-medium grained.

ca.1,701m-1,713m Claystone, light grey; occasional limestone, light grey; pyrite is common throughout, glauconite is present but rare.

Biostratigraphy:

1,500m-1,539m Eocene

This interval contains a diverse assemblage of foraminiferids, including both in-place and caved taxa. The dominant fauna comprises agglutinating foraminiferids, including Haplophragmoides walteri, Bolivinopsis spectabilis, Cyclammina amplectens and Rhabdammina discreta; this association is typical of the lower part of the Eocene in the northern North Sea. Radiolaria are common. The appearance of the planktic foraminiferid, 1,515m, Globigerina linaperta gr. characterises the Early Eocene in this area.

1,539m-1,599m Early Eocene-Late Paleocene

Common silicified and pyritized diatoms, including Coscinodiscus sp. 1 and C. sp. 2, characterize this interval, which is referred to the North Sea 'Ash Marker' and is of Early Eocene to Late Paleocene age.

1,599m-1,713m Late-?Middle Paleocene

The top of this interval is recognised by the reappearance downhole of common agglutinating foraminiferids including many of the taxa which were present in the Eocene, together with Hyperammina sp., Psammosphaera sp., Saccammina sp. and common Bolivinopsis spectabilis, Rhabdammina discreta, Ammodiscus glabratus and Haplophragmoides spp.

No fossils of definite Middle and Early Paleocene age are present.

Environment:

1,500m-1,539m Marine, outer sublittoral to bathyal. The fauna of agglutinating foraminiferids is typical of a 'deepwater' environment with restricted circulation near the sea-bed. The presence of radiolaria suggests 'open-marine' circulation in the upper part of the water column.

1,539m-1,599m Marine, sublittoral to bathyal, with contemporaneous volcanic activity.

1,599m-1,713m Marine, outer sublittoral to bathyal. The fauna of agglutinating foraminiferids is typical of a 'deepwater' environment with restricted circulation near the sea-bed.

4.2 1,713m-1,725m AGE INDETERMINATE

No samples received.

Remarks:

The sample gap, 1,713m-1,725m, obscures the exact position of the Paleocene-Cretaceous boundary but from regional evidence it is extremely unlikely that a complete sequence exists within this interval. The Late-?Middle Paleocene rests unconformably on the Late Cretaceous (Late Maastrichtian). The uppermost part of the Maastrichtian appears to be absent.

4.3 1,725m-1,905m LATE CRETACEOUS; Maastrichtian-Campanian

Lithostratigraphy:

Shetland Group

1,725m-1,905m Claystone, grey; thin beds of limestone, grey and light brown, common between 1,725m and ca.1,794m; pyrite common throughout, glauconite present but rare, siderite abundant below ca.1,893m.

Biostratigraphy:

Microfauna: The top of this interval is marked by the first downhole occurrence of Reussella szajnochae, a regionally consistent marker which "tops" in the lower part of the Late Maastrichtian. The apparent scarcity of the characteristic uppermost Maastrichtian fauna in this well may be due to the sample gap above 1,725m. Pseudotextularia elegans, the most important member of this fauna, is scarce below 1,725m, and it is possible that the flood of this taxon which usually occurs in the topmost Maastrichtian is missing between 1,713m-1,725m.

The presence of Pseudotextularia elegans, with Globigerinelloides messinae, Abathomphalus mayaroensis and Rugoglobigerina rugosa confirms the presence of at least part of the Late Maastrichtian in this well.

Below ca.1,755m calcareous foraminiferids become scarcer and agglutinating species more common. The fauna is sparse in the lowest part of the interval and there is no evidence of any of the regional faunal markers seen in nearby wells below the Campanian.

Microflora: No samples were examined from the upper part of this unit. Microfloras recorded at 1,797m (F.S.E.) and below are generally sparse and contain some Tertiary caving. Several long-ranging Early Tertiary-Late Cretaceous species are present, including the dinoflagellate cysts Palaeoperidinium pyrophorum (from 1,803m) and Spongodinium delitiense (from 1,833m). Other species which occur at 1,833m and below indicate an age not younger than Maastrichtian. These include the dinoflagellate cysts Diconodinium firmum, Spinidinium cf. clavum, Chlamydophorella nyei and Chattangiella spp. together with the pollen Orbiculapollis globosus (of Maastrichtian-Campanian age), Mancicorpus cf. senonicus and Aquilapollenites spp. The presence of the dinoflagellate cysts Hexagonifera chlamydata (at 1,875m) and of Odontochitina operculata (at 1,890m and below) indicates that the base of the interval, below 1,875m, is not younger than Campanian.

Environment:

Marine, outer sublittoral to bathyal. The association of calcareous planktic foraminiferids with calcareous and agglutinating benthic foraminiferids above ca.1,755m is typical of the influence of open sea

currents in the upper part of the water column and well oxygenated bottom conditions. The lower part of the interval (below ca.1,755m) with its sparsity of calcareous taxa and relative abundance of agglutinating taxa represents more restricted conditions at the sea-bed, and presumably carbonate dissolution.

Remarks:

Late Cretaceous (Maastrichtian-Campanian) sediments rest unconformably on the Early Jurassic (Pliensbachian-?Late Sinemurian) Dunlin Formation at 1,905m.

4.4 1,905m-1,926m EARLY JURASSIC; Pliensbachian-?Late Sinemurian

Lithostratigraphy:

Dunlin Formation

Amundsen Member

1,905m-ca.1,926m Interbedded claystone and siltstone, grey; abundant siderite, common pyrite.

ca.1,923m-1,926m As above, with sandstone, fine-medium grained, moderately well sorted, subangular-angular, clay matrix in part.

Biostratigraphy:

Microfauna: The top of this interval is taken at the first downhole occurrence of Dentalina matutina. Ogmoconchella transversa (1,914m), Ogmoconchella sp., Frondicularia terquemi, Sarcenaria sublaevis and Tristix sp. also occur in the interval. The downhole occurrence together of Ogmoconchella transversa and Dentalina matutina is typical of the lower part of the Late Pliensbachian regionally and

they range together into the Early Pliensbachian. The absence of a number of other regional faunal markers in the lower part of the Dunlin Formation suggests a possible hiatus between the Dunlin and Statfjord Formations at 1,926m.

Microflora: The two ditch samples examined from this interval contain assemblages dominated by Early Tertiary and Late Cretaceous caving. In-place species are rare and are mainly long-ranging Jurassic spores and pollen. The association of common Chasmatosporites spp. (at 1,905m) with Cerebropollenites thiergarti, and the paucity of trilete spores, is perhaps more characteristic of the Early than of the Middle Jurassic, but no age-restricted species are present.

Environment:

1,905m-1,926m Marine, ?littoral-sublittoral. These sediments were mainly deposited in a shallow marine environment. The sand at the base of the Dunlin Formation (1,923m-1,926m) is probably a transgressive unit.

4.5 1,926m-3,395m (T.D.) EARLY JURASSIC-LATE TRIASSIC; Sinemurian-?Norian

Lithostratigraphy:

Statfjord/Cormorant Formations

Lithologic descriptions of samples in this interval are based upon core samples (see Appendix) and selected cutting samples.

The Statfjord Formation is recognised by the downhole appearance of sand, "clean", subangular-angular, medium-coarse grained, poorly sorted, in the ditch cuttings sample 1,926m-1,929m.

ca.1,929m-ca.2,088m Sands (as above) interbedded with claystone, mid grey-brown, slightly silty, non-calcareous, micromicaceous, accessory pyrite. Siderite is abundant between ca.1,944m and ca.1,995m. Occasional beds of sandstone, white, fine-medium grained, subangular-angular, moderately well sorted, well consolidated, slightly calcareous matrix.

ca.2,088m-ca.2,157m Claystone, purple-red mottled, calcareous, micromicaceous, lignitic; siderite abundant in the upper part of the interval; occasional clean sands and grey siltstone beds.

ca.2,157m-ca.3,388.74m Claystone, dominantly brick red, calcareous-slightly calcareous, micromicaceous, pyritic; siderite rare, probably caved from interval above. Interbedded with grey-green-purple claystone and sandstone (ca.2,796m-ca.3,381m samples heavily contaminated with white drilling artifact).

Biostratigraphy:

1,926m-1,995.45m EARLY JURASSIC; Sinemurian-?Hettangian.

Microfauna: Occasional foraminiferids and ostracods occur throughout this interval but they are all presumed to be caved.

Microflora: Assemblages are generally sparse through this interval, in both core and ditch samples. They comprise long-ranging Mesozoic spores and pollen including Cyathidites spp., bisaccate pollen and Chasmatosporites sp. A reworked Triassic miospore, Triadispora sp., was recorded at 1,951.50m.

In the absence of age-restricted species a general Sinemurian-?Hettangian age is assigned to this interval, based on its stratigraphical position between better-dated units above and below.

1,995.45m-2,811m EARLY JURASSIC-LATE TRIASSIC; Hettangian-Rhaetian

Microfauna: Barren.

Microflora: The top of this interval is taken at the core sample at 1,995.45m which contains a rich and moderately diverse spore/pollen assemblage. The presence of Aratrisporites minimus and Trachysporites fuscus indicates an age not younger than Hettangian. Other longer-ranging species present include Quadraeculina anellaeformis (abundant) and Conbaculatisporites mesozoicus.

Ditch samples through the rest of this interval contain only very sparse microfloras, mainly consisting of long-ranging spores and pollen with only rare specimens of more age-restricted taxa. The latter include Trachysporites fuscus, T. asper and Aratrisporites minimus (Hettangian and older) and other species more characteristic of the Early Jurassic-Rhaetian such as Calamospora mesozoica/tener, Conbaculatisporites mesozoicus, Cerebropollenites thiergarti, Nevesisporites bigranulatus and cf. Carnisporites spiniger.

The first downhole appearance of Ovalipollis ovalis is at 2,205m. This species is typical of the Rhaetian, although it is known to range up into the Hettangian. A Rhaetian age is therefore possible from 2,205m (and below) but the evidence is inconclusive and the whole interval is dated as undifferentiated Hettangian-Rhaetian.

2,811m-3,395m (T.D.) LATE TRIASSIC; Rhaetian-?Norian.

Microfauna: Barren.

Microflora: The presence of Granuloperculatipollis rudis at 2,811m, and its association below that depth with consistent Ovalipollis ovalis, indicates the penetration of sediments definitely not younger than Rhaetian and possibly Early Rhaetian in age. Other species present include Uvaesporites sanguinolentiformis and Carnisporites anteriscus, both of which range through the Hettangian and Rhaetian.

Assemblages are very sparse below 2,910m and mainly comprise long-ranging spores/pollen. Both of the core samples at 3,379.20m and 3,388.65m are barren, although the ditch sample at 3,375m contains Granuloperculatipollis rudis which, if in place and not caved, indicates an age not older than Norian at that depth. However, no restricted Early Rhaetian or Norian taxa were recorded in this sequence and it is possible that the whole interval could be Rhaetian (undifferentiated) in age. In the absence of more positive evidence the interval is assigned a Rhaetian-?Norian age.

Environment:

1,926m-ca.2,088m Marine, "nearshore", littoral-inner sublittoral with transitional "non-marine" claystones.

ca.2,088m-ca.2,157m Transitional, continental-marine, including alluvial and fluvial deposits.

ca.2,157m-3,388.74m Continental, mainly alluvial and fluvial "red beds".

APPENDIX

Lithological descriptions of core samples.

Core 4
1,945.60m-1,945.63m

Claystone, mid grey, silty, non-calcareous, micro-micaceous, irregular laminae of lignite; accessory pyrite.

Core 4
1,951.50m-1,951.53m

Claystone, dark grey-black, highly lignitic, slickensides developed, non-calcareous.

Core 6
1,964.70m-1,964.73m

Claystone, dark grey-brown, non-calcareous, micro-micaceous.

Core 6
1,966.40m-1,966.43m

Claystone, dark grey-brown, non-calcareous, micro-micaceous, irregular laminae of fine grained brown sand.

Core 6
1,972.58m-1,972.62m

Sandstone, fine grained, subangular to angular, well sorted, moderately well consolidated, non-calcareous matrix; laminae of grey more micaceous sand, brown, highly micaceous (some biotite) accessory lignite.

Core 7
1,976.50m-1,976.54m

Claystone, dark grey-brown, non-calcareous, micromicaceous.

Core 7
1,979.50m-1,979.54m

Sandstone, coarse grained, subangular to angular, moderately sorted, well consolidated with calcareous matrix, light grey, accessory lignite, and pyrite.

Core 7
1.980.01m-1,980.06m

Sandstone, medium grained, subangular to angular, well sorted, well consolidated, slightly calcareous matrix, light brown, accessory mica.

Core 7
1,986.90m-1,986.94m

Claystone, dark grey, non-calcareous, micromicaceous, accessory pyrite.

Core 8
1,989.30m-1,989.34m

Claystone, light grey, non-calcareous, micromicaceous, accessory pyrite.

Core 8
1,993.97m-1,994.00m

Sandstone, medium grained, subangular grains, moderately well sorted, moderately well cemented, slightly calcareous matrix, light brown.

Core 8
1,995.46m-1,995.50m

Claystone, very dark grey-black, non-calcareous, accessory pyrite.

Core 9
2,007.05m-2,007.09m

Sandstone, medium grained, subangular to angular, moderately well sorted, very well consolidated, calcareous matrix, very light grey-buff.

Core 9
2,009.70m-2,009.74m

Claystone, dark grey-brown, shaley, slicken-sides, non-calcareous, micromicaceous, accessory pyrite.

Core 10
2,013.13m-2,013.17m

Sandstone, medium-coarse grained, rounded to subangular grains, moderately well sorted, poorly consolidated, non-calcareous cement, mid-brown, accessory lignite.

Core 11
2,023.50m-2,023.54m

Sandstone, fine grained, subangular to angular grains, well sorted, well consolidated, calcareous matrix, light grey, micromicaceous.

Core 11
2,028.73m-2,028.78m

Sandstone, fine-coarse grained, grains subangular to angular, poorly sorted, moderately well consolidated, non-calcareous matrix, mid-brown.

Core 12
2,035.40m-2,035.44m

Claystone, dark grey-brown, non-calcareous, occasional irregular silty laminae, buff, micromicaceous.

Core 13
2,055.40m-2,055.44m

Claystone, mottled mid-grey and red, non-fissile, irregularly silty, slicken-sides, non-calcareous, micromicaceous.

Core 14
2,074.80m-2,074.84m

Sandstone, medium grained, subangular to angular grains, moderately well sorted, very well consolidated, calcareous matrix, light grey, micromicaceous.

Core 15
2,080.30m-2,080.34m

Claystone, brick red to brown, non-fissile, irregularly sandy, non-calcareous, micromicaceous.

Core 15
2,084.16m-2,084.20m

Sandstone, fine grained, rounded to subangular, well consolidated, slightly calcareous matrix, light grey, micromicaceous.

Core 16
3,379.20m-3,379.25m

Siltstone, purple to grey, slightly calcareous, micromicaceous.

Core 16
3,381.97m-3,381.03m

Sandstone, fine-grained, rounded to subangular grains, well sorted, well consolidated, non-calcareous matrix, dark purple to grey, micro-micaceous.

Core 16
3,388.65m-3,388.74m

Sandstone, fine to medium grained, subangular to angular grains, moderately well sorted, well consolidated calcareous matrix, orange to brown, occasional irregular dark brown silty patches, micromicaceous.

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OPERATOR

DATE

SEARCH 1982

PAGE

WELL 34/10 -13

NORWEGIAN OFFSHORE

Block 34/10 Quadrant 34

Revised version 1981 - 1984 a.b.

STRATIGRAPHIC LOG

SCALE 1 : 1000

PALEOSERVICES
Well Logging Data for Geologists and Engineers

LEGEND

Wells
Cores
Cuttings
Sidewall cores
Fluid shows
Oil
Gas
Water
Core recovery

SEDIMENTARY HISTORY©

CLIENT: STATOIL

WELL NO: 34/10-13. NORWEGIAN OFFSHORE

FIGURE: 1 | DATE: MARCH 1982

PROJECT NO: 900 | ANALYST: R.W.M., C.A.B., L.O.A.

PALEOSERVICES
Unit 15 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
- Transgressive unit

* Vail et al. 1980

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
PLIOCENE
5
10 MIOCENE
15
20
25 OLIGOCENE
30
35
40
45 EOCENE
50
55 PALEOCENE
60
65 MAASTRICHTIAN
70
75 CAMPANIAN
80 SANTONIAN
85 CONIACIAN
90 TURONIAN
95 CENOMANIAN
100
105 ALBIAN
110 APTIAN
115 BARREMIAN
120
125 HAUTERIVIAN
130 VALANGINIAN
135 BERRIASIAN
RYAZAN
PORTLANDIAN
140 KIMMERIDGIAN
145 OXFORDIAN
150
155 CALLOVIAN
160 BATHONIAN
165
170 BAJOCIAN
AALENIAN
175
180 TOARCIAN
PLIENSBACHIAN
185 SINEMURIAN
190 HETTANGIAN
195 RHAETIAN
200 NORIAN

* Present sea level.

Bolivinopsis spectabilis
Coscinodiscus sp. 1.
Reuseila szajnochae
Hexagonifera chlamydata
Granulopercullatipollis rudis consistent Ovalipollis ovalis
Trachysporites fuscus
Aratrisporites minimus
Dentalina matutina
No in-place microfauna

SECTION ABOVE 1500m NOT STUDIED.

1500
1539
1599
1713
(SAMPLE GAP 1713m-1725m)
1725
1905
Ca 100-105 mys.
POSSIBLE HIATUS
RED BEDS
AMUNDSEN
DUNLIN
CORMORANT/STATFJORD
1905
1926
?2157
3395 T.D.