



STATOIL WELL 6407/1-2  
SUMMARY OF  
BIOSTRATIGRAPHY  
KEROGEN ANALYSIS  
JUNE 1983

Prepared for:  
Den norske stats oljeselskap a.s  
Forus  
P.O.Box 300  
4001 Stavanger

Prepared by: Tor Bjærke, LAP



**L A P** LABORATORIUM FOR ANVENDT PALYNOLOGI  
LABORATORY FOR APPLIED PALYNOLOGY  
TOR BJÆRKE P.O.BOX 118 3290 STAVERN NORWAY TLF.: 034 98 522

## INTRODUCTION

The summaries contained in the biostratigraphical report from Well 6407/1-2 is presented separately in this report.

SUCCESSION

<u>Top of intervals</u>	<u>Age</u>	<u>Thickness</u>
410m (top not seen)	Pleistocene, early	180m+
590m	Pliocene	840m
1430m	Pliocene - Miocene transition	150m
1580m	Miocene, late	150m
-----	?Unconformity	-----
1730m	(Barren)	70m
-----	Unconformity	-----
1800m	Oligocene, early-middle	80m
1880m	Eocene, middle-late	280m
2160m	Eocene, early	30m
2190m	Late Paleocene - early Eocene	30m
2220m	Paleocene, middle	10m
2230m	Paleocene, early-middle	50m
2280m	Paleocene, early	40m
-----	?Unconformity	-----
2320m	Maastrichtian	27.5m
-----	Unconformity	-----
2347.5m	Campanian, early	112.5m
2460m	Campanian, early - ?Santon	190m
-----	?Unconformity	-----

continued

<u>Top of intervals</u>	<u>Age</u>	<u>Thickness</u>
2650m	?Cenomanian	430m
3080m	Late Albian - early Cenomanian	80m
3160m	Albian	300m
3460m	Aptian	68.5m
- - - - -	Unconformity	- - - - -
3528.5m	Ryazanian	9.5m
- - - - -	Unconformity	- - - - -
3538m	Oxfordian	123m
- - - - -	?Unconformity	- - - - -
3661m	?Bathonian	99m
3760m	Bathonian, earliest	45m
- - - - -	Unconformity	- - - - -
3805m	Aalenian - ?Bajocian	15m
3820m	Late Toarcian - Aalenian	215m
4035m	Late Pliensbachian - early Toarcian	105m
4140m	Late Pliensbachian	40m
4180m	?Pliensbachian	40m
- - - - -	?Unconformity	- - - - -
4220m (approx.)	Hettangian - ?early Sinemurian	160m
4380m	Hettangian	110m
4490m	Hettangian, early	57m
- - - - -	?Unconformity	- - - - -
4547m	Rhaetian	13m+
4560m TD		

The stratigraphical breakdown is based on uncorrected depths.  
Electric logs were not made available for this study.

SUMMARY

1. This report is based on micropaleontological study of 117 ditch cuttings samples from the interval 410m to 3560m, and palynological and kerogen analysis of 241 ditch cuttings samples, sidewall cores and conventional cores from the interval 1855m to 4560m TD.

A brief lithological examination was carried out on all samples studied to support biostratigraphical interpretations.

2. Analysis commenced in sediments of early Pleistocene age at 410m consisting of sandy and silty clay deposited in an open marine shelf environment.
3. Pliocene sediments are present from 590m. A thick sequence of clay, silt and sand deposited in an open marine shelf environment represents the Pliocene sequence.
4. A transitional Pliocene-Miocene interval is identified between 1430m and 1580m. Grey mudstone and siltstone were deposited in an open marine shelf environment.
5. Late Miocene mudstone with some silt- and v.f.sandstone is present at 1580m. An open marine environment also prevailed during deposition of this interval.
6. The interval 1730m to 1800m was barren of microfossils, probably due to poor samples obtained around casing point (1789m). An unconformity separates the intervals below and above this barren interval. The exact position of this unconformity could not be located due to lack of fossil evidence.

7. At 1800m an early to middle Oligocene sequence was penetrated. Mudstone with subordinate silt and sandstone was deposited in an open marine shelf environment. Kerogen analysis shows a low to moderate terrestrial input in a low energy distal environment.
8. A middle to late Eocene sequence is present between 1880m and 2160m. Dark claystone and greenish mud were deposited in a shallow open marine shelf environment. Input of terrestrial plant debris was moderate. Dominance of agglutinated foraminiferal fauna indicates environmental stress or secondary dissolution of foraminiferal tests.
9. Red claystone of early Eocene age appears at 2160m. A low energy open shelf environment with low to moderate terrestrial input is suggested for this interval.
10. The sequence between 2190m and 2220m is given a late Paleocene - early Eocene age. Siltstone with subordinate sandstone and greenish mudstone was deposited within this interval. A slight regressive development is recorded up through this unit. Environment remained open marine.
11. A well defined middle Paleocene horizon was identified at 2220m. An open marine shelf environment was established at this horizon.
12. Sediments of early to middle Paleocene age are present between 2230m and 2320m. Dark silty mudstone and subordinate siltstone deposited in an open marine environment with high input of terrestrial plant debris is found within this interval.
13. An unconformity probably separates the early Paleocene from the underlying Maastrichtian at 2320. Deposition of dark mudstone and red claystone took place in an open marine shelf environment.

14. Another unconformity separates the Maastrichtian from the early Campanian below at 2347.5m. Grey shale and laminated claystone/silt-sandstone is present between 2347.5m and 2650m. An open marginal marine environment with low to medium input of terrestrially derived plant debris was established.

The age of the lower part of the interval is poorly defined and it may extend down into the Santonian

15. The sequence between 2650m and 3080m is also poorly defined. A Cenomanian age is suggested for this interval. Marine conditions prevailed throughout the interval with deposition of silty claystone and subordinate sandstone. Input of terrestrial plant debris was moderate.
16. Albian to early Cenomanian sediments were recorded between 3080m and 3460m. Claystone, siltstone and minor sandstone was deposited in an open marine environment.
17. Between 3460m and 3528.5m an Aptian sequence consisting of black shale, siltstone and red claystone was identified. Marine conditions also prevailed during deposition of this sequence.
18. The sidewall core at 3528.5m produced a diagnostic Ryazanian palynomorph assemblage. Unconformities are present above and below this thin interval. Siltstone and claystone were deposited in a marginal marine environment. A kerogen assemblage typical for the late Jurassic (-earliest Cretaceous) 'hot shales' was recorded.

19. An Oxfordian age is given for the sediments at 3538m. Definitely early Oxfordian sediments are present between 3580m and 3661m. The characteristic 'hot shale' facies disappears around 3560m and is replaced by a normal marginal marine assemblage. Shale dominates in the upper part of the interval while silty shale and minor v.f. sandstone are characteristic in the lower part.
20. Samples from the cored interval between 3661m and 3719m did not produce age diagnostic assemblages. The sandstones are however, regarded as a regressive continuation of the Bathonian sedimentary cycle. A hiatus is consequently inferred between the top of the sandstones at 3661m and the top core sample at 3660.5m of early Oxfordian age.
21. Early Bathonian sediments are present between 3760m and 3805m. A marginal marine environment with high terrestrial input was established.
22. Abrupt change in organic facies and appearance of stratigraphically diagnostic assemblages at 3805m suggest an unconformity at this depth. Bituminous shales of Aalenian-?Bajocian age deposited in a restricted marine or brackish low energy environment are present between 3805m and 3820m.
23. The appearance of sandstones defines the top of the interval 3820m to 4035m. This sandstone marks the termination of a Late Toarcian-Aalenian regressive development. Marginal marine environment with high terrestrial input and deposition of silty shales are suggested for the middle and lower part of the interval.



24. Late Pliensbachian - early Toarcian sediments are present between 4035m and 4140m. Silty shale and v.f. sandstone were deposited in a marginal marine environment. Input of terrestrial plant debris was low in the lower part increasing considerably upwards.
25. The sequence between 4140m and 4180m is given a late Pliensbachian age. Grey siltstone is probably the "in situ" sediment deposited in a restricted marginal marine environment.
26. The interval 4180m to 4220m is defined on lithological evidence. Sandstone dominates over this interval and fossil evidence is poor. A tentative Pliensbachian age is suggested. This sandstone may have been deposited during a transgressive episode at the beginning of the Pliensbachian-Toarcian sedimentary cycle. A marginal marine high energy environment is suggested for this interval.
27. A Hettangian - ?early Sinemurian continental sequence is present down to 4547m. Cyclic sedimentation of bituminous shale, coal, siltstones and sandstones took place in a top delta or coastal plain environment. Bituminous shale and coal are most abundant between 4380m and 4490m. Increased deposition of sandstones is noted towards the top of the sequence. The upper boundary of the unit is poorly defined due to low fossil productivity.
28. The well terminated in sediments of Late Triassic, Rhaetian age between 4547m and 4560m (TD). The evidence regarding facies is poor but a non-marine depositional environment is also suggested for these sediments. An unconformity probably separates the Rhaetian and Hettangian sequences.

### Depositional history

Based on information and interpretations presented in this report the depositional history in Well 6407/1-2 may be outlined as follows:

During Rhaetian times a top delta or coastal plain environment was established in the area. After a short period of non-deposition or slight erosion around the Triassic - Jurassic boundary (4547m) sedimentation continued in the Hettangian - ?early Sinemurian (4547 - ca 4220m) with deposition of bituminous shales, coals, silt- and sandstones in a top delta or coastal plain environment. Sedimentation kept pace with subsidence and the area shows high stability during this period. Increased sandstone deposition towards the top of the interval shows that fluvial processes were more extensive during the later part of this sedimentary cycle. Sedimentation terminated in the ?early Sinemurian and a period of erosion or non-deposition occurred in the late Sinemurian and possibly into the early Pliensbachian.

The area was transgressed in the Pliensbachian with deposition of a marginal marine sandstone (?4220m - 4180m) and a restricted shallow marine basin was established. Silty shales, silt and sandstones were deposited during the late Pliensbachian to late Toarcian. Periods of low sediment input occurred probably due to low relief in the area.

This sedimentary cycle terminated with deposition of sandstones (3820-3890m) in a regressive development.

A restricted marine of brackish low energy environment was established and shales were deposited above the sandstone horizon during the Aalenian (?Bajocian) (3805-3820m).

An unconformity separates this unit from the silty shales of earliest Bathonian age above (3760-3805m) and again sandstones were deposited in a regressive development marking the termination of the Bathonian sedimentary cycle (3661-3760m).

The area was transgressed in the early Oxfordian, and silty shales were deposited (3580-3661m). The upper part of the incomplete Oxfordian sequence was deposited in a marine environment with restricted circulation. High input of terrestrial plant debris under partly stagnant conditions formed a typical 'hot shale' facies (3538-3560m).

Kimmeridgian and Portlandian sediments are not recorded from this well, but evidence of a Ryazanian transgression is seen at 3528.5m. Marine shales of this age also present a 'hot shale' facies.

A long period of non-deposition separates the Ryazanian from the overlying Aptian - Cenomanian sedimentary cycle (2650-3526m). Red and dark claystones were deposited during the Aptian and open normal marine conditions were established. A thick sequence of marine sediments were deposited during the Albian-Cenomanian and significant subsidence occurred the area resulting in an increased rate of sedimentation.

An unconformity is suggested around 2650m separating the late Cretaceous and the Cenomanian. During the ?Santonian - early Campanian marine sediments again were laid down (2347.5-2650m).

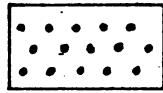
Red and dark grey marine claystones were deposited during the Maastrichtian. Unconformities are probably present both below and above this unit.

Sedimentation commenced in the early Paleocene and marine conditions prevailed until the middle Oligocene. A sequence of greenish and red clays, mudstones and minor silt- and sandstone were deposited (2320-1800m). Distinct changes in sedimentary environment within the framework of an open marine shelf environment are seen through the sequence. These changes probably reflect variations in sediment input rather than drastic variations in subsidence.

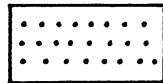
A period of uplift and non-deposition or erosion occurred in the late Oligocene - early Miocene. An unconformity separates the early-middle Oligocene from the late Miocene at 1730-1800m.

An open marine shelf environment was established in the late Miocene - early Pliocene with deposition of mudstones (1430-1730m). During the Pliocene the basin subsided considerably and a thick sequence of sandy and silty mud was deposited (590-1430m). An open marine shelf environment prevailed throughout the interval.

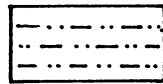
Sedimentation continued into the early Pleistocene with deposition of sandy and silty clay in a marine shelf environment (410-590m).

LEGEND TO ENCLOSURESLITHOLOGY

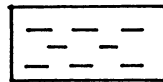
SAND/SANDSTONE  
MEDIUM - COARSE



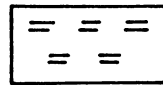
SAND/SANDSTONE  
FINE - MEDIUM



SILT/SILTSTONE



CLAY/SHALE



MUD

SAMPLES

Ditch cuttings sample (DCS)



Sidewall core (SWC)



Conventional core (CC)

FOSSIL OCCURENCE

Rare - persistent (DCS)



Common - abundant (DCS)



Rare - persistent (SWC)



Common - abundant (SWC)



Rare - persistent (CC)



Common - abundant (CC)