PALEONTOLOGICAL STUDY OF THE STATOIL 34/10-3 OFFSHORE NORWAY WELL

By

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INTRODUCTION

Paleontological studies were carried out on the Statoil 34/10-3 well from 1748m to 2802m with the purpose of verifying and eventually polishing up Paleoservices stratigraphic interpretation.

As well as material processed at EPR-E, we used slides loaned from Paleoservices Laboratory to carry out Palynological and Micropaleontological studies.

The list of the samples examined at EPR-E is given in the appendix.

Our studies support the following stratigraphic interpretation:

TOP (m)	AGE	
1748	Late Maastrichtian	CRETACEOUS
1784	Early Maastrichtian	
1823	Early Maastrichtian-Late Campanian	
1892	Albian-Aptian	
1895	Early Bathonian	JURASSIC
1914.8	Bajocian	
2095	Toarcian	
2170	Pliensbachian	
2471.7	Sinemurian	
2581	Hettangian	
2660	Rhaetian	

STRATIGRAPHY

CRETACEOUS 1748m - 1892m

LATE MAASTRICHTIAN 1748m - 1781m

Foraminifera:

At 1748m, the top of Maastrichtian is characterized by the presence of *Globotruncana contusa*, *Pseudotextularia elegans*, *Heterohelix globulosa* and *Globigerinelloides multispina*.

At 1762m, *Abathomphalus mayaroensis*, *Globotruncana arca* and *Rugoglobigerina* ex. gr. *rugosa* are observed.

Nannofossils:

At 1748m, appear *Arkhangelskiella cymbiformis* and *Micula staurophora*. *Nephrolithus frequens* is observed from 1754m down.

EARLY MAASTRICHTIAN 1784m - 1814m

The presence of *Arkhangelskiella cymbiformis* without *Nephrolithus frequens* suggests an Early Maastrichtian age.

EARLY MAASTRICHTIAN - LATE CAMPANIAN 1823m - 1889m

Nannofossils:

The association of *Arkhangelskiella cymbiformis* and *Reinhardtites* sp. aff. *anthophorus* at 1823m and the presence of *Reinhardtites anthophorus* at 1844m indicate a Maastrichtian to Late Campanian interval.

Foraminifera:

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

In this interval, nannofossils and foraminifera become rare from 1874m.

ALBIAN-APTIAN 1892m

The presence of *Glomospira* sp., *Textularia* sp. and *Patellina subcretacea* indicate an Albian-Aptian age.

JURASSIC 1895m - 2645.5m

EARLY BATHONIAN 1895m - 1908.6m

All the samples from this interval contain a strictly terrestrial association. Among the miospores encountered were: *Classopollis classoides, Cerebropollenites mesozoicus, Perinopollenites elatoides, Quadraeculina anellaeformis* and *Densoisporites velatus*. None of these microfossils are age restricted; they are commonly found in deposits of Bathonian or Bajocian age. We give an Early Bathonian age to this interval, due to the top occurrence in a core of *Nannoceratopsis gracilis* at 1914.8m, indicating the upper limit of Bajocian deposits.

BAJOCIAN 1914.8m - 2085.5m

The top occurrence of *Nannoceratopsis gracilis* at 1914.8m indicates the upper limit of Bajocian deposits. Consecutive core samples downwards contain the same terrestrial microflora as in the Bathonian sediments. *Callialasporites dampieri, C. trilobatus, Klukisporites variegatus, Contignisporites problematicus, Neoraistrickia gristhorpensis* and *Cyathidites australis* are the most common sporomorphs. Sporadic occurrences of *Nannoceratopsis* spp., are observed within this interval. *Nannoceratopsis senex* is present from 1920m down and becomes as frequent as *N. gracilis* from 2075m down.

TOARCIAN 2095m - 2150m

It's somewhat difficult to give a precise date to this interval. *Coronatispora valdensis*, whose base occurrence is considered as representing a Late Toarcian age, is still present here. It is worth to not that the top of the Dunlin Formation is situated at 2095m. The ostracods *Polycope plumhoffi* and *Camptocythere* cf. *toarciana*, indicative of a Toarcian to Aalenian age, are reported at 2105m, 2125m and 2165m. *Nannoceratopsis gracilis* and *N. senex* are well represented, but the dominance of the later over the former is not fully convincing; we, however, decided to place the top of the Toarcian at 2095m.

PLIENSBACHIAN 2170m - 2467.2m

The first downhole appearance of *Mancodinium semitabulatum, Tectatodinium gochti* and *Fromea elongata* indicates that Pliensbachian sediments are encountered. At 2189m, the association of *Camptocythere* cf. *toarciana* and *Ektyphocythere intrepida*, indicative of a Toarcian age, is reported; but this observation is issued from a ditch cutting sample and could easily represent a caved occurrence.

The first downhole occurrence of *Cerebropollenites thiergartii* associated with *Mancodinium semitabulatum* confirms the presence of sediments of Pliensbachian age. Representatives of the *Nannoceratopsis* group are still present; this group has its base within the Pliensbachian. The ostracods *Trachycythere tubulosa, Lophodentina tricostata, Ogmoconcha aequalis* and *Ogmoconchella* sp., indicative of a Late Pliensbachian age, are reported at 2294m. At 2344m, *Ogmoconchella* sp., *Liasina vestibulifera* and *Nanacythere* sp. 4322 Michelsen give the same age. *Wicherella semiora, Ogmoconcha contractula, Ogmoconchella* sp. and *Pseudohealdia truncata* with rare *Ogmoconchella transversa* give at 2390m the base of the Late Pliensbachian; *Wicherella semiora* is the marker index in this association. *Ogmoconchella transversa, Gammacythere ubiquita, Pseudohealdia truncata* and *Ogmoconchella bispinosa* indicate at 2414m an Early Pliensbachian age; *Gammacythere ubiquita* is the marker index in this association. The presences, at 2444m, and 2450m of *Ogmoconcha amalthei amalthei* and *Ogmoconchella danica* respectively, indicate that Early Pliensbachian strata are still present. It appears that the Late Pliensbachian section is thicker than the Early Pliensbachian interval.

SINEMURIAN 2471.7m - 2564m

Presence of *Kraeuselisporites reissingeri* and absence of representatives of the *Nannoceratopsis* group from 2471.7m down indicate the top of the Sinemurian. *Cerebropollenites thiergartii* and *C. mesozoicus* are still present. Long ranging sporomorphs represent the bulk of the microfloral associations; among them are *Quadraeculina anellaeformis, Contignisporites problematicus, Araucariacites australis* and *Classopollis classoides.*

The ostracod *Cristacythere*? sp. at 2475m indicates a Hettangian to Late Sinemurian age.

HETTANGIAN 2581m - 2645.5m

Presence of *Kraeuselisporites reissingeri* associated with *Cerebropollenites thiergartii* and absence of *Cerebropollenites mesozoicus* are indicative of Hettangian strata. *Chasmatosporites apertus* and undifferentiated Disaccate pollen grains are the main components of the associations encountered within this interval.

RHAETIAN 2660m - 2802m (T.D.)

At 2660m, the appearance of *Ricciisporites tuberculatus* and the absence of *Cerebropollenites thiergartii* indicate the top of the Rhaetian. *Classopollis classoides* and undifferentiated Disaccate pollen grains are still abundant and represent the main fraction of the association. At 2752m and 2769m, *Ovalipollis ovalis, Rhaetipollis germanicus* associated with *Ricciisporites tuberculatus* are present, thus confirming the Rhaetian age of the sediments. The absence of older associations in the well indicate that it ends at 2802m, in Rhaetian strata.

COMPARISON BETWEEN EPR-E AND PALEOSERVICES

BIOSTRATIGRAPHIC INTERPRETATIONS ON STATOIL 34/10-3

(see attached paleolog)

CRETACEOUS

Upper limit of the late Maastrichtian:

The highest sample available is at 1748m, and both Paleoservices and EPR-E agree that it represents the upper limit of the Maastrichtian.

Upper limit of the Early Maastrichtian:

We place the top of the Early Maastrichtian at 1784m, due to the presence of *Arkhangelskiella cymbiformis* without *Nephrolithus frequens*; this boundary, observed in other wells (33/9-7, 33/12-6, 34/10-2), is not mentioned by Paleoservices, which considers this association to be indicative of a Middle Maastrichtian age.

Upper limit of the Early Maastrichtian-Late Campanian:

At 1823m, the association of *Arkhangelskiella cymbiformis* and *Reinhardtites* aff. *anthophorus*, followed closely at 1844m by *Reinhardtites anthophorus*, gives a Late Campanian to Early Maastrichtian age to the interval. A similar stratigraphic interpretation is given by Paleoservices.

Upper limit of the Albian-Aptian:

The top of the Albian-Aptian was found at 1889m in a ditch cutting sample. The sidewall core samples examined by Paleoservices at 1886m, 1887m, 1888.5m, 1890m and 1891m were not available to us. The ditch cutting sample at 1886m was nondiagnostic. We consider the presence of *Glomospira* sp. without *Hedbergella* to be a fair index for Albian to Aptian strata. *Patellina subcretacea* was found once in an Albian reference sample.

JURASSIC

Limit between the Early Bathonian and Bajocian:

Both laboratories place the upper limit of the Jurassic sediments at 1895m. In previous reports, we pointed out that EPR-E gave, to the first downhole appearance of *Nannoceratopsis gracilis*, a different stratigraphic significance than did other laboratories, including Paleoservices. This difference is reflected here by the fact that EPR-E place the top of the Bajocian at 1914.8m, due to the occurrence of *Nannoceratopsis gracilis*, whereas Paleoservices place this level in an undifferentiated interval of Early Bathonian to Bajocian age. But in our opinion, this difference is purely conventional and does not reflect any serious stratigraphic disagreement.

Limits between the Bajocian, Toarcian and Pliensbachian:

The top of Toarcian sediments is not clearly marked. There is not here an obvious dominance of *Nannoceratopsis senex* over *N. gracilis*, a criteria that we normally use to set the Bajocian-Toarcian boundary. Another difficulty in this section is the difference between the topmost appearances of our Pliensbachian markers: *Mancodinium semitabulatum* has its top at 2170m, as *Cerebropollenites thiergartii* appears for the first time in the section at 2240m. Toarcian ostracods are still present at 2189m but could be caved at this depth and the first Pliensbachian ostracod appears at 2264m. A compromise was found in setting the Toarcian-Pliensbachian limit at 2170m where we have the highest occurrence of one of our Pliensbachian marker indexes (*Mancodinium semitabulatum*). It is quite possible, as indicated by Paleoservices, that some of our Pliensbachian section is of Toarcian age and, similarly, that some of our Toarcian section is in part of Bajocian age. Our interpretation gives a precise position to the Pliensbachian-Toarcian limit, as compared with Paleoservices' which remains rather vague regarding stage boundaries.

Upper limit of the Sinemurian:

The top of the Sinemurian is placed at 2471.7m at the first appearance of *Kraeuselisporites reissingeri* where representatives of the *Nannoceratopsis* group do not occur anymore. We have not considered the first downhole occurrence of our Sinemurian marker index to be reworked as Paleoservices did.

Upper and lower limits of the Hettangian:

The upper limit of the Hettangian is placed at 2581m where *Kraeuselisporites reissingeri* and *Cerebropollenites thiergartii* occur. The deepest occurrence of *Cerebropollenites mesozoicus*, known to have the base of its range in Sinemurian, is situated at 2564m. Paleoservices gives a Sinemurian-Hettangian age for this interval. We both agree as to the dating of the bottom of the section.

Upper limit of the Rhaetian:

The topmost occurrence of *Ricciisporites tuberculatus* at 2660m, where *Cerebropollenites thiergartii* does not occur anymore, is considered, by both laboratories, to represent the top of Rhaetian sediments. The age is confirmed by the presence, lower down, of *Ovalipollis ovalis* and *Rhaetipollis germanicus*.

JPV:MP:JPC:cm

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LIST OF DITCH CUTTINGS SAMPLES STUDIED FOR MICROPALEONTOLOGY

(M: Foraminifera and/or Ostracod)

(C: Coccolith)

1748m	M-C	2066m	M
1754m	C	2084m	M
1762m	M	2105m	M
1763m	C	2126m	M
1772m	C	2144m	M
1781m	C	2150m	M
1784m	M-C	2165m	M
1793m	C	2171m	M
1802m	C	2186m	M
1805m	M	2189m	M
1814m	C	2204m	M
1823m	C	2234m	M
1826m	M	2264m	M
1832m	C	2294m	M
1844m	C	2324m	M
1847m	M	2354m	M
1853m	C	2384m	M
1862m	C	2390m	M
1874m	M-C	2414m	M
1880m	M	2444m	M
1883m	C	2450m	M
1886m	M	2475m	M
1889m	M	2505m	M
1892m	M-C	2535m	M
1898m	M	2565m	M
1907m	M	2595m	M
1928m	M	2625m	M
1964m	M	2655m	M
1985m	M	2685m	M
2003m	M	2718m	M
2024m	M	2748m	M
2045m	M		

APPENDIX

LIST OF SAMPLES STUDIED FOR PALYNOLOGY

Cuttings	1871m
Cuttings	1877m
SWC	1883m
Cuttings	1886m
SWC	1887m
SWC	1888.5m
Cuttings	1895m
SWC	1903.5m
Core	1904.8m
Core	1905.8m
Core	1906m
Core	1906.7m
Core	1907.7m
Core	1908.6m
Core	1910.1m
Core	1914.8m
Cuttings	1916m
Core	1920m
Core	1920.95m
Core	1926.8m
Cuttings	1922-28m
Core	1932m
Core	1940.05m
Core	1940.6m
Core	1945.6m
Core	1946.1m
Core	1955.1m
Core	1955.9m
Core	1960.4m
Core	1961.1m
Core	1966m
Core	1966.7m
Core	1973.8m
Core	1976.1m
Core	1979.2m
Core	1985.4m
Core	1993m
Cuttings	1997m
Core	2003.9m
Core	2005.4m
Cuttings	2009-15m
Core	2013m
Core	2025m
SWC	2030m
SWC	2045m
SWC	2075m
SWC	2085.5m
SWC	2095m
Cuttings	2111m
SWC	2130m
SWC	2150m
SWC	2170m
SWC	2185m
SWC	2200m
SWC	2215m
SWC	2228m
SWC	2240m
SWC	2250m
Cuttings	2258-64m
SWC	2275m
Cuttings	2282-88m
SWC	2300m
Cuttings	2312-18m
Cuttings	2330-36m
Cuttings	2345m
Cuttings	2357-63m
Cuttings	2373-78m
Cuttings	2387-93m
Cuttings	2402-08m
Cuttings	2417-23m
Cuttings	2432-38m
Cuttings	2447-60m
Core	2467.2m
Core	2471.7m
Core	2476.1m
Cuttings	2481-87m
SWC	2492.5m
Cuttings	2502-08m
Cuttings	2511m
SWC	2522m
Cuttings	2529-36m
Cuttings	2543-49m
SWC	2564m
Cuttings	2575-81m
Cuttings	2589-96m
Cuttings	2603-09m
SWC	2620m
SWC	2623.5m
Cuttings	2633-39m
SWC	2645.5m
SWC	2660m
SWC	2674.5m
Cuttings	2680-86m
SWC	2692m
Cuttings	2700-06m
Cuttings	2724-30m
SWC	2735m
Cuttings	2746-52m
Cuttings	2763-69m
Cuttings	2776-83m
SWC	2788.5m
Cuttings	2802m