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THE BIOSTRATIGRAPHY OF BP/CONOCO/PELICAN  
16/8-1 WELL, NORWEGIAN NORTH SEA

by

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## ABSTRACT

The well BP/Conoco/Pelican, 16/8-1, penetrated deposits dated on microfossil evidence thus:-

178 m - 388 m	RECENT - PLEISTOCENE
394 m - 892 m	PLIOCENE
898 m - 958 m	MIOCENE
964 m - 1108 m	MIOCENE - OLIGOCENE
1120 m - 1375 m	OLIGOCENE
1384 m - 1501 m	} EOCENE
1513 m - 1621 m	
1633 m - 1750 m	} PALAEOCENE
1753 m - 1768 m	
1771 m - 1777 m	EARLY (DANIAN)
1780 m - 1792 m	MAASTRICHTIAN - CAMPANIAN
1795 m - 1810 m	CAMPANIAN
1822 m	SANTONIAN - CONIACIAN
1840 m - 1876 m	LATE - MIDDLE ALBIAN
1882 m - 1894 m	EARLY ALBIAN - APTIAN
1900 m - 1918 m	EARLY APTIAN
1921 m - 1930 m	EARLY BARREMIAN
1939 m - 1970 m	LATE
2005 m - 2041.3 m	EARLY } HAUTERIVIAN
2050 m	EARLY VALANGINIAN
2055 m - 2065 m	TITHONIAN
2074.5 m	EARLY TITHONIAN OR LATE KIMMERIDGIAN
2083 m - 2112 m	EARLY KIMMERIDGIAN
2116 m - 2125 m	UNDATED

A biostratigraphical summary chart (Fig. 1) is included.

### INTRODUCTION

This report summarises the palaeostratigraphical results obtained from microfaunal and palynological analyses in the interval 178 m - 2125 m in well 16/8-1. A total of 211 samples were studied of which 192 were ditch cuttings; the remainder were sidewall cores. One hundred and eighty-four samples throughout the well were examined for microfaunal content (Hoskin) and 47, largely in the Mesozoic, for acid-resistant microplankton (Duxbury and Williams).

### SAMPLE LIST

F ≡ Microfaunal examination.  
P ≡ Palynological examination.  
\* ≡ Sidewall core.

178 F	382 F	526 F	772 F
232 F	388 F	532 F	826 F
280 F	394 F	574 F	880 F
352 F	400 F	628 F	886 F
370 F	460 F	676 F	892 F
376 F	520 F	724 F	898 F

922 F	1450 F	1771 F	1972 F
940 F	1462 F	1774 F	1981 F
952 F	1474 F	1777 F	1990 F
964 F	1483 F	1780 F	2002 F
970 F	1492 F	1789 F	*2005 P
982 F	1501 F	1792 F	2008 F
1000 F	1513 F	1795 F	2014 F
1012 F	1525 F	1798 F	2017 F
1024 F	1534 F	1801 F	2020 F
1036 F	1549 F	1810 F	2023 F
1048 F	1561 F	1822 F	2026 F
1060 F	1567 F	1834 F	*2026.5 P
1072 F	1570 F	1840 P	2035 F
1084 F	1576 F	1846 P	*2041.3 P
1096 F	1582 F	*1847.3 FP	2044 F
1108 F	1585 F	1852 P	2047 F
1120 F	1600 F	1861 FP	*2050 FP
1132 F	1609 F	1864 F	2050 F
1150 F	1612 F	1867 FP	2053 F
1162 F	1615 F	1870 F	*2055 FP
1174 F	1618 F	1876 F	*2060 P
1180 F	1621 FP	1882 FP	2062 F
1186 F	1624 F	1885 F	*2065 P
1198 F	1633 P	1888 F	2065 F
1204 F	1636 F	1891 F	2068 F
1210 F	1639 F	1894 F	2071 F
1216 F	1642 FP	1900 FP	2074 F
1222 F	1645 FP	1906 F	*2074.5 P
1246 F	*1647.3 P	1912 FP	2077 F
1264 F	1648 P	1915 FP	2080 F
1276 F	1651 FP	1918 FP	2083 F
1288 F	1654 P	1921 FP	*2087.5 P
1300 F	1660 F	1924 F	2089 P
1312 F	1672 F	1927 F	2092 F
1327 F	1681 F	1929 F	2095 P
1336 F	1690 F	1930 FP	2101 FP
1345 F	1702 F	1939 FP	2107 P
1351 F	1714 F	1942 F	2110 F
1360 F	1729 F	1945 F	*2112 P
1375 F	1741 F	1948 FP	2113 FP
1384 F	1750 F	*1950 P	2116 P
1393 F	1753 F	1951 F	2120 P
1402 F	1756 F	1954 F	2122 P
1411 F	1759 F	1957 F	2150 P
1426 F	1762 F	1960 F	2195 P
1435 F	1765 F	1963 F	2250 P
1444 F	1768 F	*1970 P	

QUATERNARY

RECENT - PLEISTOCENE; 178 m - 388 m

Within this interval, *Protelphidium orbiculare*, *Elphidium incertum* and *E. clavatum* were found and these indicate a Recent - Pleistocene age. A number of reworked Late Cretaceous forms were also observed.

TERTIARY

PLIOCENE; 394 m - 892 m

The appearance of *Cibicides lobatulus* var. *grossa* and *C. scaldisiensis* at 394 m indicates that Pliocene deposits have been penetrated. The presence of *Loxostomum lammersi* at 724 m and of *Pseudoeponides pseudotepidus* at 880 m suggest an Early Pliocene age at these levels.

MIOCENE; 898 m - 958 m

A Miocene age is suggested by the occurrence of sponge spicules and sterrasters at 898 m, of *Bolboforma metzmacheri* at 922 m and of *Uvigerina hosiusi* and *Asterigerina staeschei* at 940 m.

MIOCENE - OLIGOCENE; 964 m - 1108 m

*Coscinodiscus* sp.A first appears at 964 m with abundant specimens occurring lower in this interval. *Alabamina tangentialis* is first seen at 1012 m. Both of these species are typical of the Oligocene and have been used as Oligocene marker species. However, since the former may occur in basal Miocene deposits and the latter has been recorded from the Middle Miocene, this interval has been assigned a Miocene-Oligocene age.

OLIGOCENE; 1120 m - 1375 m

At the top of this interval, a number of specimens of *Asterigerina gurichi* were observed and these are indicative of an Oligocene age. This is substantiated by the occurrence of *Turrilina alsatica* at 1162 m; common *A. gurichi* also occur at this depth. *Rotaliatina bulimoides*, which was observed at 1210 m., is a commonly used Middle Oligocene marker form in the North Sea and occurs abundantly below this depth. Other characteristic Oligocene taxa include *Coscinodiscus* sp.B at 1264 m and *Sigmoilina tenuis* at 1276 m.

EOCENE; 1384 m - 1621 m (EARLY EOCENE; 1513 m - 1621 m)

The appearance of *Cyclammina challinori* at 1384 m indicates that Eocene deposits have been penetrated. Deposits of Early Eocene age are first indicated at 1513 m with the occurrence of *Ammobaculites* sp.A and *Bolivinopsis spectabilis*. This age is supported by the presence of white and pink-stained planktonic Foraminifera, including *Subbotina triloculinoides* and *Globigerina yeguaensis* at 1567 m (mid-Ypresian) and of the diatom taxon *Coscinodiscus* sp.1 at 1582 m and 1615 m (Early Ypresian).

PALAEOCENE; 1633 m - 1777 m (EARLY PALAEOCENE; 1753 m - 1777 m)

The top of the Palaeocene is taken at the first appearance of *Wetzeliella* N1, a key dinoflagellate cyst species. This taxon is rare in cuttings samples at 1633 m, 1642 m and 1645 m, but is common in the 1647.3 m sidewall core and in cuttings at 1648 m.

Foraminifera characteristic of the Palaeocene include *Cyclammina* sp.A and *Trochammina* sp.A, both at 1660 m. The microfauna becomes green-stained below 1672 m.

Between 1753 m and 1768 m, several glassy and brown-stained forams indicative of Early Palaeocene deposits were observed. These include *Globorotalia (Turborotalia) compressa*, *G.(T.) pseudobulloides*, *Globoconusa daubjergensis/kozlowskii*, *Quadrinorphina allomorphinoides*, *Anomalinoidea velascoensis* and *Discorinopsis parvula*.

The appearance of chalk and white-stained examples of *G.(T.) pseudobulloides*, *Anomalinoidea velascoensis*, *Allomorphina halli* and *Subbotina triloculinoides* between 1771 m and 1777 m suggests that the Danian (sensu stricto) has been penetrated.

#### CRETACEOUS

##### MAASTRICHTIAN - CAMPANIAN; 1780 m - 1792 m

The top of this interval is marked by the first occurrences of several taxa, including *Rugoglobigerina rugosa rugosa*, *R. rugosa rotundata*, *Stensioina pommerana* and *Gavelinella vombensis*. *Reussella szajnochae* first occurs at 1789 m. Each of these taxa suggests a Maastrichtian - Campanian age for this interval. The absence of the forms *Pseudotextularia elegans*, *Racemiguembelina fructicosa* and *Globotruncana contusa* may suggest that the Late Maastrichtian is missing.

##### CAMPANIAN; 1795 m - 1810 m

The appearance of pink-stained *Rugoglobigerina rugosa* s.l., *Reussella szajnochae*, *Aragonia* sp. and *Gyroïdina quadrata* at 1795 m indicates that the Campanian has been penetrated. *Bolivinoidea draco miliaris*, which has a range of Early Maastrichtian - Late Campanian, was also recorded at 1795 m. Other forms consistent with a Campanian age include *Stensioina exsculpta*, *Globotruncana linneiana* s.l., *Triaxia dubia* and *Bolivina incrassata* at 1798 m and *Gavelinella clementiana* and *Globotruncana arca* at 1801 m.

##### SANTONIAN - CONIACIAN; 1822 m

The presence of *Globotruncana paraventricosa*, *Stensioina praeexsculpta* and *S. exsculpta gracilis* at 1822 m suggests a Santonian - Coniacian age at this level.

##### LATE - MIDDLE ALBIAN; 1840 m - 1876 m

The 1840 m cuttings sample yielded a very limited palynoflora indicative of a Late Albian age. It contains *Apteodinium grande*, which is characteristic of the Late Albian, and *Necrobroomea jaegeri* which ranges into sediments no younger than Late Albian. The cuttings sample at 1846 m and the sidewall core at 1847.3 m produced fairly diverse palynofloral assemblages, again indicative of a Late Albian age. Several of the taxa observed in these two samples range no higher than

Late Albian. These include *Litosphaeridium conispinum*, *Apteodinium grande*, *Oxoidinium scabrosum*, *Rhombodella natans*, *Gonyaulacysta helicoidea* and *Carpodinium granulatum*. Also present were forms which have their first stratigraphical occurrence in the Late Albian, including *Xiphophoridium alatum* and *Hexagonifera chlamydata*. *Protoellipsodinium spinocristatum* was seen as high as 1867 m and this indicates that pre-Vraconian sediments have been penetrated.

Foraminifera characteristic of a Middle-Late Albian age first appear, downhole, at 1867 m and include *Spiroplectinata annectens* with *S. complanata* appearing at 1870 m. Other forms, which may occur within the Albian, include *Hedbergella planispira*, *Eggerellina mariae*, *Valvulineria gracillima* and *Dorothia filiformis*. Pink staining first appears at 1864 m where agglutinated foraminifera were affected. *Textularia foeda*, which first appeared at the base of this interval (1876 m), has a published range which reaches into the Middle Albian but is most abundantly found in Late Aptian to Early Albian deposits.

EARLY ALBIAN - APTIAN; 1882 m - 1894 m

The presence of *Conorotalites aptiensis* suggests a range of Early Albian - Aptian, this range being substantiated at 1891 m by the occurrence of *Gaudryina dividens*. *Hedbergella infracretacea* and *H. trochoidea* appear at 1891 m, the former appears in flood form at 1894 m.

EARLY APTIAN; 1900 m - 1918 m

The top of this interval is placed at the first downhole occurrence of *Kleithriasphaeridium simplicispinum*, a dinoflagellate cyst which is not observed in assemblages younger than Early Aptian. Other taxa observed at 1900 m include *Dingodinium albertii*, *Aptea polymorpha* and *Systematophora schindewolfi*, each of which range no higher than Aptian. *Gardodinium trabeculosum* and *Deflandrea perlucida* were both present at 1912 m and again these range no younger than Aptian. Several taxa considered to be present in deposits no younger than earliest Aptian were observed in the lower part of this interval. These include *Sirmiodinium grossi*, *Heliodinium voigti*, *Phoberocysta neocomica* and *Heslertonina heslertonensis* at 1915 m and *Ctenidodinium elegantulum* and *Muderongia cf. staurota* at 1918 m. These last six taxa are more typical of Barremian and older deposits than of the Aptian, but the absence of *Pseudoceratium pelliiferum* (a species which probably marks the top of the Barremian) above 1921 m suggests that the whole of the interval 1900 m - 1918 m may be considered of Early Aptian age.

The first appearances of *Gavelinella barremitana* and *Conorotalites intercedens* at 1912 m and *Lenticulina ouachensis* at 1915 m are consistent with an Early Aptian age.

EARLY BARREMIAN; 1921 m - 1930 m

The top of this interval is marked by the first downhole occurrence of the dinoflagellate cysts *Pseudoceratium pelliiferum* and *Kleithriasphaeridium corrugatum*. The former ranges through deposits no younger than Barremian and the latter is considered to be absent from deposits

younger than Early Barremian. At 1930 m, *Cribroperidinium cornutum* was observed. This taxon has been reported only from the Late Barremian, but probably ranges into younger material. The occurrence of this species here may indicate a small thickness of Late Barremian deposits between the 1912 m and 1921 m samples or may be due to caving from the Early Aptian above. In either case, *Cribroperidinium cornutum* is not indigenous at 1930 m. Much of the Barremian is absent in this well.

Foraminifera characteristic of an Early Barremian age include *Lenticulina eichenbergi*, which occurs as single specimens at each of the following depths, 1921 m, 1924 m and 1930 m, *Lenticulina crepidularis* at 1921 m and *Lenticulina schreiteri* and *Conorotalites sigmoicosta* at 1927 m. A sidewall core (No.13) at 1929 m contains the red-stained foraminifera, *Gaudryina dividens*, *Gavelinella barremiana* and *Conorotalites aptiensis*, which indicate an Aptian age. This age dating is inconsistent with the age determined using ditch cuttings samples but the constituent fauna is similar to that which occurs in the Early Aptian interval above.

HAUTERIVIAN; 1939 m - 2041.3 m

Palynological evidence from this interval is based on well-preserved and generally common dinoflagellate cysts recovered from two cuttings samples (at 1939 m and 1948 m) and five sidewall core samples (at 1950 m, 1970 m, 2005 m, 2024.6 m and 2041.3 m). Throughout the interval, *Nelchinopsis kostromiensis*, a taxon restricted to the Hauterivian was observed. The top of the interval is placed at the first downhole occurrence of this form. Also present throughout was a typically Hauterivian background assemblage including *Heliodinium voighti* (common), *Kleithriasphaeridium corrugatum*, *Gonyaulacysta cf. cladophora*, *Heslertonia helertonensis*, *Phoberocysta neocomica* and *Spiniferites? dentatus*.

Abundant specimens of *Lenticulina eichenbergi* appear in the topmost sample and continue throughout this interval. In this interval the foraminifera and ostracoda which have published ranges that occur throughout or extend into the Hauterivian include *Lenticulina (Marginulinopsis) foeda*, *L. schreiteri*, *L. crepidularis*, *Cytherelloidea ovata*, *Vaginulina kochii*, *Conorotalites sigmoicosta* and *Protocythere triplicata*. *Acrocythere hauteriviana laeva*, which is recorded at 1951 m, is a Late Hauterivian ostracod.

Palynological evidence may be used to subdivide the Hauterivian as follows:-

(i) Late Hauterivian; 1939 m - 1970 m

Within this sub-interval several species of dinoflagellate cyst which range into deposits no younger than Hauterivian were observed. These include *Nelchinopsis kostromiensis* and *Gonyaulacysta confossa*\* throughout and *Aprobolocysta eilema*\* and *Canningia cf. reticulata*\* at 1970 m. The sidewall core samples at 1950 m and 1970 m yielded taxa which occur in deposits no older than Late Hauterivian, including

\* Duxbury (in press).

*Necrobroomea jaegeri*, *Coronifera oceanica* and *Gonyaulacysta cf. cassidata* at 1950 m and *Deflandrea terrula*, *Adnatosphaeridium vetusculum* and *Muderongia crucis* (f. common) at 1970 m. In both of these sidewall cores, the background assemblages contained *Deflandrea perlucida*, *Cleistosphaeridium polypes* and *Oligosphaeridium asterigium* (f. common).

On dinoflagellate cyst evidence, the 1939 m - 1970 m sub-interval may be correlated with the late 'C' divisions of the Speeton (N. Yorks) coastal section; probably with the divisions C1-C3.

(ii) Early Hauterivian; 2005 m - 2041.3 m

*Nelchinopsis kostromiensis*, which is restricted to the Hauterivian, was observed throughout this sub-interval. At 2005 m, taxa were present which indicate an age no younger than Early Hauterivian. These include *Pareodinia dasyforma* and *Gonyaulacysta* N10. Species indicating the age of this sub-interval to be no older than Hauterivian include *Gonyaulacysta perforobtus\** at 2005 m, *Kleithriasphaeridium simplicispinum*, *Spiniferites? dentatus*, *Necrobroomea longicornuta*, *Gonyaulacysta fastigiata*, *G. helicoidea* and *G.* N10 at 2024.6 m and *Nelchinopsis kostromiensis* at 2041.3 m. *Nematosphaeropsis scala\** was observed at 2024.6 m and this is again typical of the Early Hauterivian.

EARLY VALANGINIAN; 2050 m

This sidewall core sample yielded a sparse, poorly preserved palynoflora which was nevertheless diagnostic. Taxa observed which range into deposits no younger than Early Valanginian include *Spiniferites alatus\**, *Endoscrinium pharo\**, *Occisucysta evitti* and *Psaligonyaulax apatela*. This assemblage may equally suggest a Berriasian or Early Valanginian age, but the additional occurrence of a single specimen of *Ctenidodinium elegantulum* suggests an age no older than Early Valanginian.

JURASSIC

TITHONIAN; 2055 m - 2065 m

This interval is represented by three sidewall core samples (at 2055 m, 2060 m and 2065 m). Each sample yielded very rich, fairly varied palynomorph assemblages of a Tithonian age. Taxa observed in all three samples include *Prasinophyceae* (common), *Pterospermella* sp. (common), *Canningia* sp. (common), *Parvocavatus spinosus\** and *Endoscrinium pharo\**. In addition, the 2055 m and 2060 m samples yielded Proximate NM3, "*Oligosphaeridium*" NCl and cf. *Broomea ramosa* and the 2065 m sample yielded *Pareodinia dasyforma*, *Leptodinium eumorphum* and *Classopollis echinatus* (f. common).

The association of *Prasinophyceae*, *Canningia* sp. and *Pterospermella* sp, each of which were common, together with Proximate NM3, "*Oligosphaeridium*" NCl and cf. *Broomea ramosa* suggests an age no younger than Tithonian for the 2055 m sample. Further, the presence of *Parvocavatus spinosus\** and *Endoscrinium pharo\** throughout suggests an age no older than Tithonian for the interval as a whole.

\* Duxbury (in press)



The appearance of the foraminifera *Haplophragmoides* sp.A in the sidewall core sample at 2055 m is consistent with a Tithonian age.

EARLY TITHONIAN OR LATE KIMMERIDGIAN; 2074.5 m

This sidewall core sample yielded a rich but restricted palynoflora composed largely of *Gonyaulacysta* cf. *longicornis* and *Pterospermella* sp. In addition, however, *Egmontodinium polyplacophorum* was observed and this taxon is known only in deposits of Early Tithonian and Late Kimmeridgian age.

EARLY KIMMERIDGIAN; 2083 m - 2112 m

Abundant specimens of *Rhaxella perforata* are first seen, downhole, in ditch cuttings at 2083 m; its recorded range is Middle Oxfordian - Early Kimmeridgian.

Three sidewall core samples and five cuttings samples from this interval yielded very sparse and very poorly preserved dinoflagellate cyst assemblages which indicate a Kimmeridgian age. *Gonyaulacysta longicornis*, which is considered to range no higher than Kimmeridgian, is present at 2087.5 m, and *Oligosphaeridium pulcherrimum* (sensu Gitmez 1970), which is not present in sediments older than Kimmeridgian, was seen as deep as 2112 m.

UNDATED INTERVAL; 2116 m - 2125 m

No microfossils were recovered between 2116 m and the top of red beds at 2125 m. An age may not, therefore, be assigned to this interval.

CONCLUSIONS

The oldest material in 16/8-1 to which a specific age may be assigned is between 2112 m and 2083 m and is of Early Kimmeridgian age. This is succeeded (as indicated by the sidewall core at 2074.5 m) by deposits of Late Kimmeridgian or Early Tithonian age. The presence of material which may be of Late Kimmeridgian age at the oldest only 8.5 m above Early Kimmeridgian deposits strongly suggests that at least the Middle Kimmeridgian is missing in this well. The subsequent Tithonian sequence is probably complete with the Jurassic/Cretaceous boundary between 2055 m and 2050 m.

The Berriasian is not represented here and the oldest Cretaceous deposits recognised are of an Early Valanginian age. Other notable hiatuses within the Cretaceous section are between 1921 m and 1912 m where the Middle and Late Barremian are missing, between 1840 m and 1822 m where the Cenomanian and Turonian are probably lacking and between 1780 m and 1777 m where the Late Maastrichtian may not be present.

A fairly thick Tertiary sequence was observed between 1777 m and 394 m and each Series is probably represented. No obvious hiatuses were recognised within the Tertiary.

A thin series of Pleistocene - Recent material was seen between 388 m and 178 m.

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