PALEONTOLOGICAL STUDY OF THE STATOIL 34/10-6

OFFSHORE NORWAY WELL

By

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INTRODUCTION

Paleontological studies were carried out on the Statoil 34/10-6 well from 1762m to 2362m, to verify and eventually polish up Paleoservices interpretation.

For the palynological studies, we used mainly slides borrowed from Paleoservices, although two samples were also processed at EPR-E. Palynological quantitative data are based exclusively on sidewall core samples, but cutting samples provided additional qualitative information.

Nannofossil, foraminifer and ostracode studies are based on samples prepared at EPR-E. The list of the samples studied at EPR-E is given in the appendix.

Our studies support the following stratigraphic interpretation:

TOP (m)	AGE
1762	Late Maastrichtian
1888	Early Maastrichtian - Late Campanian
1990	Barremian - Hauterivian
1996	Bathonian
2132	Early Bathonian
2269	Early Bajocian (Aalenian)
2287	Early Bajocian (Aalenian) to Late Toarcian
2362 (T.D.)	still in Early Bajocian (Aalenian) to Late Toarcian

STRATIGRAPHY

CRETACEOUS 1762m - 1993m

LATE MAASTRICHTIAN: 1762m - 1876m

Foraminifera:

At 1762m, the top of Maastrichtian is characterized by the presence of *Heterohelix globulosa, H. glabrans* and *Globigerinelloides multispina.*

At 1783m, *Globotruncana contusa, G. havanensis, G. arca* and *Rugoglobigerina* ex. gr. *rugosa* are observed.

Nannofossils:

At 1771m, *Nephrolithus frequens, Arkhangelskiella cymbiformis, Eiffellithus turriseiffeli, Kamptnerius magnificus* and *Cribrosphaerella ehrenbergi* confirm a Late Maastrichtian age for this interval.

From 1846m, the coccoliths are very scarce or absent.

EARLY MAASTRICHTIAN - LATE CAMPANIAN: 1888m - 1981m

Nannofossils:

The association of *Arkhangelskiella cymbiformis* and *Reinhardtites anthophorus* at 1888m indicates an Early Maastrichtian to Late Campanian age.

Foraminifera:

Globigerinelloides multispina, Rugoglobigerina ex. gr. *rugosa, Globotruncana havanensis* and *Heterohelix* spp. are the most important species present in this unit.

BARREMIAN - HAUTERIVIAN: 1990m - 1993m

Foraminifera and Ostracodes:

At 1990m, *Vidalina* sp., *Uvigerinammina* sp., *Patellina subcretacea*, *Conorotalites intercedens* and *Dorothia* aff. *kummi* are present. The ostracodes *Pontocyprella* sp., *Bairdia* sp. and *Cardobairdia* are also observed.

At 1993m, *Gavelinella barremiana*, *Dorothia subtrochus*, *Trocholina* sp., *Spirillina* sp., *Lenticulina* aff. *heiermanni*, *Conorotalites sigmoicosta* and the ostracode *Cytheropteron* cf. *reightonensis* are observed. These forms suggest a Barremian - Hauterivian age.

Nannofossils:

The samples contain caved coccoliths.

JURASSIC: 1996m - 2362m

BATHONIAN: 1996m - 2125m

The uppermost sample from this interval contains a rather rich palynological assemblage, including several dinoflagellate species not observed above the Dogger, such as *Hystrichogonyaulax regalis*, *H. pectinigera* and *Pareodinia evittii*. Among the terrestrial palynomorphs, *Quadraeculina anellaeformis* has been identified. This palynological assemblage points out to a Bathonian age.

Between 2050m and 2116m, dinoflagellates are relatively scarce in the 9 sidewall core samples studied. *Nannoceratopsis gracilis* has not been observed, and is also lacking in the cutting sample from 2119m - 2125m.

From 1996m to 2074m, *Cerebropollenites mesozoicus* is abundant, representing 27 to 39 % of the palynological assemblage.

EARLY BATHONIAN - BAJOCIAN: 2132m - 2260m

The sidewall core at 2132m contains rare specimens of *Nannoceratopsis gracilis*. This dinoflagellate marker does not occur above the Early Bathonian.

Between 2141m and 2231m, the sidewall cores do not contain marine microplankton and terrestrial palynomorphs are absent or very rare.

A similar, almost barren interval has been observed in the 34/10-4 well, between 1826m and 1896m, and in the 34/10-5 well, between 2054m and 2115m.

EARLY BAJOCIAN (AALENIAN): 2269m - 2281m

While *Nannoceratopsis gracilis* is lacking in the cutting sample from 2254 - 2260m, it dominates the microplankton assemblage in the sidewall core at 2269m. An Early Bajocian (Aalenian) age is very likely. A similar dominance of *Nannoceratopsis gracilis* has been observed between 1902.7m and 1912m in the 34/10-4 well, and at 2142m in the 34/10-5 well.

EARLY BAJOCIAN (AALENIAN) TO LATE TOARCIAN: 2287m - 2362m (T.D.)

The three sidewall cores at 2287m, 2300m and 2345m contain numerous small dinoflagellates. Some of these forms have been recently described by BJAERKE, who observed them in the Toarcian from Spitzbergen. They include *Moesiodinium raileanui*, present in the three sidewall cores studied. This very characteristic microplankton assemblage has been observed in the 34/10-4 well, where it has its top at 1938m, and in the 34/10-5 well, where it has been observed first at 2166m. This correlation is supported by the presence at 2296m, 2302m and 2323m of the ostracode marker *Camptocythere parvula*, identified in a similar stratigraphic position in the 34/10-4 and 34/10-5 wells.

The ostracode genus *Praefuhrbergiella* has been identified at 2323m. This genus has not been observed so far below the Early Bajocian (Aalenian).

At 2345m, the dinoflagellate marker species *Nannoceratopsis triceras* has been identified. It has been observed at 1973m in the 34/10-4 well, at 2215m and 2230m in the 34/10-5 well.

The precise age of the 2287 to 2362m interval remains somewhat uncertain. The recorded dinoflagellates have been observed so far in the Toarcian, while the ostracodes tend to support an Early Bajocian (Aalenian) age. Until additional data permit to determine the precise range of both groups of microfossils, we will continue to date this interval as Early Bajocian (Aalenian) to Toarcian.

The Early Toarcian ostracode marker *Ektyphocythere intrepida* has not been observed, and the dominance of small sphaeromorphs characterizing locally the Early Toarcian does not occur in the deepest cutting sample examined at 2355 - 2362m; we believe therefore than the Early Toarcian has not been penetrated.

COMPARISONS BETWEEN EPR-E AND PALEOSERVICES

BIOSTRATIGRAPHIC INTERPRETATION ON STATOIL 34/10-6

(See attached paleolog)

CRETACEOUS

EPR-E agrees with Paleoservices in attributing to the Late Maastrichtian the first sample we examined, at 1762m. Paleoservices places the upper limit of its Maastrichtian - ?Campanian unit at 1792m, based on the first occurrence of *Reussella szajnochae*, but points out that this regional marker lie within the lower part of the Late Maastrichtian. At EPR-E, we place the top of our Early Maastrichtian - Late Campanian unit at 1888m, where *Arkhangelskiella cymbiformis* is associated with *Reinhardtites anthophorus*.

Both Paleoservices and EPR-E have identified Early Cretaceous microfaunas between 1990m and 1993m. Paleoservices attributes this horizon to the Hauterivian - ?Valanginian, EPR-E to the Barremian-Hauterivian.

JURASSIC

The main discrepancy between EPR-E and Paleoservices stratigraphic interpretations concerns the dating of the SWC at 1996m. Paleoservices lists several generally long ranging dinoflagellate species and the radiolarian *Dictyomitra* sp. In the absence of Earliest Kimmeridgian or Late Oxfordian dinoflagellate markers, they attribute this horizon to the Kimmeridgian.

EPR-E, on the other hand, has identified in the same palynological slide several Middle Jurassic dinoflagellates and *Quadraeculina anellaeformis*, not observed so far above the Bathonian. We attribute, therefore, to the Bathonian the SWC at 1996m.

There is a complete agreement on the top of the Early Bathonian, based on the top occurrence of rare specimens of *Nannoceratopsis gracilis*, and on the top of the Early Bajocian (Aalenian), based on the relative abundance of the same dinoflagellate species. There is no real discrepancy on the top of the next unit, attributed to the Early Bajocian - Toarcian. Both Paleoservices and EPR-E observe the top occurrence of several dinoflagellate taxa at 2287m, but, using mainly lithologic criteria, Paleoservices places the top of this unit slightly higher, at 2275m.

APPENDIX

LIST OF SAMPLES STUDIED FOR PALYNOLOGY

E: processed by EPR-E; all other samples: slides loaned by Paleoservices)

	DEPTH (m)	
Cutt.	1990	E
SWC	1992	
Cutt.	1993	E
SWC	1996	
Cutt.	1999-2002	
"	2005-11	
"	2020-26	
"	2032-38	
SWC	2050	
Cutt.	2056-59	
SWC	2068	
Cutt.	2068-71	
SWC	2074	
"	2077	
"	2081	
"	2086	
"	2095	
"	2106	
"	2116	
Cutt.	2119-25	
SWC	2132	
SWC	2141	
Cutt.	2149-55	
"	2161-67	
"	2176-82	
"	2191-97	
SWC	2205	
"	2212	
Cutt.	2218-24	
SWC	2231	
Cutt.	2239-45	
"	2254-60	
SWC	2269	
Cutt.	2278-81	
SWC	2287	
"	2300	
Cutt.	2302-08	
"	2314-20	
"	2329-35	
"	2344-50	
SWC	2345	
Cutt.	2355-62	

LIST OF SAMPLES STUDIED FOR MICROPALEONTOLOGY

(Processed at EPR-E)

(M: Foraminifer and/or Ostracode, C: Coccolith)

	DEPTH (m)	
Cutt.	1762	M-C
"	1771	C
"	1783	M-C
"	1804	M-C
"	1825	M-C
"	1846	M-C
"	1867	M-C
"	1876	C
"	1888	M-C
"	1909	M-C
"	1930	M-C
"	1951	M-C
"	1960	M
"	1972	M-C
"	1981	M
"	1990	M-C
"	1993	M-C

	DEPTH (m)	
Cutt.	2251	M
"	2260	M
"	2272	M
"	2287	M
"	2296	M
"	2302	M
"	2308	M
"	2314	M
"	2320	M
"	2323	M
"	2329	M
"	2335	M
"	2341	M
"	2344	M
"	2350	M
"	2356	M
"	2359	M
"	2362	M

MEM:JPC:MP:cm
OCTOBER 1980

STATOIL 34/10-6

LOG 1

SCALE : 1/2000

PREPARED BY M.E. MILLIOUD, J.P. COLIN, M. PONS
EPR-E (BORDEAUX) October 1980

METERS	EPR-E	PALEOSERVICES	REMARKS
1700			
	1762	1762	1762 *Heterohelix globulosa, H. glabrans Globigerinelloides multispina*
	LATE MAASTRICHTIAN	LATE MAASTRICHTIAN	1771 *Nephrolithus frequens, Arkhangelskiella cymbiformis*
		1792	1783 *Globotruncana contusa Gl. havanensis*
1800	LATE MAASTRICHTIAN	MAASTRICHTIAN	
	1888	—	1888 *Arkhangelskiella cymbiformis* associated with *Reinhardtites anthophorus*
1900	EARLY MAASTRICHTIAN	CAMPANIAN	
	—		
	LATE CAMPANIAN		
	1990 EARLY CRETACEOUS BARREMIAN - HAUTERIVIAN	1990 EARLY CRETACEOUS HAUTERIVIAN-?VALANGINIAN	1990 *Uvigerinammina sp., Conorotalites intercedens* 1993 *Cytheropteron cf. reightonensis*
2000	1996	1996 KIMMERIDGIAN 1999	1996 *Hystrichogonyaulax regalis, Quadraeculina anellaeformis*
	BATHONIAN	BATHONIAN	
2100			
	2132	2132	2132 *Top Nannoceratopsis gracilis*
	EARLY BATHONIAN	EARLIEST BATHONIAN	
	—	—	
2200	BAJOCIAN	BAJOCIAN	
	2269	2269 EARLY BAJOCIAN (AALENIAN)	2269 *Nannoceratopsis gracilis (abundant)*
	EARLY BAJOCIAN (AALENIAN) 2287	2275	2287 *Moesiodinium raileanui, Camptocythere cf. gracilis*
2300	EARLY BAJOCIAN (AALENIAN)	EARLY BAJOCIAN (AALENIAN)	2296 *Camptocythere parvula*
	—	—	2323 *Praefuhrbergiella sp.*
	TOARCIAN	TOARCIAN	2345 *Nannoceratopsis triceras*
	2362	2362	2362 T.D.

STATOIL 34/10-6

JURASSIC MICROPLANKTON AND POLLEN - SPORES DISTRIBUTION CHART

Prepared by M.E. MILLIOUD EPR-E (Bordeaux) october 1980

DEPTH (meters)

SAMPLES STUDIED

MARINE MICROPLANKTON / POLLEN-SPORIES RATIOS (Marine / Microplankton)

SPECIES

MARINE MICROPLANKTON

- Sirmiodinium cf. grossii
- Hystrichogonyaulax cf. cornigera
- Hystrichogonyaulax pectinigera
- Hystrichogonyaulax regalis
- Pareodinia ceratophora
- Pareodinia evittii
- Parvocysta sp. B in Bjaerke
- Chythroeisphaeridia pocockii
- Chythroeisphaeridia spp.
- Ctenidodinium cf. kettonense
- Nannoceratopsis gracilis
- Nannoceratopsis gracilis sbsp. A
- Nannoceratopsis senex
- Nannoceratopsis cf. spiculata
- Leiofusa jurassica
- Micrhystridium spp.
- Veryhachium spp.
- Parvocysta barbata (N-101)
- Dino N-102
- Nannoceratopsis ambonis
- Fromea elongata
- Dino type 2 in Thusu
- Moesiodinium raileanui
- ?Parvocysta cracens
- Parvocysta cf. contracta
- Facetodinium faustum
- Pterospermopsis spp.
- Nannoceratopsis triceras
- Luehndea spinosa
- Scriniocassis weberi

POLLEN-SPORES

- Alisporites spp.
- Classopollis spp.
- Deltoidospora spp.
- Osmundacidites wellmanii
- Cerebropollenites mesozoicus
- Vitreisporites pallidus
- Podocarpidites spp.
- Quadraeculina anellaeformis
- Chasmatosporites spp.
- Lycopodiumsporites austroclavidites
- Lycopodiumsporites spp.
- Tripartina variabilis
- Callialasporites dampieri
- Cerebropollenites thiergartii
- Neoraistrickia truncata
- Chomotriletes sp.
- Corrugatisporites amplectiformis
- Rugalskaisporites cicatricosus
- Kraeuselisporites reissingeri
- Clavatisporites hughesii
- Stereisporites aulosonensis
- Ceratosporites spinosus
- Deltoidospora juncta
- Leptolepidites equatibossus
- Leptolepidites rotundus
- Inaperturopollenites spp.

DEPTH (meters)	SAMPLES STUDIED
2000	1992
	1995
	1999-01
	2005-11
	2020-26
	2032-38
	2050
	2056-59
	2068
	2074
	2077
	2081
	2086
2100	2095
	2106
	2116
	2119-25
	2132
	2141
	2149-55
	2161-67
	2176-82
2200	2191-97
	2205
	2212
	2218-24
	2231
	2239-45
	2254-60
	2269
	2278-81
	2281
2300	2300
	2302-08
	2314-20
	2329-35
	2344-50
	2345
	2355-62
	2362
	T.D.

Present, no quantitative data

\+ < 4 %

* 4 - 10 %

▲ 11 - 25 %

• > 25 %

DISTRIBUTION CHART OF CALCAREOUS MICROFOSSILS IN 34/10-6

Prepared by J.P. COLIN and M.PONS EPR-E (Bordeaux) october 1980

DEPTH (Meters)

2400 2300 2200 2100 2000 1900 1800

T.D. 2362 2359 2356 2350 2344 2341 2335 2329 2323 2320 2314 2308 2302 2296 2287 2272 2660 2251 1993 1990 1981 1972 1960 1951 1930 1909 1888 1876 1867 1846 1825 1804 1783 1771 1762

SAMPLES STUDIED / SPECIES

NANNOFOSSILS

Nephrolithus frequens
Arkhangelskiella cymbiformis
Cribrosphaerella ehrenbergi
Kamptnerius magnificus
Micula staurophora
Predicosphaera cretacea
Zygodiscus spiralis
Eiffellithus turriseiffeli
Lucianorhabdus cayeuxi
Chiastozygus litterarius
Biscutum sp.
Cretarhabdus crenulatus
Glaukolithus diplogrammus
Glaukolithus sp.
Braarudosphaera bigelowi
Biscutum testudinarium
Glaukolithus compactus
Ahmuellerella octoradiata
Lithastrinus sp.
Predicosphaera spinosa
Eiffellithus anceps
Microrhabdulus stradneri
Rhabdolithina splendens
Watznaueria barnesae
Reinhardtites anthophorus
Staurolithites bochotnicae

FORAMINIFERA

Heterohelix globulosa
Heterohelix glabrans
Globigerinelloides multispina
Globotruncana contusa
Globotruncana arca
Globotruncana havanensis
Globigerinelloides spp.
Rugoglobigerina ex. gr. rugosa
Hedbergella spp.
Globorotalites sp.
Pseudotextularia elegans
Reussella szajnochae szajnochae
Heterohelix spp.
Rugoglobigerina subpetaloidea
Bathysiphon sp.
Ammodiscus sp.
Globigerinelloides messinae
Gyroidinoides sp.
Globigerinelloides asper
Globotruncana sp.
Marginulina sp.
Trochammina sp.
Kalamopsis grzybowskii
Karreriella aff. aegra
Textularia sp.
Dorothia spp.
Conorotalites intercedens
Polymorphinids
Vidalina sp.
Patellina subcretacea
Patellina sp.
Dorothia kummi
Migros textilarioides
Glomospira sp.
Lenticulina spp.
Uvigerinammina sp.
Trocholina sp.
Gavelinella barremiana
Gavelinella sp.
Dorothia subtrochus
Spirillina spp.
Lenticulina aff. heiermanni
Nodosaria sp.
Trochammina sp.
Trochammina topagorukensis
Lenticulina sp.
Haplophragmoides sp.
Ammobaculites sp.
Nodosaria vulgata
Nodosaria dispar
Ammodiscus asper
Verneuilinoides mauritii
Citharina sp.
Dentalina sp.
Eugottulina liassica
Nodosaria claviformis

OSTRACODES

Cytherella sp.
Pontocyprella sp.
Bairdia sp.
Cardobairdia sp.
Paracypris sp.
Cytheropteron cf. reightonensis
Monoceratina sp.
Camptocythere cf. gracilis
Saxellacythere sp.
Camptocythere parvula
Ostracoda sp. 5 Plumhoff
Praefuhrbergiella sp.
Ostracoda sp. 2 Plumhoff