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ROBERTSON RESEARCH INTERNATIONAL LIMITED

OILFIELDS REPORT NO. 2234

THE BIOSTRATIGRAPHY OF THE INTERVAL 186m - 1842m FROM THE CONOCO 10/5-1 NORWEGIAN NORTH SEA WELL

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C O N T E N T S

Enclosures

I

SUMMARY

The well terminated in granite basement dated as late Precambrian, which is overlain by a thin, unfossiliferous, quartzitic sandstone of probable early Palaeozoic age.

About 330m of Upper Permian, Zechstein deposits containing some rich palynofloras occur above this quartzitic sandstone. A soft dark shale section, probably equivalent to the Kupferschiefer occurs at the base. This is followed by an anhydritic-dolomitic section and then a thick dominantly limestone series. Deposition as a whole is considered to have been in the shallow margins of an inland hypersaline sea. The Zechstein deposits pass up into a non-marine poorly sorted sand and subordinate shale sequence of presumed Triassic age.

An unconformity separates the Triassic sands from the overlying Jurassic beds. Shallow marine and deltaic sands with minor shales and lignite are at the base of the Jurassic sequence and are considered on palynological evidence and ostracode fauna to be Middle Jurassic in age. A further unconformity separates the Middle Jurassic from the Upper Jurassic since the Bajocian - Bathonian deposits are overlain directly by an Upper Jurassic sequence. A possible thin development of late Oxfordian (p2) - early Kimmeridgian occurs at the base of the Upper Jurassic with a thick marine shale and clay sequence ranging from Kimmeridgian to Volgian above.

Sedimentation appears to have continued into, and throughout, the Lower Cretaceous without any significant break although marked microfaunal and microfloral changes occur at

the Jurassic-Cretaceous boundary. The basal Lower Cretaceous beds of Ryazanian age have a similar clay lithology to the Volgian but in the overlying Valanginian a fine sand and clay facies occurs in which the numbers of microplankton are reduced suggesting shallower more restricted marine conditions. The clay-sand facies continues into the lower part of the Hauterivian but in the later Hauterivian, Barremian and most of the Aptian - Albian intervals a grey-black clay predominates, apart from an uppermost red shale and chalk section. Microfaunas are moderate to poor and they suggest that an inner sublittoral predominantly open marine environment prevailed.

Overlying the Lower Cretaceous is a thick and apparently complete Upper Cretaceous carbonate sequence. From the Cenomanian up to the middle part of the Coniacian interval the lithology is white to light grey, glauconitic chalk from which moderately rich planktonic foraminiferal assemblages were recovered - an indication that the environment of deposition had good open marine connections. Near the top of the Coniacian there is a change to a soft, white chalk facies which persists through most of the remaining Upper Cretaceous. This lithological change is accompanied by a faunal change from a dominantly planktonic to a dominantly calcareous benthonic foraminiferal assemblage. This suggests that open sea connections became rather limited. Water depths, however, remained similar, except in the Maastrichtian when shallow shelf conditions prevailed.

Carbonate deposition continued into the Danian but chert is a significant component of the lithologies here. A major

facies change occurs at the top of the Danian and in the overlying Palaeocene deep water clay lithologies containing only impoverished microfaunas occur together with abundant tuffs - evidence of considerable volcanic activity. This passes up into a sequence of glauconitic, sandy clays which on rather slender palaeontological evidence is dated as ?Lower Eocene.

II

INTRODUCTION

This report summarises the results of the micropalaeontological, palynological and stratigraphical analyses which have been carried out on material received from the interval 186m - 1842m from the Conoco 10/5-1 Norwegian North Sea Well under Project No. IIA/767/1181.

Under this project a total of 480 ditch cuttings and 6 sidewall cores was analysed utilising standard micropalaeontological techniques. In addition 40 composited ditch cuttings and 13 sidewall core samples covering the interval 1260m - 1842m were treated palynologically.

A summary of the determinations obtained by these analyses has already been communicated by telex and telephone and forms the framework of factual information on which this report is based. A summary of the sequence penetrated in this well can be seen in Table I.

The terminology adopted for the environmental conclusions follows that of Hedgpeth (1957) from which Table 2 of this report is taken.

The Jurassic biostratigraphic units used in this report are those proposed in our study - "The Jurassic of Northwest Europe: Offshore Project". Their stratigraphical significance is summarised in Table 3.

The prepared samples and recorded information are now filed and curated in the confidential records section of these laboratories.

We wish to acknowledge the continued co-operation and assistance received from the various members of Conoco Norway with whom we have been associated during the course of this work.

The personnel involved with this report are as follows:

C. G. LOMAS	(Lithologies and well coordinator)
J. W. CHURCH	(Lower Cretaceous and Jurassic micropalaeontology)
C. N. DENISON	(Palynology)
N.J.B. HAWARD	(Tertiary micropalaeontology)
C. A. NICHOLSON	(Upper Cretaceous micropalaeontology)

SUCCESSION

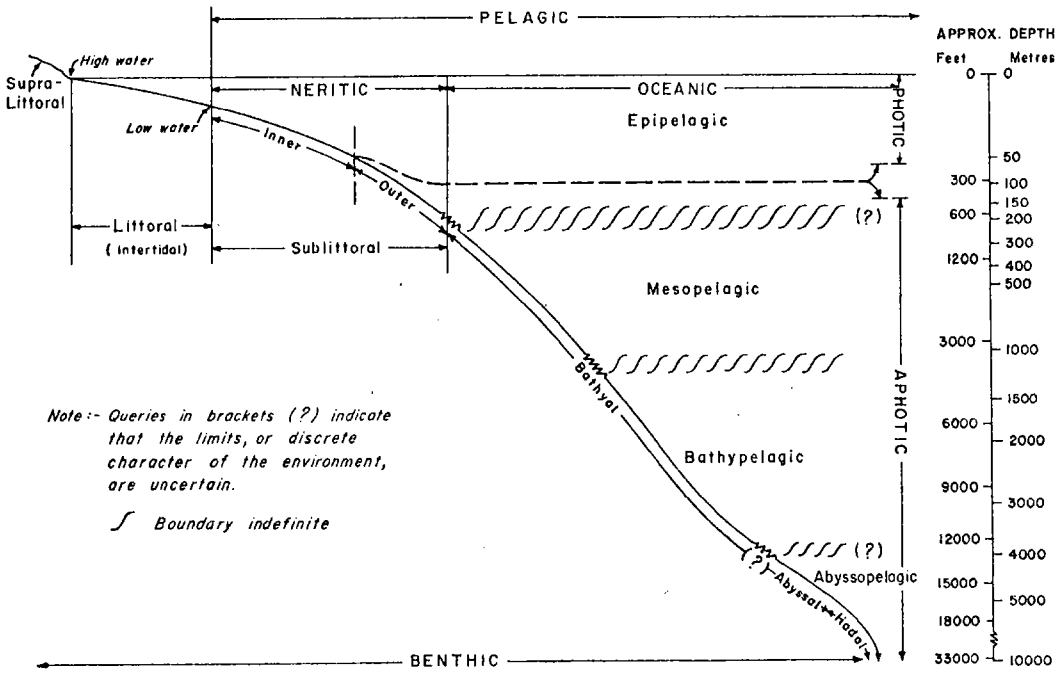
TABLE 1

Interval	Thickness	Stage	System/ Subsystem
186m - 264m	+ 78m	--	?Lower Eocene
270m - 330m	± 60m	--	Palaeocene
336m - 402m	± 66m	Danian	Lower Palaeocene
408m - 504m	± 96m	Maastrichtian	Upper Cretaceous
510m - 540m	± 30m	early Maastrichtian	
543m - 618m	± 75m	late Campanian	
624m - 759m	±135m	early Campanian	
765m - 795m	± 30m	Santonian	
798m - 975m	±177m	Coniacian	
978m - 1029m	± 51m	?Turonian	
1035m - 1038m	± 3m	Turonian	
1044m		Cenomanian	
1044m - 1098m	± 54m	Albian-Aptian	Lower Cretaceous
1104m - 1113m	± 9m	Barremian	
1119m - 1285m	±166m	Hauterivian	
1290m - 1323m	± 33m	Valanginian	
1329m - 1353m	± 24m	Ryazanian	
1359m - 1398m	± 39m	Volgian (o)	Upper Jurassic
1404m - 1475m	± 71m	Kimmeridgian (pl)	
1479m - 1524m	± 45m	Bathonian - Bajocian	Middle Jurassic

Interval	Thickness	Stage	System/ Subsystem
1530m - 1578m	± 48m	--	Triassic
1581m - 1809m	±228m	Zechstein	Upper Permian
1815m - 1818m	± 3m	--	Indeterminate (?Lower Palaeozoic)
1824m - 1842m	+ 18m	--	Precambrian

TABLE 2

CLASSIFICATION OF MARINE ENVIRONMENTS



The classification of marine environments used in this report is presented in diagrammatic form above. Pelagic (water) and Benthic (bottom) environments are recognised.

PELAGIC	BENTHIC
Neritic	Supralittoral
Oceanic	Littoral (Intertidal)
Epipelagic	Sublittoral
Mesopelagic	Inner
Bathypelagic	Outer
Abyssopelagic	Bathyal
	Abyssal
	Hadal

The classification is after Hedgpeth (1957) and results from several years discussion by a Committee of the Division of Earth Sciences, National Research Council, National Academy of Sciences, Washington D. C.

SUBSYSTEMS	STAGES			SUB-STAGE DIVISIONS AS USED IN THIS REPORT	
	Traditional English usage		AS USED IN THIS REPORT	INFORMAL SUB-STAGE AGES	BIOSTRAT. UNITS
LOWER CRETACEOUS	BERRIASIAN		RYAZANIAN		
UPPER JURASSIC	PORTLANDIAN		VOLGIAN	*late*	n
				mid	o 1
	KIMMERIDGIAN	M. - U.		*early*	o 2
		LOWER	KIMMERIDGIAN	*late*	p 1
				early	p 2
	OXFORDIAN			*late*	
				mid	q 1/2
				early	r
MIDDLE JURASSIC	CALLOVIAN			*late*	s 1
				mid	s 2
				early	t 1 a
	BATHONIAN			*late*	t 1 b
				mid	t 2 a/b
				early	v 1
	BAJOCIAN			*late*	v 1
				early	v 2
LOWER JURASSIC	TOARCIAN			*late*	w
				early	x 1
	PLIENSBACHIAN	U.	DOMERIAN		x 2
		L.	CARIXIAN		y
	SINEMURIAN			*late*	y
				early	z 1
	HETTANGIAN				z 2 a
UPPER TRIASSIC	RHAETIAN				z 2 b

TABLE 3

THE BIOSTRATIGRAPHIC UNITS OF THE JURASSIC AS ESTABLISHED BY ROBERTSON RESEARCH INTERNATIONAL LIMITED

DATE: OCT. 1975

TERTIARY

INTERVAL 186m - 264m; ?Lower Eocene

General Lithology

Clay is the dominant lithology. This is brownish grey or olive grey, shaly and micaceous. In the upper few samples coarse sand, granules and pebbles are present together with shell fragments but these are considered to be caved. At 210m there is an incoming of very fine to fine, clear sand which is believed to be in situ. This sand continues down to about 234m. Glauconite is also present in trace amounts at 210m and is then present in some abundance from 228m to the base of the interval. It is fine to medium-grained and light to moderate green in colour.

Micropalaeontology and Stratigraphy

The only diagnostic form that occurs in this section is a single specimen of Turrilina brevispira at 198m. The rest of the section is virtually devoid of foraminifera but radiolaria are noted in high numbers from about 228m. Some reworking of chalky bryozoan material is seen at the top of the section.

Considering the limited microfaunal data and the evidence of reworking the interval can only be considered to be of ?Lower Eocene age.

Environment

The presence of specimens of Bathysiphon and Haplophragmoides together with a dominantly clay lithology tends to

indicate a deep water environment of deposition. The absence of planktonic foraminifera indicates that the area was not exposed to full oceanic conditions. However below 228m other factors that appear to be independent of oceanic conditions, such as nutrient supply, were suitable for the development of the radiolaria. On the available evidence it is suggested that outer sublittoral to bathyal conditions prevailed during this interval.

INTERVAL 270m - 330m; Palaeocene

General Lithology

The top sample consists of olive grey clay, below which at 276m there is an incoming of abundant tuffs. These continue to be abundant to 300m and thereafter occur in smaller amounts. The tuffs are mainly dark grey with a rough nobbly texture containing dark brown glass shards. Others are speckled light grey and black with a highly calcareous groundmass or dusky yellowish brown with black mineral fragments. Olive grey clay also occurs in which abundant black minerals are present. Between 318m and 330m sand is present in moderate amounts. It is very fine to fine-grained, clean and angular sand and is associated with minor quantities of glauconite. In the bottom sample there is also some light grey, moderately hard claystone.

Micropalaeontology and Stratigraphy

The top of the Palaeocene is placed on the influx of Coscinodiscus sp. 1. This is accompanied by Coscinodiscus sp. 2

and an influx of large flattened radiolaria. A Palaeocene age for this section is further indicated by the exceptionally good development of tuffaceous material at 276m and below.

The microfauna is impoverished, Haplophragmoides spp. being the dominant foraminifera. Red staining is noted in the upper part of this section.

Environment

A restricted outer sublittoral to bathyal environment of deposition is postulated for this interval since the microfauna and background lithology remain essentially unchanged from the overlying section. A degree of igneous activity is noted and this is reflected in the abundance of Coscinodiscus and radiolaria both of which are silica dependent organisms. The abundance of tuffs also implies a nearby source and recent work has suggested this to be in the Skagerrak to the east of this well.

INTERVAL 336m - 402m; Danian, Lower Palaeocene

General Lithology

An incoming of chalk occurs at the top of this interval. It is very light grey, firm and contains abundant sponge spicule cavities. Some glauconite and light grey chert also occur. The top two samples, however, still contain very common clay and claystone as in the interval above, but from 448m downwards chalk and chert occur exclusively. At about 366m the chalk becomes light grey and contains rare glauconite.

Micropalaeontology and Stratigraphy

The top of the Danian is placed on an influx of Lower Palaeocene-type fauna and the first occurrence of a chalk lithology at 336m. Confirmation that Danian sediments have been penetrated is given by the occurrence of Globorotalia compressa at 342m. This is followed lower in the section by Globigerina cf. pseudobulloides, Globigerina pseudobulloides and Gavelinonion nobilis. A good planktonic assemblage dominated by Globigerina cf. triloculinoides occurs at 390m near the base of the section. In general, however, the assemblage is poorly developed. Sponge spicules are noted in abundance at 354m.

Environment

On microfaunal and lithological evidence a general inner to outer sublittoral environment of deposition is envisaged for this interval. The presence of planktonic foraminifera suggests that conditions were not restricted as in the overlying intervals and that at least limited mixing of oceanic and coastal waters occurred.

V

CRETACEOUS

INTERVAL 408m - 504m; Maastrichtian, Upper Cretaceous

General Lithology

Chalk is the dominant lithology throughout this interval. Initially it is light grey and firm but below about 445m it becomes increasingly very light grey to white in colour and softer and smoother in texture. Chert is less abundant than in the overlying interval; it is initially light grey but becomes light brown translucent and also dark grey and brownish grey. Fossil fragments particularly of bryozoa and echinoids, are locally common.

Micropalaeontology and Stratigraphy

The appearance of Stensioina pommerana in the top sample of this interval indicates that the Maastrichtian has been penetrated. The section between 408m and 439m contains a moderately rich microfauna dominated by non-diagnostic calcareous benthonic foraminifera. Below 439m and throughout the rest of this interval several diagnostic Maastrichtian forms occur, including Bolivina incrassata gigantea, Rugoglobigerina rugosa rugosa, Bolivina incrassata incrassata, Bolivinoides draco draco and Abathomphalus mayaroensis. Between 445m and 504m the microfauna is rich, consisting predominantly of calcareous benthonic foraminifera with a subordinate but persistent occurrence of both planktonic and agglutinating foraminifera.

Radiolaria and echinoid debris occur throughout. Ostracoda are fairly common in the lower part of the unit.

Environment

The chalk lithology encountered throughout this interval along with the presence of calcareous benthonic foraminifera, bryozoa and echinoid debris, suggest deposition in an inner sublittoral environment. Planktonic foraminifera are present only in small numbers indicating very little connection with the open sea.

INTERVAL 510m - 540m; early Maastrichtian, Upper Cretaceous

General Lithology

Soft, white chalk is present throughout this interval and the samples are contaminated with cement.

Micropalaeontology and Stratigraphy

The presence of Bolivinoides draco miliaris at 510m indicates that early Maastrichtian sediments have been penetrated. The microfaunal assemblage is rich and consists predominantly of calcareous benthonic foraminifera with subordinate numbers of planktonic and agglutinating foraminifera. Bryozoa, radiolaria and echinoid debris are common throughout while ostracodes are fairly common at the top of the interval.

Environment

A shallow inner sublittoral environment with poor connections to the open sea is thought to have existed in early Maastrichtian times for reasons similar to those given for the overlying interval.

INTERVAL 543m - 618m; late Campanian, Upper Cretaceous

General Lithology

Soft, white chalk is again the dominant lithology but minor developments of light brownish grey or very light grey chert also occur. At 579m some hard, white, cherty limestone is developed.

Micropalaeontology and Stratigraphy

The appearance of Globotruncana marginata at 543m indicates that late Campanian sediments are present in this well. The microfaunal assemblage is similar to that of the overlying unit, consisting predominantly of calcareous benthonic foraminifera accompanied by small numbers of planktonic and agglutinating foraminifera. Echinoid debris and sponge spicules are common throughout this interval but bryozoa and radiolaria are less persistent. Ostracoda occur fairly abundantly throughout.

Environment

The decrease of bryozoan fragments and relative increase of sponge spicules possibly indicate slightly deeper water than

that of the overlying interval; therefore, an inner to outer sublittoral environment is postulated for this unit.

Planktonic foraminifera persist throughout the interval, but are never very common, therefore there were limited connections with the open sea.

INTERVAL 624m - 759m; early Campanian, Upper Cretaceous

General Lithology

Again soft, white chalk is present. Chert is absent from this interval but small fossil fragments are locally common.

Micropalaeontology and Stratigraphy

The incoming of Globorotalites micheliniana at 624m and the subsequent appearance of Gavelinella clementiana at 690m suggest the presence of early Campanian deposits. The microfaunal assemblage is rich and is again dominated by calcareous benthonic foraminifera, still accompanied by persistent but small numbers of planktonic and agglutinating foraminifera. Echinoid debris and sponge spicules are very common throughout the interval and the ostracode genus Cytherella is fairly abundant.

Environment

The lithology and microfauna again suggest that deposition occurred in an inner to outer sublittoral environment with a slight open marine effect.

INTERVAL 765m - 795m; Santonian, Upper Cretaceous

General Lithology

Soft, white chalk occurs together with light brownish grey, translucent chert.

Micropalaeontology and Stratigraphy

The appearance of Stensioina exsculpta granulata at 765m indicates that deposits of Santonian age have been penetrated. Confirmation of this age is given by the occurrence of Stensioina exsculpta gracilis at 783m. The microfaunal assemblage is moderately rich and dominated by calcareous benthonic foraminifera in which the genus Stensioina is common. Agglutinating foraminifera occur in persistently small numbers but planktonic foraminifera are only found sporadically. Echinoid debris and sponge spicules are common but ostracodes are much less abundant.

Environment

A general sublittoral environment is postulated for this interval on the evidence given by the lithology and microfaunal assemblage. Conditions may have been more restricted than during the early Campanian since planktonic foraminifera are virtually absent.

INTERVAL 798m - 975m; Coniacian, Upper Cretaceous

General Lithology

Soft, white chalk together with light brownish grey, translucent chert continue down to about 819m. Below this the chalk becomes harder and grades towards a limestone, with its colour changing from white to very light grey. Then further down the section at 864m it becomes light grey with locally abundant small calcite fragments. This lithology continues to about 925m below which there is a gradual re-appearance of very light grey chalk which at this level contains very fine or silt sized glauconite together with traces of mica, calcite, and Inoceramus fragments.

Micropalaeontology and Stratigraphy

The increase of planktonic foraminifera at 798m with the re-appearance of Globotruncana linneiana tricarinata and Globotruncana cf. arca is thought to be indicative of Coniacian deposits. Confirmation of a Coniacian age is given by the appearance of Globotruncana linneiana cf. coronata at 890m and Globotruncana linneiana coronata with Globotruncana linneiana linneiana at 953m. The microfaunal assemblage predominantly consists of calcareous benthonic foraminifera over the section 798m - 929m, below which the planktonic foraminifera increase in numbers and become the most important foraminiferal group. Echinoid debris and sponge spicules are common throughout the unit with radiolaria becoming abundant below 869m. Ostracodes are rare.

Environment

The lithology and microfaunal assemblage down to 929m suggest that a restricted, general sublittoral environment prevailed during the deposition of this section. From 935m to the base of the interval the increase in planktonic foraminifera indicates that the sublittoral environment was greatly affected by open marine influences.

INTERVAL 978m - 1029m; ?Turonian, Upper Cretaceous

General Lithology

Moderately soft, slightly glauconitic and slightly micaceous, light grey chalk is present in the top two samples. At 990m there is an influx of light to medium grey chalk, limestone and argillaceous limestone/calcareous shale but in the sample below at 993m there is a return to very light grey chalk containing both glauconite and small calcite fragments. This lithology continues to the base of the interval.

Micropalaeontology and Stratigraphy

The increase of planktonic foraminifera at 978m, including forms which have been assigned to Praeglobotruncana cf. stephani, suggests that possible Turonian sediments are present. The microfaunal assemblage of this interval is moderately rich and dominated by planktonic foraminifera with subordinate numbers of calcareous benthonic and agglutinating foraminifera present. Radiolaria are common throughout the interval. Ostracodes are absent.

Environment

The lithology and microfaunal assemblage of this interval are indicative of an open marine, inner to outer sublittoral environment.

INTERVAL 1035m - 1038m; Turonian, Upper Cretaceous

General Lithology

This interval contains soft,white to very light grey chalk with calcite fragments and glauconite.

Micropalaeontology and Stratigraphy

The appearance of Praeglobotruncana stephani and Lingulogavelinella turonicus at 1035m indicates that Turonian deposits have been penetrated. The creamy-white chalk preservation of the microfauna throughout this interval is diagnostic of a Turonian age. The microfaunal assemblage is moderately rich and consists predominantly of planktonic foraminifera.

Environment

The lithology and microfauna of this interval are indicative of an open marine, inner to outer sublittoral environment.

INTERVAL 1044m; Cenomanian, Upper Cretaceous

General Lithology

The sample consists predominantly of soft, white to very light grey chalk with subordinate soft, pink chalk. From the colouration of the fossils it is suggested that the pink chalk is Lower Cretaceous in age while the white-grey chalk is Cenomanian.

Micropalaeontology and Stratigraphy

The occurrence of the diagnostic Cenomanian form Gavelinopsis cenomanica in this sample suggests that a thin section of Cenomanian sediments is present. Lower Cretaceous sediments also occur at this depth.

Environment

An open marine, inner to outer sublittoral environment is postulated for this interval, similar to that of the overlying unit.

INTERVAL 1044m - 1098m; Albian-Aptian, Lower Cretaceous

General Lithology

The lithology at the top of this interval, represented by the sample at 1044m, is soft, pink chalk. At 1050m there is a variety of lithotypes including soft, reddish brown marl, greyish black clay, light grey, micaceous, calcareous and glauconitic siltstone, fine to medium-grained glauconite and brownish black lignite. From 1053m to the base of the interval

greyish black, slightly calcareous clay is the main lithology. In addition traces of dark brown, crystalline dolomite occur at 1068m and pyrite is present in small amounts below this.

Micropalaeontology and Stratigraphy

Moderate to poor assemblages have been recovered from this interval although at 1050m good numbers of foraminifera are present.

The appearance of a solitary pink-stained specimen of Anenobulimina macfadyeni at 1044m tentatively suggests the presence of Albian sediments. This is confirmed by a more marked microfaunal change at 1050m and the incoming of Gavelinella intermedia and Hedbergella planispira.

A general Albian-Aptian age determination has been assigned to this interval because it has not been possible to define satisfactorily the Albian-Aptian boundary. It is possible, however, that interval 1095m - 1098m, based on the incoming of Hedbergella infracretacea may be of Aptian age. Evidence for the presence of the Aptian age is provided by the occurrence at 1128m, as caved forms, of the ostracodes Pontocyprella rara and Schuleridea derooi.

Environment

The assemblages recovered from this section are composed of calcareous benthonic and agglutinating foraminifera with a minor planktonic element. This composition suggests a general sublittoral environment of deposition with little open marine influence.

INTERVAL 1104m - 1113m; Barremian, Lower Cretaceous

General Lithology

This interval consists of dark grey to greyish black clay with minor amounts of light to medium grey limestone.

Micropalaeontology and Stratigraphy

It has proved difficult to identify the top of the Barremian, however, the appearance at 1104m of Gavelinella barremiana suggests the penetration of the Barremian. Hedbergella infracretacea occurs more commonly in this interval.

Environment

A general sublittoral environment is again indicated for this interval. The slightly higher numbers of planktonic foraminifera in comparison to the overlying and underlying sections suggests greater open marine influence and perhaps greater water depths.

INTERVAL 1119m - 1285m; Hauterivian, Lower Cretaceous

General Lithology

Dark grey,calcareous clay is the dominant lithology to a depth of 1218m. Minor lithologies in this upper section include pyrite, dark brown,crystalline dolomite, fine to medium glauconite and medium grey,cryptocrystalline limestone. In the section from 1225m to the base of the interval there is an important development of sand. This is mainly very fine

and silty, but coarse to very coarse, clear, rounded sand occurs sporadically. Dark grey clay or soft shale, however, is still present in abundance.

Micropalaeontology, Palynology and Stratigraphy

Moderate numbers of foraminifera were consistently recovered from this interval. The assemblages are dominated by species of relatively large calcareous benthonic forms. Upper Cretaceous caving is common at 1239m and 1245m.

The occurrence of significant numbers of Epistomina ornata and Epistomina caracolla caracolla (both particularly prominent between 1230m and 1239m) in association with Vaginulinopsis humilis humilis, Hechtina antiqua and Lenticulina schreiteri indicates an Hauterivian age for this interval.

Three samples towards the base of this interval (1260m, 1272m, 1281m) were examined for palynomorph content. They proved to be rich in dinoflagellate cysts, with considerable species diversity; miospores are less common, exhibit lower species diversity, with Bisaccate grains being the dominant element.

Most of the dinoflagellate cyst species present are of general early Cretaceous age, with few forms restricted to the Neocomian. A tabulate form of Muderongia simplex from 1272m has not been recorded from deposits younger than Hauterivian.

A sidewall core sample at 1285' contained a rich palynomorph assemblage dominated by dinocysts. Two specimens of Tubotuberella apatela were recorded in this assemblage. This species has only rarely been recorded from the earliest Hauterivian in this area of the North Sea.

Kerogen from this section is dominantly inertinite, with some telinite. Some plant debris, possibly attributable to a lignite-based additive compound is also present.

Environment

The association of large calcareous benthonic foraminifera, gastropods and bivalve debris suggests that these deposits were laid down under inner sublittoral conditions.

The wide diversity of microplankton species present suggests open marine conditions with good current circulation. The relatively low numbers of miospores, with the dominanace of wind-dispersed Bisaccate grains suggests a distant shoreline, although minor amounts of woody debris (telinite) and some miospores were introduced from a terrestrial source.

INTERVAL 1290m - 1323m; Valanginian, Lower Cretaceous

General Lithology

Sand and soft shale or clay like that of the overlying interval is present here. In addition some medium grey, cryptocrystalline limestone occurs at 1299m.

Micropalaeontology, Palynology and Stratigraphy

A distinct microfaunal change occurs at 1290m with an increase in the numbers of agglutinating foraminifera. The presence of Ammovertella Cellensis in these assemblages indicates that the Valanginian has been penetrated.

Palynomorph assemblages from this interval are poorer both in diversity and abundance of dinocysts and miospores. The uppermost sample at 1290m is richer than underlying samples, but this is attributed to caving from the more prolific overlying Hauterivian interval.

The dinocysts recorded from this interval were all present in the Hauterivian. Consequently, it is possible that some of them may be caved. Miospores are sparse in samples 1290m and 1311m. A rich miospore assemblage was recorded at 1302m, which included the reworked Triassic form Ricciisporites tuberculatus, and at 1320m.

Kerogen from this interval is dominantly inertinite, although rather sparse. Again, it is possible that most of the kerogen has caved from the Hauterivian.

The paucity of microplankton and an increase of the miospore content of assemblages from this interval suggest that a different formation has been penetrated. As no new species of microplankton have been recorded, and the miospores indicate only a general early Cretaceous age, the palynomorph assemblages do not permit an age determination more precise than pre-Hauterivian.

Environment

A similar inner sublittoral environment as indicated for the Hauterivian is suggested for this section. The increase in the agglutinating component of the assemblages may suggest that water depths were shallower than in the Hauterivian.

Sparse microplankton also suggest shallower water possibly associated with restricted marine conditions. Periodic increases in miospore abundance indicate a closer shoreline than in the Hauterivian, with greater emphasis of palynomorphs derived from a terrestrial source.

INTERVAL 1329m - 1353m; Ryazanian, Lower Cretaceous

General Lithology

Greyish black to dark grey clay or soft shale is the main lithology. In addition, medium to dark grey, cryptocrystalline limestone occurs in the upper part of the interval together with light brown, translucent calcite. Other minor lithologies include light to moderate brown, cryptocrystalline siderite, pyrite and very fine to fine sand.

Micropalaeontology, Palynology and Stratigraphy

The top of this interval has been drawn on the appearance of orange-stained foraminifera which coincides with an increase in the calcareous benthonic component of the microfauna. From 1338m agglutinating foraminifera form a more significant element of the assemblage.

No diagnostic forms have been recovered from this interval but the general aspect of the microfauna and the appearance of Epistomina "stellicostata", Conorboides valendisensis and the ostracode Mandelstamia sp. suggest that this section is of Ryazanian age. Further evidence for a Ryazanian age occurs at 1359m where the ostracodes Schuleridea juddi and Mandelstamia sexti are recorded.

Very prolific microfloras were recovered from this interval. Miospores dominate the assemblages in the upper part (1329m and 1341m), whilst in the lower part (1347m SWC and 1350m) approximately equal proportions of microplankton and miospores are present. In all samples the high numerical abundance is accompanied by a high species diversity.

The marked increase in microfloral abundance indicates that a different formation has been penetrated at the top of this interval, although again most of the dinocysts present indicate a general early Cretaceous age. However, the association of Tubotuberella apatela (particularly abundant in 1347m SWC) with Scriniodinium "magnificum" together with the species Parvocavatus tuberosus indicates a Ryazanian age.

Kerogen content over this interval is mostly inertinite, with telinite and minor amorphous sapropel in the sidewall core.

Environment

The general assemblages recovered from this interval suggest that sedimentation occurred in an inner sublittoral environment.

Palynomorph assemblages indicate that considerable amounts of terrestrial derived elements were entering the area of deposition. This influence is more strongly felt in the upper part of the interval. Towards the base marine microplankton become more abundant, possibly indicating a more distant shoreline at this time. Acanthomorph acritarchs are fairly common throughout the interval, which is usually interpreted (Wall, 1965) as indicating that deposition occurred in a nearshore high-energy environment.

VI

JURASSIC

INTERVAL 1359m - 1398m; Volgian(o), Upper Jurassic

General Lithology

Dark grey clay or soft shale is again present. In addition some black lignite occurs at 1359m and medium grey, calcite-veined limestone just below. Small amounts of pyrite, shell fragments and very fine sand also occur in the samples.

Micropalaeontology, Palynology and Stratigraphy

The top of the Jurassic has been drawn at 1359m on the appearance of the ostracodes Galliaecytheridea wolburgi, Galliaecytheridea spinosa and Mandelstamia tumida and a distinct palynofacies change. The subsequent occurrence of diagnostic Upper Jurassic dinocysts and foraminifera supports this conclusion.

The microfaunas recovered from this interval are generally impoverished and are dominated by calcareous benthonic foraminifera. Lower Cretaceous caving is prominent making it difficult to establish whether many of the foraminifera are in situ or not.

The incoming of the ostracodes mentioned above indicates a Volgian (unit o) age. This determination is supported by the appearance of Saracenaria triquetra, an Upper Jurassic species which is more commonly recorded in the Volgian-Kimmeridgian section. Of note is the appearance at the base of the interval of Conorboides nudus a form which may be of local stratigraphic significance.

The top of this interval is also marked by a change of palynofacies; palynomorphs become comparatively rare, and inertinite is the dominant kerogen. Most of the palynomorphs recorded have a similar preservation to those from the overlying interval, suggesting that they are caved. Forms assumed to be in situ are all long-ranging. Palynomorph assemblages are too meagre to permit an age determination for this interval.

Environment

The presence of an impoverished microfauna comprising ostracodes, calcareous benthonic and agglutinating foraminifera suggests that deposition took place in a sublittoral environment. The fact that these assemblages are at times associated with echinoderm and bivalve debris would indicate probable inner sublittoral conditions of deposition.

INTERVAL 1404m - 1475m; Kimmeridgian (p1), Upper Jurassic

General Lithology

This is much the same as the interval above with soft, dark grey shale or clay predominating. A distinct limestone band occurs around 1410m. This is medium dark and dark grey, finely crystalline and calcite-veined. Pyrite and fine sand are present in minor quantities for most of the interval but a major influx of sand occurs in the ditch cuttings at 1473m. This is mainly very fine to medium and occasionally coarse-grained, moderately sorted, subangular to subrounded, clear and colourless. The sidewall core at 1475m, representing the base of the interval, is a friable sandstone composed of similar grains.

Micropalaeontology, Palynology and Stratigraphy

A marked microfaunal change is apparent at 1410m with the significant influx of agglutinating foraminifera. The assemblages are initially rich in numbers but below 1419m the numbers decrease. Moderate assemblages persist down to 1449m but subsequently become impoverished. Agglutinating foraminifera predominate in the interval 1410m - 1443m but below this agglutinating and calcareous benthonic forms occur in equal proportions.

The general aspect of the foraminiferal assemblage recovered from these sediments indicates a Kimmeridgian-Oxfordian age. This is confirmed by the presence of the ostracodes Mandelstamia rectilinea, M. triebeli, Galliaecytheridea cf. mandelstami and Orthonotacythere interrupta which suggest a more restricted Kimmeridgian age.

Palynomorph assemblages from this interval again contain a majority of caved forms. At 1410m, however, there are forms which, from their state of preservation and their first appearance at this depth, are assumed to be in situ. These include species such as Oligosphaeridium pulcherrimum and ?Systematophora sp., indicative of a general Upper Jurassic age. The associated occurrence of "Membraniaulax" sp. (Glossodinium dimorphum of Ioannides, Stavrinos and Downie, in press) at 1404m, a form having its acme in the early Volgian/late Kimmeridgian, and Scriniodinium ?oxfordian, a form appearing downhole in the Kimmeridgian, suggests that this interval is of Kimmeridgian (pl) age.

In two ditch cuttings samples in the lower part of the underlying interval (1509m, 1521m) rich assemblages of miospores and dinocysts were recorded. These are interpreted as being caved, as Gonyaulacysta granulata/granuligera is the dominant morphotype among the dinocysts, and such an occurrence is typical of the early Kimmeridgian/late Oxfordian (p2.) However, a sidewall core at 1475m contains an assemblage of P1 aspect, whilst at 1479m the palynofacies (inertinite and large telinite fragments) suggests a Middle Jurassic age. It appears, therefore, that a very thin horizon of p2 age is probably present, although it is too thin to be detected in the samples covering this part of the well.

Environment

The significant numbers of agglutinating foraminifera in association with calcareous benthonic foraminifera and ostracodes suggest that inner sublittoral water depths prevailed during Kimmeridgian times.

The generally poor palynomorph assemblages from sediments of p1 age, and the dominance of amorphous sapropel suggests a restricted marine environment of deposition, with poor water circulation.

Evidence from cavings indicate that the environment of deposition of the postulated p2 sediments occurred in an open marine environment, with good water circulation as dinocysts are abundant, but fairly near-shore since miospores are common.

INTERVAL 1479m - 1524m; Bathonian-Bajocian, Middle Jurassic

General Lithology

This is mainly a sandy interval with minor shale or clay interbeds. The sand is chiefly very fine to medium and moderately sorted; occasional coarse grains occur initially, but in the lower part of the section the sand is distinctly coarser and more poorly sorted. For the most part grains are clear, colourless or greyish, but increasing amounts of green-stained grains occur down the section, and in the basal sample at 1524m nearly all of the sand has a dark greenish colouration. In the ditch cuttings the sand is entirely unconsolidated apart from some minor calcareous-cemented sandstone.

Shales in the interval are dark grey although an olive grey claystone is represented in the sidewall core at 1520m. Traces of lignite occur at 1509m and some moderate brown, very finely crystalline dolomite is present at 1518m.

Micropalaeontology, Palynology and Stratigraphy

There is considerable variation of kerogen content in the ditch-cuttings samples over this interval. At 1479m the appearance of inertinite and telinite in the kerogen suggests a Middle Jurassic facies, although there is a minor amount of amorphous sapropel, similar in appearance to that from the overlying Kimmeridgian. Amorphous sapropel is dominant at 1480m, but then becomes of lesser importance, with inertinite and telinite regaining dominance.

Palynomorphs from ditch-cuttings samples are the same morphotypes as those from the Kimmeridgian, and exhibit a similar state of preservation, with the exception of samples at 1509m and 1521m discussed above.

It appears probable that the majority of kerogen and palynomorphs in this interval, recovered from ditch-cuttings samples, are caved into a section which is otherwise very poorly fossiliferous.

The exception to this generally poorly fossiliferous nature is a sidewall core at 1520m. This contains a very rich assemblage of miospores of typical Middle Jurassic aspect, with Callialasporites dampieri group, Bisaccates, Cerebropollenites mesozoicus, Perinopollenites elatoides and Inaperturopollenites being abundant, with a diversity of more exotic forms also present.

Dinocysts are very rare in the assemblage, but of the forms Gonyaulacysta jurassica and Scriniodinium oxfordianum both range down into the Bathonian, whilst the forms Gonyaulacysta filapicata and Endoscrinium cf. eisenacki are typical of a Bathonian age.

Ostracodes recorded from the upper part of this interval, Pneumatocythere bajociana and ?Asciocythere sp. have been recorded only from the Bajocian, but it is possible that their ranges may extend up into the Bathonian.

The available evidence favours a Bathonian age determination, although there is a possibility of Bajocian sediments being present. The interval is therefore accorded a Bathonian-Bajocian age.

Environment

As it is only possible to regard the palynomorphs from a single sidewall core to be in situ, and the claystone lithology

of this sample is atypical of the general lithology of the interval, the environmental interpretation of the assemblage cannot be regarded as being representative of the whole interval.

The assemblage, being dominated by miospores, suggests that deposition occurred in a near-shore environment, with strong terrestrial influences. The rare dinocysts indicate that minor marine influences were present. Overall, the assemblage is suggestive of a deltaic environment.

The occurrence of lignite is also indicative of a near shore, possibly deltaic environment and this fits in with the regional palaeogeography, that of a widespread Middle Jurassic deltaic facies.

TRIASSIC

INTERVAL 1530m - 1578m; Triassic

General Lithology

Basically this interval consists of poorly sorted sand with shale or claystone interbeds. The sand is very fine to very coarse with, particularly in the top sample, granules and pebbles. Quartz is the main constituent, being colourless or pink and green-stained. In addition at 1530m there are abundant cream quartzitic fragments. Shales and claystones become relatively more common in the lower part of the section where they are light to moderate green, reddish brown, medium grey and sometimes silty, waxy or micaceous.

Palynology and Stratigraphy

Only caved palynomorphs were recorded from ditch cuttings samples over this interval. A sidewall core at 1542m proved to be barren of palynomorphs, and contained a sparse kerogen of inertinite and vitrinite. A few Cretaceous/Jurassic forms were recovered from a sidewall core at 1565m, but these are regarded as drilling-mud contaminants. Kerogen from this sample was essentially the same as the higher sidewall core, although some material had been introduced by contamination.

Due to the absence of diagnostic palynomorphs, the Triassic age assigned to the interval is based solely on its lithology; the coarse non-marine sand and the red and green shales are typical features of the Triassic of the North Sea. The top of the interval is placed where these lithologies are first encountered.

Environment

The coarse, pebbly sands, together with the red and green shales suggest high energy deposition in a non-marine environment. Proximity of the well to the Fenno-Scandian Shield suggests this to be the source of material, probably with deposition by rapid streams.

VIII

PERMIAN

INTERVAL 1581m - 1809m; Zechstein, Upper Permian

General Lithology

Shales predominate in the top 3 samples, 1581m-1596m. These are mainly medium to dark grey or reddish brown. In addition dusky brown and waxy, micaceous, silty, green-grey shale occurs. Sand similar to that occurring in the interval above, is also present in the top 3 samples, but it may be caved.

Below this, in the section 1599m - 1734m, carbonate lithologies become dominant. Initially these are very light grey or cream, sucrosic, cryptocrystalline or chalky limestones. Dark grey shales also occur in these samples and if in situ may represent interbeds in the limestone. At 1623m clusters of light brown calcite crystals also occur, while just below this the limestone tends to change to a light brown colour with a rather patchy crystalline texture. Very fine vugs are also apparent in this limestone and it becomes partially dolomitic. From about 1670m to the base of this carbonate section the lithologies are more argillaceous. The limestones are generally darker being light to medium grey, quite often containing argillaceous laminae and calcareous shale bands. Some carbonaceous flecks and larger lignite fragments also occur. Generally the limestone here is very finely crystalline or cryptocrystalline and slightly to moderately dolomitic. A minor lithology over this section is white, sucrosic anhydrite.

At 1740m there is a pronounced influx of anhydrite and this continues to be abundant to about 1755m. Limestones with dolomite and shale continue through this anhydritic section. The sidewall core at 1757m and the ditch cuttings sample at 1758m suggest that dark grey, pyritic shale is dominant here but just below this there is a recurrence of cream limestone and dolomite. At 1770m dark grey shale is again the main lithology but the sample also contains black, flattened, non calcareous, ?ironstone ooliths and also some rust-coloured, hard, oolitic ironstone. Medium to dark grey, oolitic dolomite is also present. In the basal 40m dark grey to black, soft shale is the chief lithology. Some very fine to medium sand also occurs in some samples while in the basal sample there is some light grey dolomite.

Palynology and Stratigraphy

Rich assemblages of palynomorphs were recovered from parts of this interval. The two highest samples at 1581m and 1602m contain the forms Perisaccus granulosus, Vittatina spp. and Lueckisporites virrkiae which are characteristic of the Upper Permian (Zechstein).

Below this depth samples contain poor, probably caved assemblages, until at 1640m another rich assemblage is encountered. A presumed barren zone then intervenes, with only very few caved Cretaceous/Jurassic specimens and rare, presumed caved Permian specimens being present. At 1680m rich assemblages of Permian spores reappear, these assemblages continuing down to 1767m.

A sidewall core at 1767.5m was barren of Permian palynomorphs, only a few Cretaceous/Jurassic forms being present from drilling-mud contamination. Further sidewall cores at 1775m and 1808m do contain Permian palynomorphs, but the lower sample also contains a considerable number of forms from the Cretaceous/Jurassic. The general paucity of microfloras below 1767m suggests that this section may be barren of palynomorphs, the forms which were recorded being either caved, in the case of ditch-cuttings samples, or mud contaminants in the case of the sidewall core samples.

It has not been possible to subdivide this Zechstein interval into the units Z1 - Z4 which are recognised in the southern North Sea. However, on lithological grounds it seems probable that the grey-black shale section at the base of the interval is equivalent to the Kupferschiefer.

Environment

From regional palaeogeography and the lithologies present the environment of deposition is considered to be a shallow hypersaline inland sea. The proximity of the well to the Fenno-Scandian Shield and the dominant carbonate lithology (as opposed to salt and anhydrite) suggests that deposition was near the margins of this sea.

IX

INDETERMINATE

INTERVAL 1815m - 1818m; Indeterminate (?Lower Palaeozoic)

General Lithology

The cuttings from this interval are nearly all angular fragments of very hard, quartzitic sandstone. This is medium grey and consists of poorly sorted, very fine to coarse, interlocking quartz grains. Some greyish-black shales are present in the samples but these may be caved.

Palynology and Stratigraphy

With the absence of any diagnostic palynomorphs here one can only speculate on the age. It appears to be the remnants of a basal sandstone on Precambrian granite. Since onshore Norway Precambrian granites and gneiss are known in places to be overlain by Cambrian sandstones, the same relationship may occur here. In any case the sandstone is most likely early Palaeozoic in age.

Environment

No useful data exists with which to give an environmental conclusion.

X

PRE-CAMBRIAN

INTERVAL 1824m - 1842m; Pre-Cambrian

General Lithology

Granitic fragments appear in the ditch cuttings at 1824m but quartzitic sandstones still continue to form the major part of the sample. Below this there is a gradual fall off of sandstone and an accompanying increase in granite fragments. Thin sections of the granite have been described in detail in Report No. 3090P. Partially altered feldspar is the chief constituent with minor quartz.

Stratigraphy

K/Ar age dating on the granite as outlined in the above report gave an age of 689 ± 21m years. This makes it late Pre-Cambrian in age.

The appearance of granitic fragments in the sample at 1824m is taken to indicate the top of the granite basement, but there is a possibility that the granitic fragments in the upper part of this interval are derived from pebbles in a basal conglomerate. There was, however, no evidence such as rounded surfaces to the fragments to indicate derivation from pebbles.

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APPENDIX

Sidewall Core Descriptions

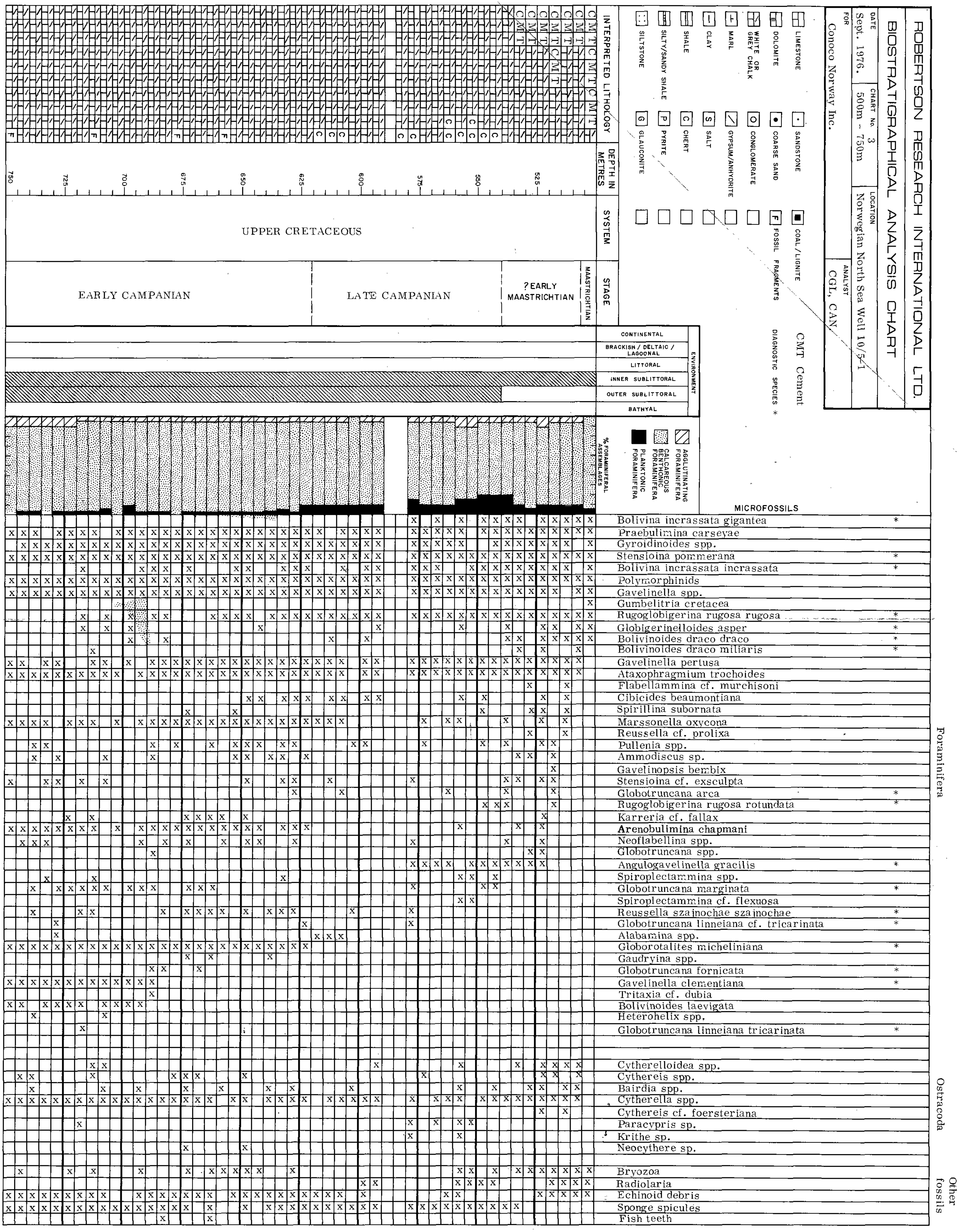
Depth	Core	State of core	Type of analysis	Lithology
1250m	30	Ex	M P	SHALE: dark grey, soft, weakly fissile, slightly silty and micaceous.
1285m	29	Ex	M P	SHALE: as 1250m.
1347m	28	Ex	M P	CLAYSTONE: dark grey, soft, sticky, moderately calcareous.
1475m	24	F	P	SANDSTONE: light olive-grey, mainly fine to medium, moderately sorted, subangular to subrounded quartz, very friable, good porosity.
1510m	21	F		SANDSTONE: as 1475m but with slight greenish colouration.
1520m	20	Ex	P	*CLAYSTONE: olive-grey, moderately hard, with small lens of fine to medium, argillaceous sandstone.
1542m	19	Ex		SANDSTONE: greenish grey, very fine to medium, silty, poorly sorted, grains of angular to subrounded quartz, feldspar and occasional rock and mineral fragments, abundant argillaceous calcareous matrix, friable, low porosity.
1565m	18	Ex		ARGILLACEOUS SILTSTONE: greyish green, silt to very fine sand with abundant slightly calcareous clay, moderately soft.
1600m	16	F		*LIMESTONE: white, very finely crystalline or sucrosic, moderately hard.
1636.5m	14	F		LIMESTONE: yellowish grey, granular texture, moderately hard.

Depth	Core	State of core	Type of analysis	Lithology
1683m	13	F	P	LIMESTONE: yellowish grey, dolomitic crystalline or micritic, with abundant fine, argillaceous laminae and occasional thin, dark grey shale bands.
1705m	11	G	P	LIMESTONE: yellowish grey, micritic, some carbonaceous flecks and streaks, hard.
1715m	10	G	P	LIMESTONE: yellowish grey, with abundant very fine, grey, argillaceous laminae and some carbonaceous flecks, micritic, moderately hard.
1757m	8	P		SHALE: dark grey, soft, moderately fissile.
1767m	6	F		*SHALE: medium dark grey and olive-grey with dark red patches, moderately hard.
1767.5m	5	P	P	*SHALE: dark grey, hard.
1775m	4	P	P	SHALE: dark grey, moderately hard.
1808m	2	P	P	SHALE: as 1775m.

* The bottles of sidewall cores 1520m, 1600m, 1767m and 1767.5m were broken and most of the contents mixed. The lithologies which were considered to match each of these bottles are given above.

M = micropalaeontological analysis.
P = palynological analysis.

Ex = excellent.
G = good.
F = fair.
P = poor.


ROBERTSON RESEARCH INTERNATIONAL LTD.
BIOSTRATIGRAPHICAL ANALYSIS CHART
DATE Sept. 1976.
CHART No. 3 500m - 750m
LOCATION Norwegian North Sea Well 10/5-1
FOR Conoco Norway Inc.
ANALYST CGL, CAN.
LIMESTONE
DOLOMITE
WHITE OR GREY CHALK
MARL
CLAY
SHALE
SILTY/SANDY SHALE
SILTSTONE
SANDSTONE
COARSE SAND
CONGLOMERATE
GYPSUM/ANHYDRITE
SALT
CHERT
PYRITE
GLAUCONITE
COAL/LIGNITE
FOSSIL FRAGMENTS
DIAGNOSTIC SPECIES *
CMT Cement
INTERPRETED LITHOLOGY
DEPTH IN METRES
525
550
575
600
625
650
675
700
725
750
SYSTEM
UPPER CRETACEOUS
STAGE
MAASTRICHTIAN
? EARLY MAASTRICHTIAN
LATE CAMPANIAN
EARLY CAMPANIAN
ENVIRONMENT
CONTINENTAL
BRACKISH / DELTAIC / LAGOONAL
LITTORAL
INNER SUBLITTORAL
OUTER SUBLITTORAL
BATHYAL
% FORAMINIFERAL ASSEMBLAGES
AGGLUTINATING FORAMINIFERA
CALCAREOUS BENTHONIC FORAMINIFERA
PLANKTONIC FORAMINIFERA
MICROFOSSILS
Foraminifera
Bolivina incrassata gigantea *
Praebulimina carseyae
Gyroidinoides spp.
Stensioina pommerana *
Bolivina incrassata incrassata *
Polymorphinids
Gavelinella spp.
Gumbelitria cretacea
Rugoglobigerina rugosa rugosa *
Globigerinelloides asper *
Bolivinoides draco draco *
Bolivinoides draco miliaris *
Gavelinella pertusa
Ataxophragmium trochoides
Flabellammina cf. murchisoni
Cibicides beaumontiana
Spirillina subornata
Marssonella oxycona
Reussella cf. prolixa
Pullenia spp.
Ammodiscus sp.
Gavelinopsis bembix
Stensioina cf. exsculpta
Globotruncana arca *
Rugoglobigerina rugosa rotundata *
Karreria cf. fallax
Arenobulimina chapmani
Neoflabellina spp.
Globotruncana spp.
Angulogavelinella gracilis *
Spiroplectammina spp.
Globotruncana marginata *
Spiroplectammina cf. flexuosa
Reussella szajnochae szajnochae *
Globotruncana linneiana cf. tricarinata *
Alabamina spp.
Globorotalites micheliniana *
Gaudryina spp.
Globotruncana fornicata *
Gavelinella clementiana *
Tritaxia cf. dubia
Bolivinoides laevigata
Heterohelix spp.
Globotruncana linneiana tricarinata *
Ostracoda
Cytherelloidea spp.
Cythereis spp.
Bairdia spp.
Cytherella spp.
Cythereis cf. foersteriana
Paracypris sp.
Krithe sp.
Neocythere sp.
Other fossils
Bryozoa
Radiolaria
Echinoid debris
Sponge spicules
Fish teeth

ROBERTSON RESEARCH INTERNATIONAL LTD.

BIOSTRATIGRAPHICAL ANALYSIS CHART

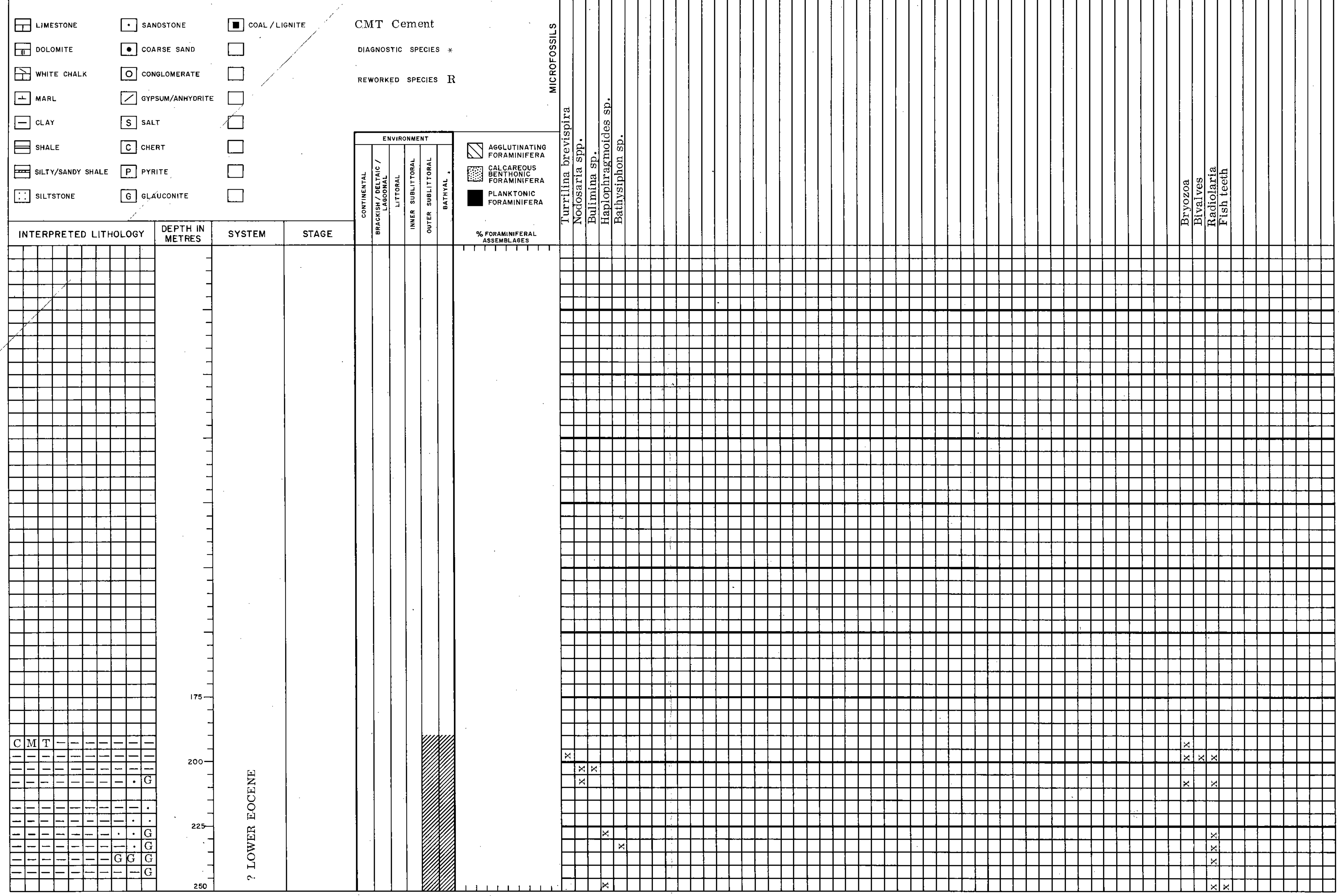
DATE	CHART No.	LOCATION
Sept. 1976.	1 186m - 250m	Norwegian North Sea Well 10/5-1

FOR	ANALYST
Conoco Norway Inc.	NJBH, CGL.

LIMESTONE, DOLOMITE, WHITE CHALK, MARL, CLAY, SHALE, SILTY/SANDY SHALE, SILTSTONE
SANDSTONE, COARSE SAND, CONGLOMERATE, GYPSUM/ANHYDRITE, SALT, CHERT, PYRITE, GLAUCONITE
COAL / LIGNITE

CMT Cement
DIAGNOSTIC SPECIES *
REWORKED SPECIES R

AGGLUTINATING FORAMINIFERA
CALCAREOUS BENTHONIC FORAMINIFERA
PLANKTONIC FORAMINIFERA



10/5-1

FORAMINIFERA RESEARCH INTERNATIONAL LTD.
CONSULTANTS

BIOSTRATIGRAPHICAL ANALYSIS CHART

DATE: Sept. 1976 | CHART No. 2 | LOCATION: Norwegian North Sea 10/5-1 Well

FOR: Conoco Norway Inc. | ANALYST: COL, NJBH, CAN

D-11

LIMESTONE · SANDSTONE · COAL/LIGNITE
DOLOMITE · COARSE SAND · VOLCANICS
WHITE OR GREY CHALK · CONGLOMERATE · FOSSIL FRAGMENTS
MARL · GYPSUM/ANHYDRITE
CLAY · SALT
SHALE · CHERT
SILTY/SANDY SHALE · PYRITE
SILTSTONE · GLAUCONITE
DIAGNOSTIC SPECIES *

INTERPRETED LITHOLOGY

DEPTH IN METRES: 500 475 450 425 400 375 350 325 300 275

SYSTEM: UPPER CRETACEOUS | LOWER PALAEOCENE | PALAEOCENE | ?LOWER EOCENE

STAGE: MAASTRICHTIAN | DANIAN

ENVIRONMENT: CONTINENTAL · BRACKISH / DELTAIC / LAGOONAL · LITTORAL · INNER SUBLITTORAL · OUTER SUBLITTORAL · BATHYAL

% TERRIGENOUS MATERIAL: 100 50 0

CALCAREOUS PLANKTONIC FORAMINIFERA · AGGLUTINATED FORAMINIFERA · CALCAREOUS BENTHONIC FORAMINIFERA

MICROFOSSILS

Foraminifera

Haplophragmoides spp.	
Nodosaria/Dentalina spp.	
Cibicides spp.	
Bathysiphon spp.	
Trochammina globigeriniformis	*
Eponides umbonatus	
Anomalina cf. grosserugosa	
Gaudryina sp.	
Spiroplectammina spectabilis	
Lenticulina spp.	
Nodosaria latejugata	
Bulimina palaeocenica	
Bulimina midwayensis	
Bulimina sp.	
Ammodiscus incertus	
Gavelinella spp.	
Pullenia americana	
Anomalina danica	
Globorotalia compressa	*
Pullenia cf. cretacea	
Globigerina cf. pseudobulloides	*
Gyroidina spp.	
Cibicides succedens	
Pulsiphonina sp.	
Gavelinella teltingensis	
Polymorphinids	
Allomorphina halli	
Arenobulimina cuskleyae	
Globigerina pseudobulloides	*
Globigerina cf. triloculinoides	
Gavelinonion nobilis	*
Eponides sp.	
Ceratobulimina sp.	
Ataxophragmoides frankei	
Gavelinella vombensis	
Stensioina pommerana	*
Gavelinopsis voltziana	
Gavelinopsis complanata	
Gavelinopsis cf. bembix	
Osangularia lens	
Anomalinoides velascoensis	
Marssonella oxycona	
Stilostomella spinosa	
Cibicides beaumontiana	
Flabellammina cf. murchisoni	
Dorothia spp.	
Gyroidinoides nitida	
Planularia harpa	
Bolivina incrassata gigantea	*
Pullenia cretacea	
Gavelinella pertusa	
Ataxophragmium cf. trochoides	
Praebulimina carseyae	*
Ammodiscus sp.	
Rugoglobigerina rugosa rugosa	*
Ataxophragmium trochoides	*
Discopulvinulina binkhorsti	*
Karreria cf. fallax	
Gyroidinoides octocamerata	
Stensioina cf. exsculpta	
Bolivina incrassata incrassata	*
Bolivinoides draco draco	*
Heterohelix globulosa	*
Abathomphalus mayaroensis	*
Gaudryina cretacea	
Reussella cristata	*
Pullenia sp.	
Spirillina subornata	

Ostracoda

Bairdia spp.	
Krithe sp.	
Cytherella spp.	
Cytherelloidea spp.	
Cythereis sp.	

Other Fossils

Radiolaria	
Large flattened radiolaria	
Coscinodiscus sp. 1	*
Coscinodiscus sp. 2	*
Fish teeth	
Echinoid debris	
Bryozoa	
Brachiopoda	

10/5-1

D-11

ROBERTSON RESEARCH INTERNATIONAL LIMITED

SUMMARY LOG : 10/5-1

AREA : NORWEGIAN NORTH SEA SPUD DATE : 1st JUNE 1976

COMPANY : CONOCO NORWAY COMPLETION DATE : 26th JUNE 1976

INTERVAL STUDIED : 186m - 1842m T.D. 1842·6 m.

Dr. No. 234/1181/3516 SCALE 1:5000 Date : 22:9:76

▮ Cored Interval ◣ Casing Shoe

The lithological symbols are a generalisation of those shown on Biostratigraphical Analysis Charts

SYSTEM	SUB-SYSTEM	STAGE / FORMATION	INTERVAL TOPS (approx.)	CASING AND CORING DETAILS
PALAEOCENE	? EOCENE	? LOWER EOCENE		
	LOWER PALAEOCENE	DANIAN	267m	
			333m	
			405m	
CRETACEOUS	UPPER CRETACEOUS	MAASTRICHTIAN		30"
		? EARLY MAASTRICHTIAN	507m	
		LATE CAMPANIAN	541m	
		EARLY CAMPANIAN	621m	
		SANTONIAN	762m	
		CONIACIAN	795m	
		? TURONIAN	976m	
		TURONIAN	1032m	
		CENOMANIAN	1041m / 1044m	
	LOWER CRETACEOUS	ALBIAN - APTIAN		
		BARREMIAN	1101m	
		HAUTERIVIAN	1116m	20"
		VALANGINIAN	1287m	
		RYAZANIAN	1326m	
		VOLGIAN	1356m	
JURASSIC	UPPER JURASSIC	KIMMERIDGIAN	1401m	
	MIDDLE JURASSIC	BATHONIAN - BAJOCIAN	1477m	
TRIASSIC			1527m	
PERMIAN	UPPER PERMIAN	ZECHSTEIN	1580m	13 3/8"
INDET.			1812m	
PRECAM.			1822m	

DEPTH (METRES / FEET): 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1100, 1200, 1300, 1400, 1500, 1600, 1700, 1800

GENERALISED LITHOLOGY

ENVIRONMENT OF DEPOSITION: CONTINENTAL | FRESHWATER | BRACKISH/DELTAIC/LAGOONAL | LITTORAL | INNER SUBLITTORAL | OUTER SUBLITTORAL | BATHYAL

Hypersaline

ROBERTSON RESEARCH INTERNATIONAL LTD.

BIOSTRATIGRAPHICAL ANALYSIS CHART

DATE	CHART No.	LOCATION
Sept. 1976	1500m-1750m	Norwegian North Sea 10/5-1 Well

FOR	ANALYST
Conoco Norway Inc.	CGL, CND.

LIMESTONE · DOLOMITE · WHITE CHALK · RED SHALE · CLAY · SHALE · SILTY/SANDY SHALE · SILTSTONE

SANDSTONE · COARSE SAND · CONGLOMERATE · GYPSUM/ANHYDRITE · SALT · CHERT · PYRITE · GLAUCONITE

COAL / LIGNITE · CARBONACEOUS SHALE · ARGILLACEOUS LIMESTONE / CALCAREOUS SHALE

DIAGNOSTIC SPECIES * · REWORKED SPECIES

ENVIRONMENT: CONTINENTAL · BRACKISH / DELTAIC / LAGOONAL · LITTORAL · INNER SUBLITTORAL · OUTER SUBLITTORAL · BATHYAL

AGGLUTINATING FORAMINIFERA · CALCAREOUS BENTHONIC FORAMINIFERA · PLANKTONIC FORAMINIFERA

% FORAMINIFERAL ASSEMBLAGES

INTERPRETED LITHOLOGY	DEPTH IN METRES	SYSTEM	STAGE
SWC 1510	1510	MIDDLE JURASSIC	BATHONIAN
SWC 1520	1520		BAJOCIAN
	1525	TRIASSIC	
SWC 1542	1542		
	1550		
SWC 1565	1565		
	1575		
SWC 1600	1600	PERMIAN	ZECHSTEIN
	1625		
SWC 1636.5	1636.5		
	1650		
	1675		
SWC 1683	1683		
	1700		
SWC 1705	1705		
SWC 1715	1715		
	1725		
	1750		

MICROFOSSILS

Foraminifera

Haplophragmoides sp.
Haplophragmoides cf. canui
Trochammina haplophragmoides sp. 1
Trochammina nitida
Microforaminifera
Fonila spp.
Ammobaculites granuligera granulata
Tasmanitids
Oligosphaeridium pulcherrimum
Pareodinia ceratophora
Gonyaulacysta cf. jurassica
Gonyaulacysta spp.
Cleistosphaeridium spp.
Gonyaulacysta jurassica
Gonyaulacysta australis
Scriniodinium dictyotum

Microplankton

Miospores

Baculatisporites Osmundacidites spp.
Cerebropollenites mesozoicus
Perinopollenites elatoides
Cyathidites spp.
Staplinisporites pseudoreticulatus
Callialasporites spp.
Bisaccates
Lycopodiacidites sp.
Inaperturopollenites sp.
Deltoidospora spp.
Cyathidites minor
Callialasporites dampieri group
Lycopocumsporites sp.
Concavissimisporites spp.
Concavissimisporites cummins group
Staplinisporites sp.
Lepolepidites major
Densoisporites velatus
Cyathidites australis
Contignisporites sp.
Striatascus spp.
Striatina spp.
Protohaploxypinus spp.
Protohaploxypinus amoenus
Lucclisporites virkkiae
Striatascus tabulatus
Perisascus granulosus
Striatopodocarpites sp.
Protohaploxypinus chaloneri
Illenites sp.
Klausipollenites schaubergeri
Vitreisporites pallidus
Jugasporites delcarmenei
Striatascus novitaensis
Vesicaspora milvinus
Limitisporites lepidus
Vesicaspora sp.
Lunatisporites spp.
Pterisiraetopunites tener
Falcisporites zapfei
Acanthaulacisporites samoilovichi
Acanthaulacisporites obscurecostus
Vesicisporites sp.

Dominant Kerogen

Inertinite
Vitrinite

Palynology Cavings

Lower Cretaceous caving
Upper Jurassic caving
Middle Jurassic caving

Other Fossils

? Conosphaera spp.

ROBERTSON RESEARCH INTERNATIONAL LTD.

BIOSTRATIGRAPHICAL ANALYSIS CHART

DATE: Sept. 1976. | CHART No. 8: 1750m-1842m | LOCATION: Norwegian North Sea 10/5-1 Well

FOR: Conoco Norway Inc. | ANALYST: CGL, CND

LIMESTONE, DOLOMITE, WHITE CHALK, RED MARL OR SHALE, CLAY, SHALE, SILTY/SANDY SHALE, SILTSTONE

SANDSTONE, COARSE SAND, CONGLOMERATE, GYPSUM/ANHYDRITE, S SALT, C CHERT, P PYRITE, G GLAUCONITE

COAL / LIGNITE, ARGILLACEOUS LIMESTONE / CALCAREOUS SHALE, OOLITIC DOLOMITE, OOLITHS, GRANITE BASEMENT

DIAGNOSTIC SPECIES *

INTERPRETED LITHOLOGY

DEPTH IN METRES: SWC1757, SWC1767, SWC1767·5, SWC1775, 1800, SWC1808, 1825, 1850

SYSTEM: UPPER PERMIAN | INDETERMINATE | PRECAMBRIAN

STAGE: ZECHSTEIN

ENVIRONMENT: CONTINENTAL; BRACKISH / DELTAIC / LAGOONAL; LITTORAL; INNER SUBLITTORAL; OUTER SUBLITTORAL; BATHYAL

HYPERSALINE

% FORAMINIFERAL ASSEMBLAGES: AGGLUTINATING FORAMINIFERA; CALCAREOUS BENTHONIC FORAMINIFERA; PLANKTONIC FORAMINIFERA

MICROFOSSILS

x			x	Protohaploxypinus perfectus	Miospores
			x	aff. Vesicaspora milvinus	
x			x	Perisaccus granulosus *	
x			x	Vittatina sp. *	
			x	Striatisaccus labdacus	
			x	Protohaploxypinus perlucidus	
x			x	Lueckisporites virkkiae *	
			x	Protohaploxypinus spp.	
			x	Illenites sp.	
			x	Striatisaccus spp.	
			x	Striatoabeites striatus	
			x	Calamospora sp.	
			x	Illenites cf. gamzi	
			x	Falcisporites zapfei	
x				?Acanthotriletes sp.	
	x	x	x	Inertinite	Dominant Kerogen
		x		Vitrinite	
x		x	x	Lower Cretaceous caving	Palynology cavings
x	x		x	Middle Jurassic caving	

ROBERTSON RESEARCH INTERNATIONAL LTD.

BIOSTRATIGRAPHICAL ANALYSIS CHART

DATE: Sept. 1976 | CHART No. 5 | LOCATION: Norwegian North Sea 10/5-1 Well

FOR: Conoco Norway Inc. | ANALYST: CGL, CWH, JWC, CAN.

LIMESTONE; SANDSTONE; COAL/LIGNITE; DOLOMITE; COARSE SAND; PINK CHALK; WHITE CHALK; CONGLOMERATE; CALCAREOUS SANDSTONE/ MARLY LIMESTONE; GYPSUM/ANHYDRITE; SIDERITE; CLAY; SALT; SHALE; CHERT; SILTSTONE; GLAUCONITE; PYRITE; SILTY/SANDY SHALE

DIAGNOSTIC SPECIES *

DEPTH IN METRES	INTERPRETED LITHOLOGY	SYSTEM	STAGE	ENVIRONMENT
1250		LOWER CRETACEOUS	HAUTERIVIAN	CONTINENTAL
1225				BRACKISH / DELTAIC / LAGOONAL
1200				LITTORAL
1175			BARREMIAN	INNER SUBLITTORAL
1150			APTIAN-ALBIAN	OUTER SUBLITTORAL
1125				BATHYAL
1100			CENOMANIAN	
1075		UPPER CRETACEOUS	TURONIAN	
1050			?TURONIAN	
1025				

% TERRIGENOUS ASTERIDS

PLANKTONIC FORAMINIFERA; BENTHONIC FORAMINIFERA; AGGLUTINATING FORAMINIFERA

MICROFOSSILS

Foraminifera

- Globotruncana marginata *
- Globotruncana linneiana coronata *
- Stensioina exsculpta gracilis *
- Rugoglobigerina/Archaeoglobigerina complex
- Praeglobotruncana cf. stephani *
- Polymorphinids
- Gavelinella spp.
- Hedbergella sp.
- Lenticulina spp.
- Haplophragmoides spp.
- Dorothia sp.
- Praeglobotruncana stephani *
- Lingulogavelinella turonicus *
- Praebulimina sp.
- Gavelinopsis cenomanica *
- Arenobulimina macfadyeni *
- Hedbergella planispira *
- Gavelinella intermedia *
- Glomospira gordialis
- Hedbergella delrioensis *
- Marssonella cf. oxycona
- Dentalina spp.
- Arenobulimina chapmani
- Cibicides formosus *
- Ammosphaeroidina sp. *
- Lingulogavelinella sp.
- Gavelinella cf. baltica *
- Pleurostomella obtusa
- Epistomina chapmani *
- Gaudryinella sherlocki
- Valvulineria gracillima
- Epistomina cf. ornata
- Marginulina gracillima *
- Gavelinopsis tourainensis
- Hedbergella infracretacea *
- Marginulina cf. sigali
- Gavelinella barremiana *
- Verneuilinoides neocomiensis
- Lenticulina nodosa *
- Ammodiscus sp.
- Citharina sp.
- Epistomina cf. stelligera
- Conorotalites aptiensis
- Vidalina sp.
- Conorboides sp.
- Epistomina ornata *
- Lenticulina heiermanni
- Pseudogaudulina sp.
- Epistomina cf. caracolla caracolla
- Vaginulina kochii *
- Conorboides hofkeri
- Lenticulina ouachensis wisselmanni
- Epistomina caracolla caracolla *
- Tristix tricarinata
- Conorotalites intercedens
- Nubeculinella sp.
- Lenticulina guttata guttata *
- Conorboides sp. A
- Lenticulina schrieteri *
- Lenticulina saxonica
- Vaginulinopsis humilis humilis *
- Gavelinella ?sigmoicosta *
- Lenticulina meridiana
- Hechtina antiqua *
- Saracenaria bronnii
- ?Orbitolina sp.
- Planularia crepidularis *
- Frondicularia concinna
- Conorotalites bettenstaedti
- Haplophragmium sp.
- Marginulina robusta
- Conorboides cf. valendisensis
- Ammobaculites coprtaceus
- Lenticulina eichenbergi *

Ostracods

- Cytherella sp.
- Cythereis sp.

Other Fossils

- Radiolaria
- Echinoid debris
- Inoceramus prisms
- Fish teeth
- Gastropods
- Bivalve debris
- Otoliths
- Belemnites

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BIOSTRATIGRAPHICAL ANALYSIS CHART

DATE	CHART No. - SIDEWALL CORE CHART	LOCATION	ANALYST
Sept. 1976		Norwegian North Sea 10/5-1 Well	CGL,JWC,CND.

FOR Conoco Norway Inc.

LIMESTONE · DOLOMITE · WHITE CHALK · MARL · CLAY · SHALE / CLAYSTONE · SILTY/SANDY SHALE · SILTSTONE

SANDSTONE · COARSE SAND · CONGLOMERATE · GYPSUM/ANHYDRITE · S SALT · C CHERT · P PYRITE · G GLAUCONITE

COAL / LIGNITE

EXAMINATION: M - MICROPALAEONTOLOGICAL · P - PALYNOLOGICAL

DIAGNOSTIC SPECIES *

REWORKED SPECIES R

ENVIRONMENT: CONTINENTAL · BRACKISH / DELTAIC / LAGOONAL · LITTORAL · INNER SUBLITTORAL · OUTER SUBLITTORAL · BATHYAL

% FORAMINIFERAL ASSEMBLAGES: AGGLUTINATING FORAMINIFERA · CALCAREOUS BENTHONIC FORAMINIFERA · PLANKTONIC FORAMINIFERA

INTERPRETED LITHOLOGY																	
DEPTH IN METRES	1808m	1775m	1767.5m	1767m	1757m	1715m	1705m	1683m	1636.5m	1600m	1565m	1542m	1520m	1510m	1475m	1347m	1285m	1250m
EXAMINATION	P	P	P			P	P	P							P	M P	M P	M P
SYSTEM	UPPER PERMIAN								TRIASSIC				MIDDLE JURASSIC		UPPER JURASSIC	LOWER CRETACEOUS		
STAGE	ZECHSTEIN												BATHONIAN – BAJOCIAN		KIMMERIDGIAN (P.)	VOLGIAN-KIMM. RYAZANIAN	VALANGINIAN	HAUTERIVIAN

MICROFOSSILS

1808m	1775m	1767.5m	1767m	1757m	1715m	1705m	1683m	1636.5m	1600m	1565m	1542m	1520m	1510m	1475m	1347m	1285m	1250m	Species		Group
																x	x	Epistomina caracolla caracolla	*	Foraminifera
																	x	Conorboides sp.		Foraminifera
																x	x	Lenticulina sp.		Foraminifera
																	x	Epistomina chapmani		Foraminifera
															x			Haplophragmoides sp.		Foraminifera
															x			?Verneuilinoides neocomiensis		Foraminifera
														x	x	x		Cleistosphaeridium spp.		Microplankton
															x	x		Tasmanitids		Microplankton
															x	x		Chytroeisphaeridia aff. pococki		Microplankton
															x	x		Tenua sp.		Microplankton
																x		Spiniferites ramosus group		Microplankton
																x		Scriniodinium sp.		Microplankton
													x	x	x	x		Gonyaulacysta spp.		Microplankton
																x		Oligosphaeridium cf. asterigerum	*	Microplankton
																x		Heslertonia sp.		Microplankton
																x		Kleithriasphaeridium sp.		Microplankton
																x		Kleithriasphaeridium "granulatum"	*	Microplankton
															x	x		Gonyaulacysta helicoidea group		Microplankton
													x	x	x	x		Acanthomorph acritarchs		Microplankton
												x				x		Pareodinia ceratophora		Microplankton
															x	x		Cribroperidinium sp.		Microplankton
																x		Cleistosphaeridium anchoriferum		Microplankton
																x		Phoberocysta neocomica		Microplankton
														x	x	x		Dingodinium albertii		Microplankton
															x	x		Chlamydophorella nyei		Microplankton
															x	x		Gonyaulacysta serrata		Microplankton
																x		Heslertonia heslertonensis	*	Microplankton
																x		Tanyosphaeridium sp.		Microplankton
															x	x		Hystrichosphaeridium spp.		Microplankton
																x		Reticulate cysts indet.		Microplankton
														x	x	x		Gonyaulacysta granuligera/granulata		Microplankton
														x		x		Oligosphaeridium sp.		Microplankton
															x	x		Hystrichodinium pulchrum		Microplankton
																x		Cyclonephelium distinctum		Microplankton
																x		Apteodinium sp.		Microplankton
															x	x		Tubotuberella apatela	*	Microplankton
															x			Sirmiodinium grossi		Microplankton
															x			Parvocavatus tuberosus	*	Microplankton
															x			Exochosphaeridium sp.		Microplankton
															x			Gonyaulacysta cretacea		Microplankton
															x			Prolixosphaeridium sp.		Microplankton
															x			Scriniodinium "magnificum"	*	Microplankton
															x			Oligosphaeridium anthophorum		Microplankton
															x			Scriniodinium campanula		Microplankton
															x			Systematophora cf. areolata		Microplankton
												x		x				Microforaminifera		Microplankton
														x				Systematophora areolata	*	Microplankton
												x		x				Scriniodinium oxfordianum	*	Microplankton
														x				Cryptarchaeodinium cf. calcaratum	*	Microplankton
												x						Gonyaulacysta jurassica	*	Microplankton
												x						Gen. et. sp. indet.		Microplankton
												x						Endoscrinium cf. eisenacki	*	Microplankton
												x						Gonyaulacysta filapicata	*	Microplankton
												x						Scriniodinium sp.		Microplankton
												x	x	x	x	x		Bisaccates		Miospores
												x		x	x	x		Baculatisporites/Osmundacidites spp.		Miospores
												x		x		x		Inaperturopollenites spp.		Miospores
																x		Gleicheniidites senonicus		Miospores
												x	x	x	x	x		Deltoidospora spp.		Miospores
												x			x	x		Callialasporites dampieri group		Miospores
												x			x	x		Staplinisporites caminus group		Miospores
												x			x	x		Cyathidites australis		Miospores
												x				x		Converrucosisporites spp.		Miospores
												x				x		Inaperturopollenites turbatus		Miospores
																x		Leptolepidites sp.		Miospores
															x	x		Cicatricosisporites spp.		Miospores
												x				x		Cyathidites minor		Miospores
												x			x			Densoisporites velatus		Miospores
												x	x		x			Perinopollenites elatoides		Miospores
												x	x	x	x			Concavissimisporites spp.		Miospores
												x		x	x			Lycopodiacidites sp.		Miospores
												x		x	x			Araucariacites australis		Miospores
												x		x	x			Lycopodiumsporites spp.		Miospores
												x		x	x			Cerebropollenites mesozoicus		Miospores
												x			x			Leptolepidites major		Miospores
												x			x			Klukisporites sp.		Miospores
															x			Chasmatosporites sp.		Miospores
												x		x	x			Classopollis sp.		Miospores
														x				?Lueckisporites sp.	R	Miospores
													x	x				Vitreisporites pallidus		Miospores
														x				Trilobosporites sp.		Miospores
							x											Protohaploxypinus chaloneri		Miospores
					x	x	x											Perisaccus granulosus	*	Miospores
					x	x	x											Protohaploxypinus spp.		Miospores
	x				x	x	x											Lueckisporites virkkiae	*	Miospores
x					x	x	x											Vittatina spp.	*	Miospores
x	x				x	x	x											Striatisaccus spp.		Miospores
					x		x											Striatisaccus noviaulensis		Miospores
	x				x	x	x											Limitisporites sp.		Miospores
							x											Striatopodocarpites sp.		Miospores
					x	x	x											Vittatina costabilis		Miospores
					x	x												Jugasporites sp.		Miospores
					x	x												Striatisaccus labdacus		Miospores
						x												Protohaploxypinus perfectus		Miospores
					x													Hamiapollenites sp.		Miospores
					x													Protohaploxypinus jacobii		Miospores
					x													Vesicaspora schaubergeri		Miospores
x		x					x											Cretaceous/Jurassic contamination		Miospores
	x	x			x	x	x					x	x	x	x	x		Inertinite		Dominant Kerogen
x	x	x											x	x	x			Amorphous sapropel		Dominant Kerogen
																	x	Gastropods		Other Fossils
																x	x	Bivalve debris		Other Fossils

ROBERTSON RESEARCH INTERNATIONAL LTD.

BIOSTRATIGRAPHICAL ANALYSIS CHART

DATE	CHART No.	LOCATION
Sept. 1976.	4 750m - 1000m	Norwegian North Sea Well 10/5-1
FOR		ANALYST
Conoco Norway Inc.		CAN, CGL.

LIMESTONE · SANDSTONE · COAL / LIGNITE
DOLOMITE · COARSE SAND · ARGILLACEOUS LIMESTONE / CALCAREOUS SHALE
WHITE OR GREY CHALK · CONGLOMERATE
MARL · GYPSUM/ANHYDRITE
CLAY · SALT
SHALE · CHERT
SILTY/SANDY SHALE · PYRITE
SILTSTONE · GLAUCONITE

x DIAGNOSTIC SPECIES

INTERPRETED LITHOLOGY

DEPTH IN METRES: 775, 800, 825, 850, 875, 900, 925, 950, 975, 1000

SYSTEM: UPPER CRETACEOUS

STAGE: EARLY CAMPANIAN; SANTONIAN; CONIACIAN; ?TURONIAN

ENVIRONMENT: CONTINENTAL; BRACKISH / DELTAIC / LAGOONAL; LITTORAL; INNER SUBLITTORAL; OUTER SUBLITTORAL; BATHYAL

% FORAMINIFERAL ASSEMBLAGES: PLANKTONIC FORAMINIFERA; CALCAREOUS BENTHONIC FORAMINIFERA; AGGLUTINATING FORAMINIFERA

MICROFOSSILS

Foraminifera

Stensioina pommerana	*
Marssonella oxycona	
Gavelinella pertusa	
Arenobulimina chapmani	
Gavelinella clementiana	*
Globorotalites micheliniana	*
Gavelinella spp.	
Polymorphinids	
Praebulimina carseyae	
Gyroidinoides spp.	
Neoflabellina spp.	
Bolivinoides decorata	
Globotruncana linneiana tricarinata	*
Stensioina exsculpta granulata	*
Stensioina cf. exsculpta	
Globotruncana marginata	*
Gaudryina spp.	
Rugoglobigerina/Archaeoglobigerina complex	
Pullenia sp.	
Stensioina exsculpta gracilis	*
Globotruncana cf. arca	
Karreria cf. fallax	
Stensioina exsculpta	*
Ammodiscus sp.	
Stensioina praeexsculpta	*
Hedbergella sp.	
Globotruncana linneiana cf. coronata	*
Hedbergella sp.	
Eponides spp.	
Heterohelix sp.	
Globotruncana linneiana linneiana	*
Globotruncana linneiana coronata	*
Globotruncana linneiana cf. bulloides	*
Praeglobotruncana cf. stephani	*
Haplophragmoides spp.	
Dorothia sp.	

Ostracoda

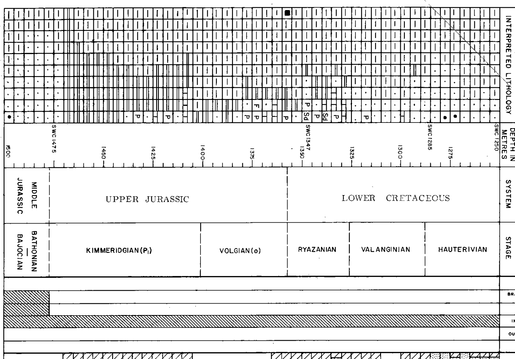
Cytherella spp.	
Cythereis spp.	
Neocythere sp.	
Bairdia sp.	
Xestoleberis sp.	

Other fossils

Echinoid debris	
Sponge spicules	
Bryozoa	
Radiolaria	

BIOSTRATIGRAPHICAL ANALYSIS CHART

Congoco Norway Inc | Norwegian North Sea 10/5-1 Well | Sept 1976 | CHART No 6 | 1250m – 1500m | LOCATION | ANALYST | GDL/JHC/SHD



Foraminifera

- Epistomina caracolla caracolla *
- Haplophragmoides sp. *
- Planularia crepidularis *
- Epistomina ornata *
- ?Haplophragmium sp. *
- Lenticulina sp. *
- Lenticulina eichenbergi *
- Marginulina cf. sigali *
- Epistomina chapmani *
- Lenticulina schrieteri *
- Lenticulina beiermanni *
- Marginulina gracilissima *
- Ammovertella celiensis *
- Polymorphinids *
- Ammobaculites coprolithiformis *
- Lenticulina saxonica *
- Epistomina caracolla anterior *
- Lenticulina polonica *
- Glomospira gordialis *
- Conorboides sp. *
- Conorboides cf. valendisensis *
- Pseudoglandulina sp. *
- Bathysiphon sp. *
- Vaginulinopsis humilis humilis *
- Marginulina robusta *
- Lenticulina guttata striata *
- Lenticulina guttata guttata *
- Ammobaculites sp. *
- Epistomina "stellicostata" *
- Haplophragmium inconstans erectum *
- Conorboides valendisensis *
- Verneuilinoides neocomiensis *
- Ammobaculites agglutinans *
- Haplophragmoides cf. canui *
- Saracenaria sp. *
- Dentalina sp. *
- Marginulina cf. costata *
- Astacolus aff. gibber *
- Reophax sp. *
- Saracenaria triquetra *
- Planularia sp. *
- Lenticulina cf. major *
- Conorboides nuda *
- Trochammina/Haplophragmoides sp. 1 *
- Trochammina globigeriniformis *
- Trochammina nitida *
- Citharina serratocostata *
- Epistomina parastelligera *
- Haplophragmoides infracalloviensis *
- Trochammina squamata *
- Lenticulina major *
- Textularia jurassica *
- Marginulina oxfordiana *

Ostracoda

- Mandelstamia sp. *
- Protocythere triplicata *
- Paracypris sp. *
- Schuleridea judii *
- Galliaecytheridea wolburgi *
- Galliaecytheridea spinosa *
- Mandelstamia tumida *
- Mandelstamia sexti *
- Mandelstamia rectilinea *
- Mandelstamia triebeli *
- Galliaecytheridea cf. mandelstami *
- Orthonotacythere interrupta *
- Macrodentina sp. *
- Galliaecytheridea cf. elongata *
- Pneumatocythere cf. bajociana ?R
- ?Asciocythere sp. ?R

Microplankton

- Cassiculosphaeridia ?magna *
- Oligosphaeridium asterigerum *
- Chlamydophorella nyei *
- Gonyaulacysta granuligera granulata *
- Hystrichosphaeridium spp. *
- Acanthomorph acritarchs *
- Heslertonia heslertonensis *
- Dictyopyxis areolata *
- Dingodinium albertii *
- Kleithriasphaeridium "glabrum" *
- Cleistosphaeridium spp. *
- Scrinodinium campanula *
- Hystrichodinium pulchrum *
- ?Daidyx anaphrissa *
- Pseudoceratium pelliferum *
- Tenua spp. *
- Gonyaulacysta serrata *
- Gonyaulacysta spp. *
- Spiniferites ramosus group *
- Paregodinia ceratophora *
- Microforaminifera *
- Tasmantitids *
- Oligosphaeridium spp. *
- Gonyaulacysta helicoidea group *
- Endoscrinium pharo *
- Cribroperidinium edwardsi *
- Wallodinium krutschi *
- Cyclonephelium distinctum *
- Muderongia simplex *
- Cassiculosphaeridium sp. *
- Meiourogonyaulax spp. *
- Tanyosphaeridium sp. *
- Necrobroomea sp. *
- Hellodinium voigti *
- Canningia sp. *
- Psaligonyaulax sp. *
- Phoberocysta neocomica *
- Gonyaulacysta cretacea *
- Paregodinia ?jaegeri *
- Cribroperidinium sp. *
- Chytroeisphaeridia cf. pococki *
- Gardodinium trabeculosum *
- Tubotuberella apatela *
- Fromea amphora *
- Cleistosphaeridium anchoriferum *
- Kleithriasphaeridium sp. *
- Scrinodinium sp. *
- Dingodinium "denticulatum" *
- Gardodinium eisenacki *
- "Membranilaula" sp. *
- Systematophora sp. *
- Oligosphaeridium pulcherrimum *
- Scrinodinium ?oxfordianum *
- Gonyaulacysta dangeardi *
- Systematophora areolata *
- Adnatosphaeridium sp. *
- Scrinodinium ?crystallinum *
- Oligosphaeridium anthophorum *
- Systematophora sp. GITME7 *

Miospores

- Concavissimisporites spp. *
- Cicatricosisporites spp. *
- Bisaccates *
- Araucariacites australis *
- Baculatisporites/Osmundacidites spp. *
- Deltoidospora spp. *
- Leptolepidites major *
- Peringopollenites clatoides *
- Staplinisporites caminus group *
- Gleicheniidites senonicus *
- Concavissimisporites variverrucatus *
- Lycopodiumsporites spp. *
- Appendicisporites sp. *
- Cerebropollenites mesozoicus *
- Inaperturopollenites spp. *
- Callialasporites dampieri group *
- Sestrosporites pseudoalveolatus *
- Leptolepidites sp. *
- Lycopodiacidites spp. *
- Circulina spp. *
- Riccisporites tuberculatus R
- Contignisporites sp. *
- Spheripollenites spp. *
- Cyathidites australis *
- Pilosisporites spp. *
- Leptolepidites hossus *
- Klukisporites sp. *
- Cyathidites minor *
- Densoisporites velatus *
- Trilobosporites bernissartensis *
- Pilosisporites trichopapillosus *
- Quadraecolina anellaeformis R
- Densosporites sp. R
- Jugasporites sp. R
- Ovalipollis ovalis R
- Inaperturopollenites turbatus *
- Trilobosporites sp. *
- Eucommiidites troedssonii *

Dinoflagellate Kerogen

- Inertinite *
- Amorphous sapropel *

Palynology cavings

- Upper Cretaceous caving *
- Tertiary caving *
- Lower Cretaceous caving *
- Upper Jurassic caving *

Other fossils

- Gastropods *
- Bivalve debris *
- Echinoderm debris *
- Fish teeth *
- ?Cenosphaera spp. *
- Lithostrobus spp. *
- Cenodictyon spp. *