L-181

.3

ROBERTSON RESEARCH INTERNATIONAL LIMITED

REPORT NO. 2398

STATOIL 1/9 - 3 (RE-ENTRY) NORWEGIAN NORTH SEA WELL: BIOSTRATIGRAPHY OF THE INTERVAL 2778m - 4570m

by

C. N. DENISON
D. J. HARRISON
D. J. SHIPP
J. UNDERWOOD

PROJECT NO. RRPS/789/A/1546

Prepared by:

Robertson Research International Limited,
Ty'n-y-Coed,
Llanrhos,
Llandudno,
Gwynedd LL30 1SA,
Wales,
U.K.

Prepared for:

P.O. Box 300,
Lagardsveien 79,
4001 Stavanger,
Norway.

December, 1978

CONTENTS

Enclosures

SUMMARY

1. The youngest deposits analysed in this re-entry well are of Eocene age.

2. Tertiary sediments of Eocene to Palaeocene age are present, with a basal Danian interval composed of shales and chalk.

3. The Tertiary/Upper Cretaceous contact appears to be conformable.

4. Chalk dominates the Upper Cretaceous sequence in which deposits of Maastrichtian to ?Cenomanian age are represented.

5. The Upper Cretaceous is conformable upon Lower Cretaceous shales of Albian to ?Ryazanian age.

6. A thin unit of Upper Jurassic, late Volgian age lies beneath the Cretaceous and is possibly conformable. It rests upon shales with minor sand of indeterminate age in which the well terminates at 4570m.

INTRODUCTION

This report summarises the results of the micropalaeontological, palynological and stratigraphical analyses which have been carried out on material received from the section 2778m - 4570m from the Statoil 1/9-3 (Re-entry) Norwegian North Sea Well under Project No. RRPS/789/A/1546.

Under this project a total of 544 ditch cuttings and 5 sidewall core samples was analysed using standard micropalaeontological and lithological techniques. In addition 51 individual and 2 composited ditch cuttings, and 2 sidewall core samples covering the section 3800m - 4569m were treated palynologically.

Work on the pre-Tertiary section of this well was hampered by the very poor quality of ditch cuttings samples which probably resulted from extensive use of a diamond bit below 3400m. As a result many of the boundaries from this part of the well must be considered to be tentative.

The basic breakdown 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 on page 4.

The Jurassic biostratigraphic units used in this report are those proposed in our study - "The Jurassic of North West Europe: Offshore Project". Their stratigraphical significance is summarised in Appendix B.

The lithostratigraphic terminology is taken from Deegan and Scull, 1977.

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 Statoil with whom we have been associated during the course of this work.

Robertson Research staff involved in this study were:

Chris Denison:	Palynology.
Derek Harrison:	Tertiary foraminifera and Well Co-ordinator.
Dave Shipp:	Cretaceous and Jurassic foraminifera.
John Underwood:	Lithologies.

III

SUCCESSION

System/Subsystem	Stage	Interval
Eocene	-	2778m - 2787m
Lower Eocene	-	2793m - 2859m
Palaeocene	-	2865m - 2955m
Lower Palaeocene	Danian	2958m - 3147m
Upper Cretaceous	Maastrichtian	3153m - 3354m
	Campanian	3360m - 3468m
	Santonian - Coniacian	3474m - 3534m
	Turonian - ?Cenomanian	3540m - 3789m
Lower Cretaceous	Albian	3791m - 3834m
	early Albian - Aptian	3843m - 3975m
	Barremian - ?Ryazanian	3981m - 4265m
Upper Jurassic	late Volgian (unit n)	4265m - 4280.5m
Indeterminate		4281m - 4570m(TI

This breakdown is based upon ditch cuttings samples, sidewall cores and limited log information supplied by Statoil.

IV

TERTIARY

INTERVAL 2778m - 2787m; EOCENE

The age assigned to this interval has been based upon the following:

- the occurrence of the foraminifera Cyclammina challinori.
- the general nature of the microfaunas.
- its stratigraphic position above sediments of definite Lower Eocene age.

LITHOLOGY

Light grey and light olive grey shales predominate in this interval. In addition subordinate hard, light grey limestone occurs and hard yellowish brown dolomite persists in the sample residues in very small amounts.

This interval is assigned to the Hordaland Group.

MICROPALAEONTOLOGY

The microfaunas over this short interval are dominated by fine grained agglutinating foraminifera with a single planktonic form occurring at 2787m. Bathysiphon spp. and Cyclammina spp. are the most common forms. The general make up of the microfaunas and the occurrence of Cyclammina challinori at 2787m indicate an Eocene age. This is supported by the stratigraphic position of the interval above Lower Eocene sediments.

Pyritised and unpyritised species of the diatom Coscinodiscus are present over the interval and flattened, reticulate, greenish grey radiolaria occur in the topmost sample.

Upper Cretaceous reworking is evident at 2781m where Rugoglobigerina rugosa rugosa occurs.

ENVIRONMENT

An outer shelf to bathyal environment is postulated for this interval on the predominance of fine grained agglutinating foraminifera in the microfaunas.

INTERVAL 2793m - 2859m; LOWER EOCENE

A Lower Eocene age can be assigned to this interval on the following:

- the occurrence of the diagnostic agglutinating form Spiroplectammina spectabilis at 2793m.

LITHOLOGY

Light grey and light olive grey shales occur throughout this interval. Light grey to off-white shales are present at 2817m and these are weakly calcareous; thin, hard, light grey limestones occur locally. Yellowish brown, crystalline, vuggy dolomite or siderite is recorded at 2823m in small amounts.

This interval probably belongs to the Hordaland Group.

MICROPALAEONTOLOGY

Spiroplectammina spectabilis occurs at 2793m, allowing a Lower Eocene age to be assigned to this interval.

Relatively impoverished microfaunas are present over this interval and the assemblages lack diversity. Agglutinating foraminifera predominate and the most common forms are Bathysiphon spp. and Cyclammina spp.

Coscinodiscus spp. and radiolaria become more signficant in the poor microfaunas. The former may be pyritised or unpyritised and occur abundantly throughout the interval. The latter are flattened, reticulate, often stained pale greenish grey and occur sporadically.

Minor Cretaceous reworking is evident with Globigerinelloides cf. asper occurring at 2799m.

ENVIRONMENT

Continued deposition in an outer shelf to bathyal environment is envisaged with the microfaunas showing no significant change from those of the overlying unit.

INTERVAL 2865m - 2955m; PALAEOCENE

The Palaeocene age of this interval is based upon:

- the occurrence of the diatom Coscinodiscus sp. 1 at 2865m.
- the subsequent occurrence of Coscinodiscus sp. 2.

LITHOLOGY

Dark grey and medium grey shales predominate in this interval with common olive grey shales. Light grey, slightly pyritic limestone occur at 2862m and persists in the ditch cuttings samples to 2886m, where there is a significant increase in the amount of limestone in the sample. Traces of limestone are also recorded at 2922m. Six sidewall cores from this interval were received and these consist of olive grey to olive black shales. Full descriptions of the sidewall cores form Appendix A at the end of this report.

Traces of fine grained, angular sand and yellow brown siderite are present at 2949m and 2955m.

These sediments have been assigned to the Rogaland Group.

MICROPALAEONTOLOGY

The diagnostic form Coscinodiscus sp. 1 is present at 2865m and a Palaeocene age for the interval is confirmed by the subsequent occurrence of Coscinodiscus sp. 2 at 2883m.

Microfaunas are extremely poor and characterised by species of Coscinodiscus and large, flattened, reticulate radiolaria. Coscinodiscus sp. 1 occurs persistently while C. sp. 2 occurs more rarely. The foraminiferal component of the assemblages is made up by Bathysiphon spp., Cyclammina spp. and occasionally other agglutinating

foraminifera such as Trochammina sp., Cystammina sp. and Spiroplectammina spectabilis.

Reworking of Danian and Cretaceous forms is more important over this interval with reworked forms occurring consistently and in relatively high numbers.

A sidewall core at 2922m proved barren of in situ foraminifera.

ENVIRONMENT

Outer shelf to bathyal conditions are again suggested on the basis of the microfaunas.

INTERVAL 2958m - 3147m; LOWER PALAEOCENE, DANIAN

The age of this interval is based upon the following:

- the occurrence of diagnostic Danian foraminifera, at and below 2958m, which are presumed to be in situ.

LITHOLOGY

Medium grey shales are present between 2958m - 3084m and form the predominant lithology. Traces of fine grained, angular sand are present at the top of the interval between 2958m - 2967m. Light grey limestone or chalk is first apparent in the ditch cuttings samples at 2997m, and subsequently (at 3012m - 3030m) yellowish grey, finely crystalline limestone is present. Olive grey shales are present below 3030m in association with medium grey shales.

There is an influx of chalky, light yellowish grey limestone or chalk at 3084m and carbonates dominate the remainder of the section, although some fissile, medium grey shales are present between 3108m - 3123m.

The Rogaland Group is represented by the argillaceous section down to 3077m; below this chalk forms the Chalk Group.

MICROPALAEONTOLOGY

The diagnostic Danian forms Globigerina triloculinoides, Globigerina pseudobulloides, Lamarckina palaeocenica, Anomalinoides velascoensis, Globorotalia compressa and Gavelinella vombensis are present at 2958m and further diagnostic foraminifera occur within the interval. The Danian forms are associated with numerous reworked Cretaceous microfossils, however, and it is possible that some of these diagnostic forms could result from reworking of Danian deposits. The top of the Danian and the age determination have not, therefore, been based solely on the presence of these diagnostic forms,but on a marked change in the microfaunas involving the increase in numbers of calcareous benthonic and planktonic foraminifera.

Microfaunas over this interval are much more diverse and numerous compared to those in the overlying Palaeocene. They comprise small numbers of agglutinating foraminifera, of which Bathysiphon spp., Ammodiscus incertus and Spiroplectammina spectabilis are the most important, and numerous planktonic and calcareous benthonic forms, the most common being those discussed above.

The top of the interval coincides with an influx of large, flattened, reticulate radiolaria. A subsequent influx of small, round radiolaria occurs at 3084m and below 3096m these have a distinct white preservation.

Reworked Cretaceous forms common to the interval include Pseudotextularia elegans elegans, P. elegans fructicosa, Rugoglobigerina rugosa rugosa, Biglobigerinella multispina and Heterohelix spp.

ENVIRONMENT

The change in microfaunas over this interval indicates an outer shelf environment with good open marine connections being suggested by the abundant planktonic foraminifera.

V

CRETACEOUS

INTERVAL 3153m - 3354m; UPPER CRETACEOUS, MAASTRICHTIAN

The age assigned to this interval is based on the following:

- the presence of Pseudotextularia elegans fructicosa, Brizalina incrassata incrassata and Rugoglobigerina rugosa rugosa at 3153m and below.

- the subsequent occurrences of other diagnostic Upper Cretaceous forms including Pseudotextularia elegans elegans within the interval.

LITHOLOGY

Yellowish grey and pale brown chalk occurs throughout this interval. Stylolitic surfaces are present locally below 3237m.

This interval and those in the underlying Upper Cretaceous are assigned to the Chalk Group.

MICROPALAEONTOLOGY

The appearance of Pseudotextularia elegans fructicosa, Brizalina incrassata incrassata and Rugoglobigerina rugosa rugosa at 3153m indicates that the Maastrichtian has been penetrated, their presence within a typical Upper Cretaceous microfauna suggesting that they are in situ and not reworked as in the overlying Danian. The occurrence of Pseudotextularia elegans fructicosa, together with Pseudotextularia elegans elegans in the upper part of this interval, further indicates that late Maastrichtian deposits are present, suggesting that the Tertiary/Upper Cretaceous boundary is conformable.

The assemblages from this interval are moderately rich and dominated by planktonic forms, principally Rugoglobigerina rugosa rugosa. Calcareous benthonic foraminifera are also present together with rarer agglutinating specimens. Ostracoda, radiolaria and echinoderm debris occur through much of the unit.

Samples were not received from the interval 3171m - 3234m.

Tertiary caving was noted in the interval and throughout the Upper Cretaceous.

ENVIRONMENT

The predominance of planktonic foraminifera and the presence of a chalk lithology suggest that deposition occurred in an open marine, outer shelf environment.

INTERVAL 3360m - 3468m; UPPER CRETACEOUS, CAMPANIAN

The age assigned to this interval is based on the following:

- the occurrence of Globotruncana sp. 1 at 3360m.
- the subsequent appearance and consistent occurrence of Globotruncana marginata within the interval.

LITHOLOGY

White to yellowish grey chalk predominates in this interval. The sidewall core at 3405m consists of a firm, platy, light grey chalk or limestone.

Additive is present below 3408m.

MICROPALAEONTOLOGY

The appearance of Globotruncana sp. 1 at 3360m marks the top of the Campanian. The subsequent occurrence, often in large numbers, of Globotruncana marginata within the interval confirms the presence of Campanian deposits. The assemblages are quite rich in the upper part of this unit, but numbers decline towards the base. Planktonic foraminifera again dominate the microfaunas while radiolaria are prominent below 3408m.

ENVIRONMENT

Outer shelf conditions are indicated by the presence of planktonic-rich microfaunas within a chalk lithology.

INTERVAL 3474m - 3534m; UPPER CRETACEOUS, SANTONIAN - CONIACIAN

The age assigned to this interval is based on the following:

- the appearance at 3474m of Stensioina praeexsculpta.
- its relative stratigraphic position.

LITHOLOGY

Yellowish white chalk is the predominant lithology in this interval. Some of the section appears to have been drilled with a diamond bit and the characteristics of the chalk destroyed.

MICROPALAEONTOLOGY

The foraminiferal recovery from this part of the section is relatively poor due to the quality of samples produced by the use of a diamond bit. The appearance of Stensioina praeexsculpta at 3474m indicates that Santonian deposits are present at this depth. The position of this interval, lying as it does on top of definitely dated Turonian sediments, suggests that it may also include some Coniacian deposits. The possibility that an unconformity may also be present cannot be excluded, however.

ENVIRONMENT

Outer shelf conditions are postulated for this interval, although the low number of foraminifera recovered may reflect reduced open marine influences.

INTERVAL 3540m - 3789m; UPPER CRETACEOUS, TURONIAN - ?CENOMANIAN

The age assigned to this interval is based on the following:

- the occurrence of Praeglobotruncana delrioensis at 3540m.
- the consistent occurrence of specimens of Praeglobotruncana.
- its relative stratigraphic position.

LITHOLOGY

The ditch cuttings samples suggest that platy white chalk is the predominant lithology in this section. Some sections within this interval appear to have been drilled with a diamond bit and as a result the exact nature of the cuttings is indistinct.

Sidewall core samples were taken in this interval. Those between 3570m - 3610m consist of firm, platy, light grey chalk or limestone, while those at 3677m, 3681m and 3695m are firm, dark grey to black shales. The sidewall core at 3680m appears to be a light olive grey to yellowish brown limestone which may be sideritic. The shales correspond to those present in the ditch cuttings between 3663m - 3687m. This shaly development is considered to be the Plenus Marl Formation within the Chalk Group. Below this the Hidra Formation is thought to be present.

MICROPALAEONTOLOGY

The top of this interval is marked by the appearance of Praeglobotruncana delrioensis at 3540m which indicates that Turonian deposits have been penetrated. The microfaunas are again generally sparse, although isolated samples are very rich in flattened specimens of Praeglobotruncana spp. which are too poorly preserved to be identified more closely. The presence of a shale sequence between 3663m and 3687m thought to represent the Plenus Marl suggests that sediments of Cenomanian age are present at the base of this interval. No Cenomanian restricted fossils were recovered, however, and consequently a Turonian - ?Cenomanian age has been assigned.

There is an influx of yellow-stained radiolaria at 3693m which may be of local significance.

ENVIRONMENT

An outer shelf environment is envisaged with open marine influences which were generally weak, although limited periods of greater open marine influence are suggested by the large numbers of Praeglobotruncana seen in some isolated samples.

INTERVAL 3791m - 3834m; LOWER CRETACEOUS, ALBIAN

The age assigned to this interval is based on the following:

- the appearance of large numbers of Hedbergella delrioensis in the sidewall core from 3791m.
- a corresponding but less distinct influx of H. delrioensis in the cuttings sample at 3795m.

LITHOLOGY

Light grey and greenish grey shales occur in association with beds of chalky limestone. The sidewall cores examined from this interval consist of firm to soft, light yellowish grey, chalky limestones and dark to medium grey shales, which may be calcareous or non-calcareous.

This interval and the remaining deposits of the Lower Cretaceous are assigned to the Cromer Knoll Group.

MICROPALAEONTOLOGY

The appearance of large numbers of Hedbergella delrioensis in the sidewall core at 3791m provides the first downhole evidence of Lower Cretaceous deposits. The nature of the microfauna, dominated by H. delrioensis, indicates that the youngest Lower Cretaceous sediments are of Albian age, suggesting that the Upper Cretaceous/ Lower Cretaceous boundary is conformable.

The recovery from the cuttings samples is generally poor and although the influx of H. delrioensis can be seen it is less clear than in the sidewall core.

PALYNOLOGY

The sidewall core at 3830m yielded a fairly sparse but relatively diverse dinocyst dominated palynoflora, in which many species are of pre-Albian age. Forms such as Ctenidodinium elegantulum and Phoberocysta neocomica do not range younger than Aptian, and Muderongia simplex ranges no younger than early Barremian. A Hauterivian - Valanginian age is suggested by the presence of Gonyaulacysta cladophora (sensu DUXBURY) and Oligosphaeridium sp. 1. However, ?Astrocysta cretacea and Odontochitina operculata range no older than Barremian.

This mixed assemblage may be the result of considerable reworking of Neocomian deposits into a section of Albian age with the in situ forms being represented by long-ranging species.

ENVIRONMENT

The predominance of planktonic foraminifera in the assemblages from this interval suggests that strong open marine influences existed and that outer shelf conditions probably prevailed.

INTERVAL 3843m - 3975m; LOWER CRETACEOUS, EARLY ALBIAN - APTIAN

The age assigned to this interval is based on the following:

- the appearance of green-stained agglutinating foraminifera at 3843m.
- the subsequent occurrence within the interval of several specimens of "Lingulogavelinella" gyroidinaeformis.
- an influx of cf. Canningia minor at 3906m.

LITHOLOGY

Medium grey shales predominate throughout this interval, although red shales occur at 3888m and reappear at 3897m. In addition traces of sphaerosiderite are recorded at 3924m. The samples from this interval are often contaminated by lost circulation material and metal fragments.

MICROPALAEONTOLOGY

The appearance of rare green-stained agglutinating foraminifera at 3843m suggests that early Albian - Aptian deposits have been penetrated and this is confirmed by the subsequent occurrence of several specimens of "Lingulogavelinella" gyroidinaeformis. Sphaerosiderite, seen at 3924m, is also typically present in sediments of early Albian - Aptian age. Planktonic foraminifera again dominate the rather poor microfaunas, although agglutinating and, to a lesser extent, calcareous benthonic foraminifera are more prominent.

Ostracoda appear near the base of this interval.

PALYNOLOGY

Ditch cuttings samples from this interval generally yielded sparse palynofloras, largely composed of long-ranging species which suggest only a general early Cretaceous age. An organic additive compound is present in this section which may be responsible for dilution of the organic residues.

At 3906m the influx of cf. Canningia minor may indicate an Aptian age.

ENVIRONMENT

The occurrence of more varied microfaunas suggests that slightly shallower, inner to outer shelf conditions existed at this time. The predominance of planktonic foraminifera reflects strong open marine influences.

INTERVAL 3981m - 4265m; LOWER CRETACEOUS, BARREMIAN - ?RYAZANIAN

The age assigned to this interval is based on the following:

- the appearance of the ostracode Cytherella cf. pyriformis at 3981m.

- the occurrence of common ostracoda and Lenticulina spp.

- the presence of a diverse palynomorph assemblage at 4083m including ?Gonyaulacysta kostromiensis, Oligosphaeridium sp. 1 and representatives of the Phoberocysta neocomica/Muderongia simplex group.

LITHOLOGY

Shales predominate throughout this interval. These vary from medium grey to medium dark grey, dark brown and brownish black. Traces of red shale are present at 3987m, 4032m and 4059m. Small amounts of medium grained, white angular sand are present at 4023m and below, but these may be caved.

Lost circulation material is common, especially in the lower part of this interval.

MICROPALAEONTOLOGY

The appearance of the ostracode Cytherella cf. pyriformis at 3981m indicates that Barremian - Hauterivian deposits have been penetrated. The microfauna of the upper part of this interval, above approximately 4100m, contains common ostracoda and Lenticulina spp. This is a typical feature of Barremian to Hauterivian assemblages.

The microfaunas from the upper part of this interval are rather poor while below 4107m the ditch cuttings are barren of foraminifera except for two samples at the base of the unit which contain rare, non-diagnostic, possibly caved forms.

PALYNOLOGY

Palynofloras are very sparse and non-age diagnostic down to 4071m, largely due to dilution by additive. In a richer and more diverse assemblage at 4083m the association of ?Gonyaulacysta kostromiensis, Oligosphaeridium sp. 1 and the Phoberocysta neocomica/Muderongia simplex group suggests a Hauterivian - Valanginian age.

Additive is abundant, and palynomorphs rare, from 4095m to the base of the interval. No further biostratigraphic interpretation is possible from the meagre palynofloras.

Consequently, it is not possible to establish the age of the oldest Cretaceous deposits present, but in view of the thickness of this interval, a relatively complete Neocomian sequence may be present, possibly as old as Ryazanian at the base. The Cretaceous/Jurassic boundary may well be conformable.

ENVIRONMENT

The microfaunas from the upper part of the interval contain few planktonic foraminifera and their general characteristics suggest deposition in an inner shelf environment with reduced open marine influences. Similar conditions are thought to have existed through the lower part of the interval.

VI

JURASSIC

INTERVAL 4265m - 4280.5m; UPPER JURASSIC, LATE VOLGIAN (unit n)

The top of this unit is based on the significant log break at 4265m (information supplied by Statoil).

The age is based upon the presence of abundant Pterospermopsis spp. and P. aureolata, and common leiospheres in the sidewall core from 4280.5m.

LITHOLOGY

The ditch cuttings samples from this interval consist mainly of shales similar to those seen in the overlying interval. However, brownish black, waxy shales are present at 4269m and a slight increase in black or greyish black shale is recorded at 4278m. Lost circulation material is common in the ditch cuttings samples.

The sidewall core at 4280.5m consists of a very hard, olive black to brownish black, slightly micaceous, slightly carbonaceous, non-calcareous shale.

This interval has been assigned to the Kimmeridge Clay Formation.

MICROPALAEONTOLOGY

No in situ microfauna was recovered from this interval.

PALYNOLOGY

The sidewall core sample from 4280.5m yielded a palynofloral assemblage almost entirely dominated by species of Pterospermopsis. A late Volgian (unit n) age is normally indicated by this palynofloral development.

ENVIRONMENT

The association of abundant Pterospermopsis spp., common leiospheres and abundant amorphous sapropel indicates deposition in a restricted marine situation with anaerobic conditions at the sediment/water interface.

VII

INDETERMINATE

INTERVAL 4281m - 4570m (T.D.); INDETERMINATE

No in situ microfossils were recovered from the samples of this interval which were heavily contaminated by additive. Consequently no definite conclusions as to the age of the basal section of this well can be made.

LITHOLOGY

The samples from this interval are generally very poor and some consist of about 90% additive, particularly at the base of the section.

Black and dark grey shales are present at the top of the section with small amounts of brownish siltstone and traces of bone fragments. Fine grained white sand also occurs in small amounts. Light grey shales, which may possibly be caved from the Lower Cretaceous, occur sporadically. Traces of medium grained, white sand are present in some samples. It is thought that the sand might possibly represent Permo-Trias deposits, but in view of the poor quality of the samples this is only a tentative suggestion.

MICROPALAEONTOLOGY

Only rare caved foraminifera are present in the samples of this interval. No in situ microfauna was recovered.

PALYNOLOGY

All samples examined palynologically yielded an abundance of an organic additive compound. Despite the evidence of a late Volgian age at 4280.5m, no Jurassic restricted taxa were recovered below this depth, only rare Lower Cretaceous elements being encountered. The presence of abundant additive has presumably totally obscured any in situ material.

ENVIRONMENT

In view of the lack of evidence, no conclusions on the environment of deposition of this basal interval can be drawn.

VIII

PALAEOENVIRONMENTAL SUMMARY

Black and dark grey shales together with small amounts of sand of indeterminate age occupy the basal section of this well from 4570m to 4281m. The poor quality of samples over this interval precludes any palaeoenvironmental conclusions being drawn.

Similar dark shales of Upper Jurassic, late Volgian age overlie the basal unit. Deposition in restricted marine conditions is indicated with anaerobic conditions at the sediment/water interface.

Shales continued to be deposited throughout the overlying Lower Cretaceous. Restricted inner shelf conditions persisted throughout the ?Ryazanian - Barremian interval, but at the end of this period slight deepening of the environment occurred with the Aptian to early Albian sediments being deposited in inner to outer shelf conditions. The remaining Albian shales were laid down in outer shelf conditions which extended throughout the overlying Upper Cretaceous chalk and into the chalk and shales of the Danian.

Shales and interbedded limestones characterise the Palaeocene, Lower Eocene and Eocene intervals and these are the youngest sediments encountered in the well. Deepening of the environment to include bathyal depths occurred at the onset of Palaeocene times and continued into the Eocene.

SELECTED REFERENCES

BARTENSTEIN, H. et al.	1962	Leitfossilien der Mikropaleontologie. Gebrüder Borntraeger, Berlin.
DEEGAN, C.E. & SCULL, B.J.	1977	A standard lithostratigraphic nomenclature for the Central and Northern North Sea. Institute of Geological Sciences, Report 77/25, Bulletin 1. Norwegian Petroleum Directorate.
FINSTAD, K.G. & SELLEY, R.C. (Editors)	1976	Jurassic Northern North Sea Symposium 1975. Norwegian Petroleum Society Publication.
KEIZER, J. & LETSCH, W. J.	1963	Geology of the Tertiary of the Netherlands. Verhandelingen, Vol. 2, Pt.2, (Trans. Jubilee Convention Pt.2).
PANNEKOEK, A.J.	1956	Geological History of the Netherlands. The Hague.
RASMUSSEN, L.B.	1974	Some geological results from five Danish exploration wells in the North Sea. Geol. Surv. of Denmark, III Series, No. 42.
ROBERTSON RESEARCH INTERNATIONAL LIMITED	1975/1976	The Jurassic of North West Europe: Offshore Project.
SORGENFREI, Th. & BUCH, A.	1964	Deep Tests in Denmark 1935-1959. Geol. Surv. of Denmark, III Series, No. 36.
WOODLAND, A.W. (Editor)	1975	Petroleum and the Continental Shelf of North West Europe, Vol. 1. Geology. Inst. Petrol.

APPENDIX A

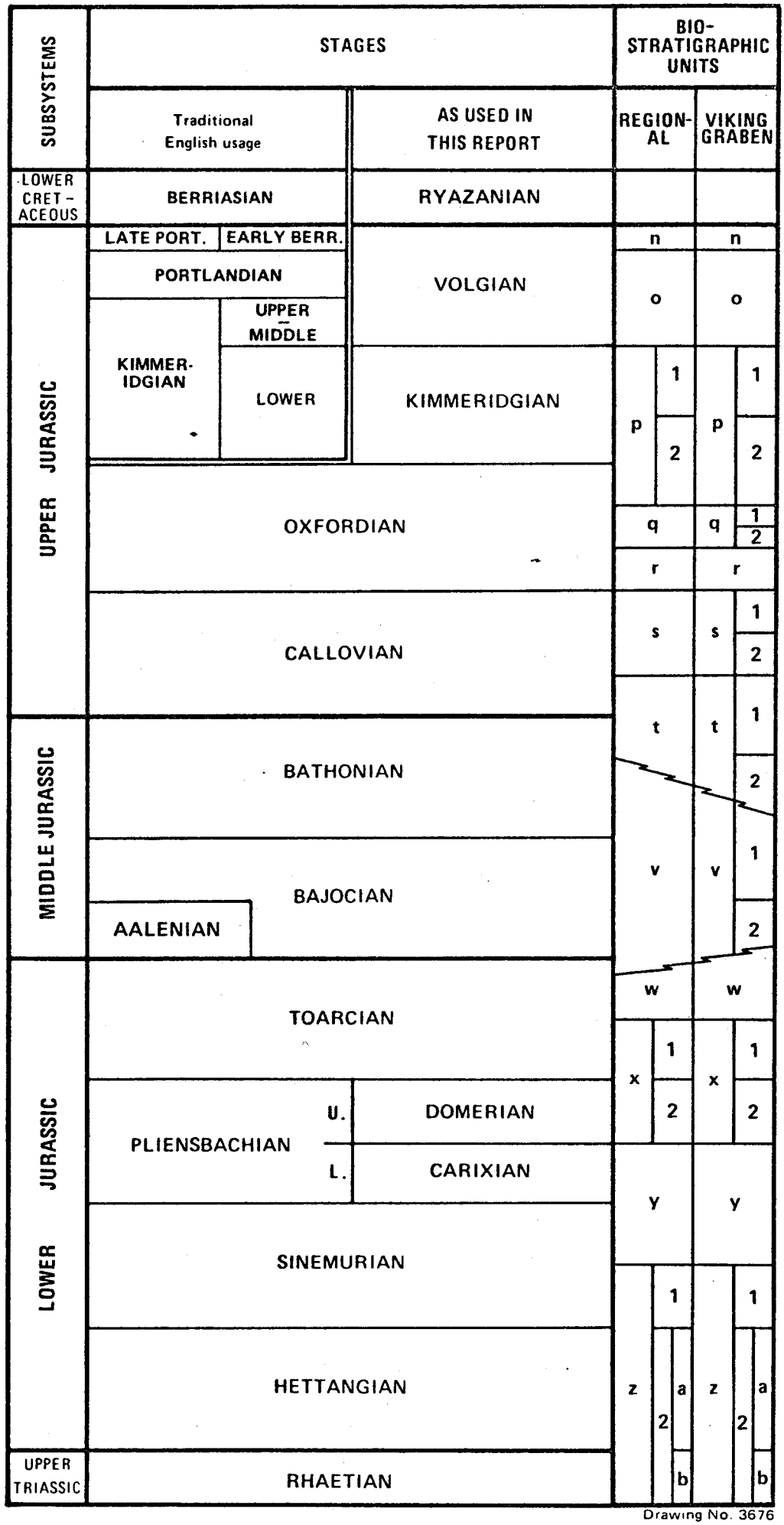
Sidewall Core Descriptions

Depth	Core No.	Run No.	Rec.	Quality of Core	Type of Analysis	Lithology
2893m	25	1	25mm	Good		SHALE: Firm, olive black, non-calcareous.
2895m	24	1	25mm	Good		SHALE: As 2893m.
2897m	23	1	30mm	Good		SHALE: Firm, olive grey, waxy, micaceous, non-calcareous.
2907m	22	1	35mm	Good		SHALE: Firm, olive black to olive grey, non-calcareous.
2909m	21	1	40mm	Good		SHALE: Earthy to firm, olive black to olive grey, non-calcareous.
2922m	19	1	15mm	Good	M	SHALE: As 2909m.
3405m	18	1	10mm	Fair		CHALK: Firm, platy, light grey.
3570m	17	1	5mm	Poor		CHALK: As 3405m.
3589m	16	1	20mm	Fair		CHALK: Firm, brittle, white.
3610m	14	1	30mm	Good		CHALK: Firm, yellowish grey, micaceous.
3677m	13	1	25mm	Good	M	SHALE: Fairly firm, dark grey to black, non-calcareous.
3680m	12	1	10mm	Fair		LIMESTONE: Friable, light olive grey to yellowish brown, ?sideritic.
3681m	11	1	15mm	Fair		SHALE: Very hard, massive, olive black, very calcareous.

Depth	Core No.	Run No.	Rec.	Quality of Core	Type of Analysis	Lithology
3695m	10	1	30mm	Good	M	SHALE: Firm, waxy, medium dark grey, slightly calcareous.
3728m	9	1	30mm	Good		CHALK: Firm to soft, light yellowish grey.
3785m	8	1	35mm	Excell.		CHALK: As 3728m.
3790m	7	1	15mm	Fair		CHALK: As 3728m.
3791m	6	1	25mm	Good	M	SHALE: Brittle, waxy, dark grey, highly calcareous.
3805m	5	1	30mm	Good		LIMESTONE: Firm to soft, light yellowish grey.
3813m	4	1	25mm	Good		LIMESTONE: As 3805m, olive grey.
3820m	3	1	35mm	Excell.	M	SHALE/LIMESTONE: Soft to firm, medium grey, highly calcareous.
3825m	2	1	35mm	Excell.		LIMESTONE: Firm to brittle, light yellowish grey, with SHALE: Firm, dark grey, highly calcareous.
3830m	1	1	25mm	Good	M, P	SHALE: Firm, brittle, medium grey, non-calcareous.
4280.5m	13	2	15mm	Good	P	SHALE: Very hard, olive black to brownish black, slightly micaceous, slightly carbonaceous, non-calcareous.

Key

M = Micropalaeontology
P = Palynology.



Drawing No. 3676

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

March 1978

LEGEND FOR STRATIGRAPHIC CHARTS

LITHOLOGY COLUMNS

Clay

Shale/claystone/mudstone

Silty/sandy clay

Silty/sandy shale/claystone/mudstone

Silt/siltstone

Sand/sandstone
- very fine to medium
- coarse sand to granules
- pebbles

Argillaceous sandstone

Limestone

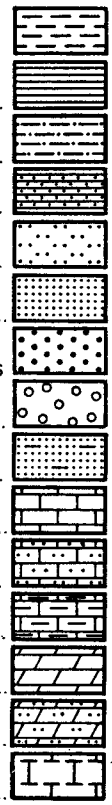
Silty/sandy limestone

Argillaceous limestone

Dolomite

Silty/sandy dolomite

Chalk



Calcareous sediments

Dolomitic sediments

Carbonaceous sediments

Anhydrite

Salt

Coal/lignite

Undifferentiated volcanics

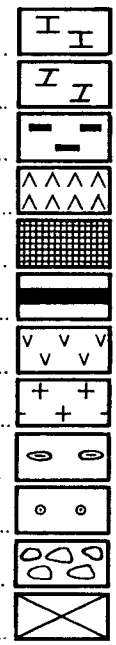
Basement (undifferentiated)

Mudflakes

Ooliths

Concretions

Sample gap



LITHOLOGICAL AND DRILLING ABBREVIATIONS

Red sedimentary rocks	red
Silica	Si
Chert	▼
Pyrite	P
Ironstone	Fe
Glauconite	G
Kaolinite	K
Siderite/sphaerosiderite	S
Shell fragments	~
Cement	cmt
Lost circulation material	lcm
Turbo drilling or diamond drilling (Samples unsuitable for good stratigraphic analysis)	tu

PALAEONTOLOGICAL SYMBOLS

Present	o
Common	●
Abundant	■
Diagnostic forms	*
Caved forms	C
Reworked forms	R
Dominant Kerogen Components: Inertinite	I
Dominant Kerogen Components: Vitrinite	V
Dominant Kerogen Components: Exinite	E
Dominant Kerogen Components: Amorphous sapropel	S
Incoming of	⌐→
Outgoing of	L→

ENCLOSURE 1

ROBERTSON RESEARCH INTERNATIONAL

BIOSTRATIGRAPHICAL ANALYSIS CHART

WELL :- 1/9-3 (RE-ENTRY)
LOCATION :- NORWEGIAN NORTH SEA
CLIENT :- STATOIL

DEPTH :- 2778m-3000m
SHEET 1 OF 7
ANALYST :- D J H, JU.

DRAWING NO. :- 398/1546/4316
DATE :- DECEMBER 1978

SCALE 1 : 2,000
ENCLOSURE 2

For legend see Enclosure 1

ROGALAND GROUP | HORDALAND GROUP

LITHOSTRATIGRAPHIC UNITS

GENERALISED LITHOLOGY

cm

3000 | 2950 | 2900 | 2850 | 2800 | 13 3/8"

DRILLED DEPTH (Metres) CASING .....
CORES ..... SIDEWALL SAMPLES .....

LOWER PALAEOCENE	PALAEOCENE	LOWER EOCENE	EOC
DANIAN			
G.pseudobull./ G.compressa	Bathysiphon spp. / Cyclammina spp.		

SYSTEM/SERIES
STAGE
MICROFAUNAL ASSEMBLAGES
PALYNOFLORAL
STRATIGRAPHIC UNITS

COMMENTS

- Dark brown stained agglutinates
- Coscinodiscus sp.2 Upper Cretaceous reworking
- Coscinodiscus sp.1
- S. spectabilis

ENVIRONMENT

TERRESTRIAL	CONTINENTAL
LACUSTRINE/FLUVIATILE	
DELTAIC	TRANSITIONAL
LITTORAL	
INNER SHELF	MARINE
OUTER SHELF	
BATHYAL	

DOMINANT KEROGEN COMPONENTS (>20μ)

% Agglutinated.....
Calcareous benthonic.....
Planktonic.....

Foraminiferal Association

FORAMINIFERA & OSTRACODA

1	Glomospira charoides	
2	Bathysiphon spp.	
3	Cyclammina spp.	
4	Cribrostomoides sp.	
5	Cyclammina cf. exigua	
6	Rugoglobigerina rugosa rugosa	R
7	Cyclammina challinori	*
8	Recurvoides sp.	
9	Trochammina sp.	
10	Globigerina praebulloides	
11	?Spiroplectammina spectabilis	
12	Spiroplectammina spectabilis	*
13	Indet. aggluts.	
14	Eponides umbonatus	
15	Cibicides sp.	
16	Gavellinoides cf. asper	R
17	Saccammina sp.	
18	Haplophragmoides sp.	
19	Globigerina linaperta gp.	
20	Globigerina pseudobulloides	R
21	Ammodiscus incertus	
22	?Trochammina sp.A	
23	Anomalinoides velascoensis	R
24	Cystammina sp.	
25	Pseudotextularia elegans elegans	R
26	Heterohelix sp.	
27	Globigerina triloculinoides	R
28	Guttulina sp.	
29	Pseudotextularia elegans fructicosa	R
30	Globigerina triloculinoides	*
31	Globigerina pseudobulloides	*
32	Lamarckina palaeocenica	*
33	Bulimina sp.	
34	Valvulineria sp.	
35	Anomalinoides sp.	
36	Globorotalia compressa	*
37	Lenticulina spp.	
38	Anomalinoides velascoensis	*
39	Gavelinella vombensis	*
40	Eponides sp.	
41	Globoconusa daubjergensis	*
42	Allomorphina halli	
43	Biglobigerinella sp.	R
44	Gyroidina/Gyroidinoides sp.	
45	Brizalina cf. incrassata	R
46	Cibicides succeedens	
47	Pullenia americana	
48	Rotaliatina sp.	
49	Verneuilinoides sp.	
50	Osangularia lens	*
51	Krithe sp.	
52	Lagena striata	
53	Cibicides proprius	
54		
55		
56		
57		

OTHER FOSSILS

58	Coscinodiscus spp. (pyritised)	
59	Coscinodiscus spp. (unpyritised)	
60	Large, flattened, reticulate radiolaria	
61	Fish teeth	
62	Coscinodiscus sp.1	*
63	Coscinodiscus sp.2	*
64	Small, round radiolaria	
65	?Triceratium sp.1	
66	Sponge spicules type A	
67	Ostracoda indet.	
68	Echinoderm debris	
69		
70		
71		
72		
73		
74		
75		
76		
77		
78		
79		
80		
81		

ROBERTSON RESEARCH INTERNATIONAL

WELL :– 1/9-3 (RE-ENTRY)
LOCATION :– NORWEGIAN NORTH SEA
CLIENT :– STATOIL

DEPTH :– 3000m-3300m
SHEET 2 OF 7
ANALYST :– DJH, JJJ, DJS

DRAWING NO. :– 398/1546/4316
DATE :– DECEMBER 1978
SCALE 1 : 2,000
ENCLOSURE 3

For legend see Enclosure 1

BIOSTRATIGRAPHICAL ANALYSIS CHART

CHALK GROUP | ROGALAND GROUP

LITHOSTRATIGRAPHIC UNITS

GENERALISED LITHOLOGY

No samples

3300 | 3250 | CORE 3 | 3200 | 3150 | CORE 2 | 3100 | CORE 1 | 3050 | 3000

DRILLED DEPTH (Metres) CASING.....
CORES..... SIDEWALL SAMPLES.....

UPPER CRETACEOUS | LOWER PALAEOCENE

SYSTEM/SERIES

MAASTRICHTIAN | DANIAN

STAGE

Rugoglobigerina rugosa rugosa | G.pseudobulloides/G.compressa

MICROFAUNAL / PALYNOFLORAL ASSEMBLAGES

STRATIGRAPHIC UNITS

COMMENTS

- No samples available
- Pseudotextularia elegans fructicosa
- Influx of small radiolaria & planktonic foraminifera with white preservation
- Dark brown staining of some agglutinates

ENVIRONMENT

TERRESTRIAL	CONTINENTAL
LACUSTRINE/FLUVIATILE	
DELTAIC	TRANSITIONAL
LITTORAL	
INNER SHELF	MARINE
OUTER SHELF	
BATHYAL	

DOMINANT KEROGEN COMPONENTS (>20μ)

Agglutinated.....
Calcareous benthonic.....
Planktonic.....
%

Foraminiferal Association

FORAMINIFERA & OSTRACODA

1	Bathysiphon spp.	
2	Ammodiscus incertus	
3	Lenticulina spp.	
4	Cibicides sp.	
5	Valvulineria sp.	
6	Globigerina pseudobulloides	*
7	Globorotalia compressa	*
8	Pseudotextularia elegans elegans	R
9	Pseudotextularia elegans fructicosa	R
10	Rugoglobigerina rugosa rugosa	R
11	Cyclammina spp.	
12	Trochammina cf. sp.A	
13	Trochammina sp.	
14	Hormosina sp.	
15	Globocomusa daubjergensis	*
16	Anomalinoides velascoensis	*
17	Bulimina cf. marginata	
18	Cytherelloidea sp.	
19	Cyclammina cf. exigua	
20	Glomospira charoides	
21	Guttulina sp.	
22	Gavelinella vombensis	*
23	Bulimina sp.	
24	Pullenia americana	
25	Heterohelix sp.	
26	Biglobigerinella multispina	R
27	Spiroplectammina spectabilis	*
28	Saccammina sp.	
29	Cystammina sp.	
30	Osangularia sp.	*
31	Verneuilina subeocaena	*
32	Osangularia lens	*
33	Globigerina trioculinoides	*
34	Dorothia bulletta	
35	Allomorphina halli	
36	Gyroidina/Gyroidinoides sp.	
37	Globigerina spp.	
38	Pullenia cretacea	
39	Lagena sp.	
40	Lagena striata	
41	Krithe sp.	
42	Rugoglobigerina rugosa rugosa	*
43	Pseudotextularia elegans fructicosa	*
44	Gavelinella spp.	
45	Dentalina/Nodosaria spp.	
46	Eponides lunata	
47	Brizalina incrassata incrassata	*
48	Dorothia sp.	
49	Polymorphinids	
50	Heterohelix globulosa	
51	Eponides spp.	
52	Pseudotextularia elegans elegans	*
53	Praebulimina carseyae	
54	Reussella szajnochae szajnochae	
55	Ammodiscus sp.	
56	Globigerinelloides asper	
57	Stensioina pommerana	
58		
59		
60		
61		
62		

OTHER FOSSILS

63	Ostracoda indet.	
64	Small, round radiolaria	
65	Large, flattened, reticulate radiolaria	
66	Coscinodiscus spp.	
67	Sponge spicules	
68	Echinoderm debris	
69	Fish teeth	
70	Coscinodiscus sp.1	*
71		
72		
73		
74		
75		
76		
77		
78		
79		
80		
81		

ROBERTSON RESEARCH INTERNATIONAL

WELL :– I/9-3 (RE-ENTRY)
LOCATION :– NORWEGIAN NORTH SEA
CLIENT :– STATOIL

DEPTH :– 3300m-3600m
SHEET 3 OF 7
ANALYST :– DJS, JU.

DRAWING NO. :– 398/1546/4316 SCALE 1 : 2,000
DATE :– DECEMBER 1978 ENCLOSURE 4

For legend see Enclosure 1

BIOSTRATIGRAPHICAL ANALYSIS CHART

CHALK GROUP

LITHOSTRATIGRAPHIC UNITS

GENERALISED LITHOLOGY

3600 3550 3500 3450 3400 3350 3300

DRILLED DEPTH (Metres) CASING.....
CORES..... SIDEWALL SAMPLES.....

UPPER CRETACEOUS

SYSTEM/SERIES

TURONIAN ? CENOMANIAN	SANTONIAN CONIACIAN	CAMPANIAN	MAASTRICHTIAN
STAGE			
Praeglobotruncana spp.		G. marginata / G. sp. 1	R. rugosa rugosa
MICROFAUNAL ASSEMBLAGES			
PALYNOFLORAL			

STRATIGRAPHIC UNITS

COMMENTS

P. delrioensis
S. praeexsculpta
influx of radiolaria
G. marginata
Globotruncana sp. 1

ENVIRONMENT

TERRESTRIAL	CONTINENTAL
LACUSTRINE/FLUVIATILE	
DELTAIC	TRANSITIONAL
LITTORAL	
INNER SHELF	MARINE
OUTER SHELF	
BATHYAL	

DOMINANT KEROGEN COMPONENTS (>20μ)

% Agglutinated.....
Calcareous benthonic.....
Planktonic.....

Foraminiferal Association

FORAMINIFERA

1	Rugoglobigerina rugosa rugosa	*
2	Gyroidinoides spp.	
3	Dentalina/Nodosaria sp.	
4	Eponides spp.	
5	Heterohelix globulosa	
6	Polymorphinids	
7	Gavelinella spp.	
8	Globigerinelloides asper	
9	Gavelinella vombensis	
10	Lenticulina sp.	
11	Praebulimina sp.	
12	Anomalinoides velascoensis	
13	Anomalinoides spp.	
14	Allomorphina sp.	
15	Dorothia spp.	
16	Globotruncana sp.1	*
17	Pullenia americana	
18	Fissurina sp.	
19	Pullenia cretacea	
20	Reussella szajnochae szajnochae	
21	Brizalina incrassata incrassata	
22	Praeglobotruncana cf. citae.	*
23	Globotruncana marginata	
24	Eponides lunata	
25	Recurvoides spp.	
26	Stensioina praeexsculpta	*
27	Praeglobotruncana citae	
28	Aragonia monolifera	
29	Globotruncana cf. linneiana group	
30	Praeglobotruncana delrioensis	*
31	Ramulina sp.	
32	Praeglobotruncana spp.	
33	Ammodiscus sp.	
34		
35		
36		
37		
38		

OTHER FOSSILS

39	Ostracoda
40	Echinoderm debris
41	Radiolaria
42	
43	
44	
45	
46	
47	
48	
49	
50	
51	
52	
53	
54	
55	
56	
57	
58	
59	
60	
61	
62	
63	
64	
65	
66	
67	
68	
69	
70	
71	
72	
73	
74	
75	
76	
77	
78	
79	
80	
81	

ROBERTSON RESEARCH INTERNATIONAL

WELL :- 1/9-3 (RE-ENTRY)
LOCATION :- NORWEGIAN NORTH SEA
CLIENT :- STATOIL

DEPTH :- 3600m-3900m
SHEET 4 OF 7
ANALYST :- D.S.CNO.JU

DRAWING NO. :- 398/1546/4316 SCALE 1 : 2,000
DATE :- DECEMBER 1978 ENCLOSURE 5

For legend see Enclosure 1

BIOSTRATIGRAPHICAL ANALYSIS CHART

CROMER KNOLL GROUP | CHALK GROUP | HIDRA FORMATION | PLENUS MARL FM | LITHOSTRATIGRAPHIC UNITS

GENERALISED LITHOLOGY

TOP CHALK

3900 3850 9 5/8" 3800 3750 3700 3650 3600

DRILLED DEPTH (Metres) CASING.....
CORES..... SIDEWALL SAMPLES.....

LOWER CRETACEOUS		UPPER CRETACEOUS	SYSTEM/SERIES
APTIAN-EARLY ALBIAN	ALBIAN	? CENOMANIAN-TURONIAN	STAGE
Green-stained aggluts./ L. Gyroidin	H. del.	Praeglobotruncana spp.	MICROFAUNAL ASSEMBLAGES
			PALYNOFLORAL

STRATIGRAPHIC UNITS

COMMENTS

Poor samples
? Additive common L. gyroidiniformis
Green staining
Influx of H. delrioensis (also SWC 3791)
Influx of yellow stained radiolaria
Caving

ENVIRONMENT

TERRESTRIAL	CONTINENTAL
LACUSTRINE/FLUVIATILE	
DELTAIC	TRANSITIONAL
LITTORAL	
INNER SHELF	MARINE
OUTER SHELF	
BATHYAL	

HUMIC

DOMINANT KEROGEN COMPONENTS (>20μ)

% Agglutinated..... Calcareous benthonic..... Planktonic.....

Foraminiferal Association

FORAMINIFERA

1 Recurvoides sp.
2 Ramulina sp.
3 Praeglobotruncana spp.
4 Bathysiphon sp.
5 Rugoblobigerina/Archaeoglobigerina spp.
6 Praeglobotruncana cf. delrioensis
7 Ammodiscus sp.
8 Polymorphinids
9 Gavelinella cf. pertusa
10 Hedbergella cf. delrioensis
11 Tritaxia cf. dubia
12 Gavelinella spp.
13 Eponides spp.
14 Hedbergella sp.
15 Heteruhelix globulosa
16 Glomospira gordialis
17 Spiroplectinata annectens
18 Hedbergella delrioensis
19 Hedbergella planispira
20 Dentalina/Nodosaria sp.
21 Lenticulina spp.
22 Valvulineria gracillima
23 Virgulina sp.
24 Lingulogavelinella gyroidinaeformis
25 Gaudryina dividens
26
27
28
29
30

MICROPLANKTON

31 Exochosphaeridium phragmites
32 Apteodinium sp.
33 Cribroperidinium spp.
34 Ovoidinium scabrosum
35 Oligosphaeridium pulcherrimum
36 Spiniferites ramosus
37 Cleistosphaeridium polypes
38 Odontochitina operculata
39 Oligosphaeridium spp.
40 Cyclonephelium distinctum
41 Chlamydophorella nyei
42 Stephodinium coronatum
43 Scriniodinium campanula
44 Hystrichodinium pulchrum
45
46
47
48
49

MIOSPORES

50 Bisaccates
51 Cerebropollenites mesozoicus
52 Cyathidites minor
53
54
55
56
57

KEROGEN

58 Inertinite
59 Vitrinite
60 Exinite
61
62
63
64
65

OTHER FOSSILS

66 Radiolaria
67 Coscinodiscus sp. ?C
68 Cenosphaera sp.
69
70
71
72
73
74
75
76
77
78
79
80
81

ROBERTSON RESEARCH INTERNATIONAL

WELL :– 1/9-3 (RE-ENTRY)
LOCATION :– NORWEGIAN NORTH SEA
CLIENT :– STATOIL

DEPTH :– 3900m-4200m
SHEET 5a OF 7
ANALYST :– DJS, JU

DRAWING NO. :– 398/1546/4316 SCALE 1 : 2,000
DATE :– DECEMBER 1978 ENCLOSURE 6

For legend see Enclosure 1

BIOSTRATIGRAPHICAL ANALYSIS CHART

CROMER KNOLL GROUP

LITHOSTRATIGRAPHIC UNITS

GENERALISED LITHOLOGY

lcm lcm red S

4200 4150 4100 4050 4000 3950 3900

DRILLED DEPTH (Metres) CASING
CORES SIDEWALL SAMPLES

STRATIGRAPHIC UNITS

SYSTEM/SERIES: LOWER CRETACEOUS

STAGE: ? RYAZANIAN-BARREMIAN | APTIAN-EARLY ALBIAN

ASSEMBLAGES
MICROFAUNAL: ? Lenticulina spp. /Ostracoda ? Green-stained agglutinates /L.gyroidinaeformis
PALYNOFLORAL:

COMMENTS
Barren of foraminifera
Increase in numbers of Lenticulina spp. and ostracoda
Influx of ostracoda

ENVIRONMENT
CONTINENTAL: TERRESTRIAL; LACUSTRINE/FLUVIATILE
TRANSITIONAL: DELTAIC; LITTORAL
MARINE: INNER SHELF; OUTER SHELF; BATHYAL

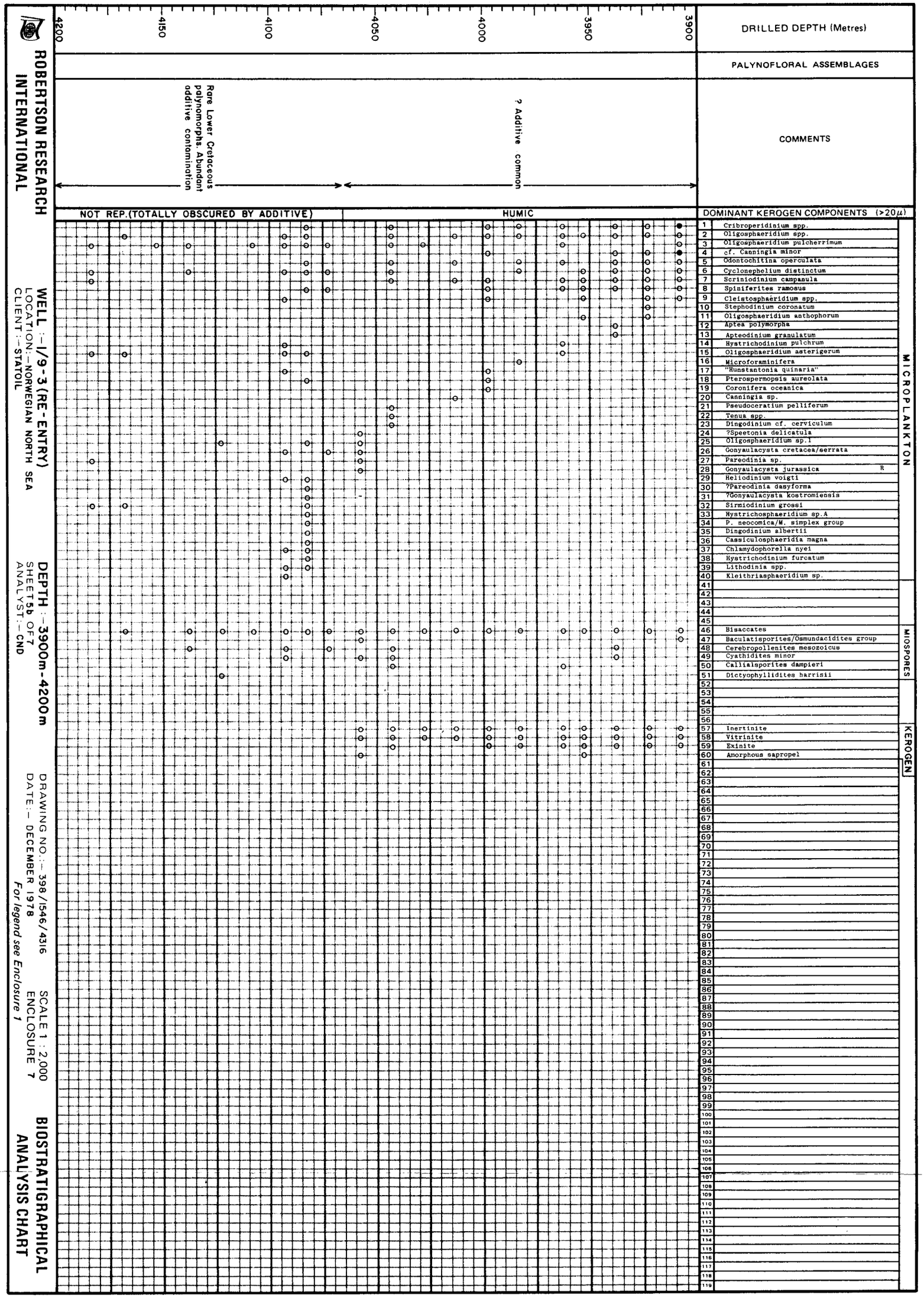
DOMINANT KEROGEN COMPONENTS (>20μ)

Foraminiferal Association
% Agglutinated..... Calcareous benthonic..... Planktonic.....

FORAMINIFERA
1 Glomospira gordialis
2 Recurvoides sp.
3 Gavelinella sp.
4 Bathysiphon sp.
5 Valvulineria gracillima
6 Verneuilinoides sp.
7 Hedbergella spp.
8 Hedbergella delrioensis
9 Lingulogavelinella gyroidinaeformis *
10 Vaginulina sp.
11 Dentalina/Nodosaria spp.
12 Lenticulina sp.
13 Gyroidinoides sp.
14 Pseudonodosaria vulgata
15 Polymorphinids
16 Textularia foeda
17 Hedbergella infracretacea
18 Lagena cf. hauteriviana cylindracea
19 Vaginulina sp.
20 Gavelinella intermedia
21 Lagena spp.
22 Lenticulina cf. schloenbachi
23 Ramulina sp.
24
25
26
27
28

OSTRACODES
29 Macrocypris sp.
30 Krausella minuta
31 Pontocyprella sp.
32 Cytherella cf.pyriformis *
33 Cytherella sp.
34 Bairdia sp.
35 ?Cytherella sp.
36 Cytherella pyriformis *
37 Paracypris sp.
38
39
40
41
42

OTHER FOSSILS
43 Radiolaria
44 Fish teeth
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81


ROBERTSON RESEARCH INTERNATIONAL
WELL :- 1/9-3 (RE-ENTRY)
LOCATION:- NORWEGIAN NORTH SEA
CLIENT :- STATOIL
DEPTH :- 3900m-4200m
SHEET 5b OF 7
ANALYST:- CND
DRAWING NO.:- 398/1546/4316
DATE:- DECEMBER 1978
For legend see Enclosure 1
SCALE 1 : 2,000
ENCLOSURE 7
BIOSTRATIGRAPHICAL ANALYSIS CHART
4200
4150
4100
4050
4000
3950
3900
DRILLED DEPTH (Metres)
PALYNOFLORAL ASSEMBLAGES
COMMENTS
Rare Lower Cretaceous palynomorphs. Abundant additive contamination
? Additive common
NOT REP.(TOTALLY OBSCURED BY ADDITIVE)
HUMIC
DOMINANT KEROGEN COMPONENTS (>20μ)
MICROPLANKTON
MIOSPORES
KEROGEN
1 Cribroperidinium spp.
2 Oligosphaeridium spp.
3 Oligosphaeridium pulcherrimum
4 cf. Canningia minor
5 Odontochitina operculata
6 Cyclonephelium distinctum
7 Scriniodinium campanula
8 Spiniferites ramosus
9 Cleistosphaeridium spp.
10 Stephodinium coronatum
11 Oligosphaeridium anthophorum
12 Aptea polymorpha
13 Apteodinium granulatum
14 Hystrichodinium pulchrum
15 Oligosphaeridium asterigerum
16 Microforaminifera
17 "Hunstantonia quinaria"
18 Pterospermopsis aureolata
19 Coronifera oceanica
20 Canningia sp.
21 Pseudoceratium pelliferum
22 Tenua spp.
23 Dingodinium cf. cerviculum
24 ?Speetonia delicatula
25 Oligosphaeridium sp.1
26 Gonyaulacysta cretacea/serrata
27 Pareodinia sp.
28 Gonyaulacysta jurassica R
29 Heliodinium voigti
30 ?Pareodinia dasyforma
31 ?Gonyaulacysta kostromiensis
32 Sirmiodinium grossi
33 Hystrichosphaeridium sp.A
34 P. neocomica/M. simplex group
35 Dingodinium albertii
36 Cassiculosphaeridia magna
37 Chlamydophorella nyei
38 Hystrichodinium furcatum
39 Lithodinia spp.
40 Kleithriasphaeridium sp.
41
42
43
44
45
46 Bisaccates
47 Baculatisporites/Osmundacidites group
48 Cerebropollenites mesozoicus
49 Cyathidites minor
50 Callialsporites dampieri
51 Dictyophyllidites harrisii
52
53
54
55
56
57 Inertinite
58 Vitrinite
59 Exinite
60 Amorphous sapropel
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119

ROBERTSON RESEARCH INTERNATIONAL

WELL :- 1/9-3 (RE-ENTRY)
LOCATION :- NORWEGIAN NORTH SEA
CLIENT :- STATOIL

DEPTH :- 4200m-4500m
SHEET 6 OF 7
ANALYST :- DJS, CND, JU

DRAWING NO. :- 398/1546/4316 SCALE 1 : 2,000
DATE :- DECEMBER 1978 ENCLOSURE 8

For legend see Enclosure 1

BIOSTRATIGRAPHICAL ANALYSIS CHART

HUMBER GROUP
KIMMERIDGE CLAY FM.
CROMER KNOLL GROUP
LITHOSTRATIGRAPHIC UNITS

GENERALISED LITHOLOGY

1cm 1cm
red
S
1cm

4500 4450 4400 4350 4300 4250 4200

DRILLED DEPTH (Metres) CASING.....
CORES..... SIDEWALL SAMPLES.....

STRATIGRAPHIC UNITS

INDETERMINATE	UPPER JUR. / LOWER CRETACEOUS
	LT. VOLG / BARREMIAN - ? RYAZANIAN
	UNIT n

SYSTEM/SERIES
STAGE
UNIT

ASSEMBLAGES
MICROFAUNAL
PALYNOFLORAL

COMMENTS

Palynomorph assemblages from ditch cuttings below 4280·5m (swc.) consist of rare caved Lower Cretaceous morphotypes with abundant additive contamination. Possible in situ Jurassic forms are very rare.

Rare Lower Cretaceous palynomorphs. Abundant additive contamination

No in situ microfauna rare caved forms present

Barren of foraminifera

ENVIRONMENT

TERRESTRIAL	CONTINENTAL
LACUSTRINE/FLUVIATILE	
DELTAIC	TRANSITIONAL
LITTORAL	
INNER SHELF	MARINE
OUTER SHELF	
BATHYAL	

NOT REPRESENTATIVE (TOTALLY OBSCURED BY ADDITIVE)

DOMINANT KEROGEN COMPONENTS (>20μ)

% Agglutinated.....
Calcareous benthonic.....
Planktonic.....

Foraminiferal Association

FORAMINIFERA

1	Glomospira charoides
2	Lenticulina sp.
3	Hedbergella sp.
4	Polymorphinid
5	Dentalina/Nodosaria sp.

MICROPLANKTON

12	Tenua spp.
13	Canningia spp.
14	Sirmiodinium grossii
15	Oligosphaeridium pulcherrimum
16	Cribroperidinium spp.
17	Cyclonephelium distinctum
18	Cleistosphaeridium sp.
19	Pterospermopsis sp.
20	Leiospheres

MIOSPORES

26	Bisaccates
27	Baculatisporites/Osmundacidites group
28	Cerebropollenites mesozoicus

ROBERTSON RESEARCH INTERNATIONAL

WELL :– 1/9-3 (RE-ENTRY)
LOCATION :– NORWEIAN NORTH SEA
CLIENT :– STATOIL

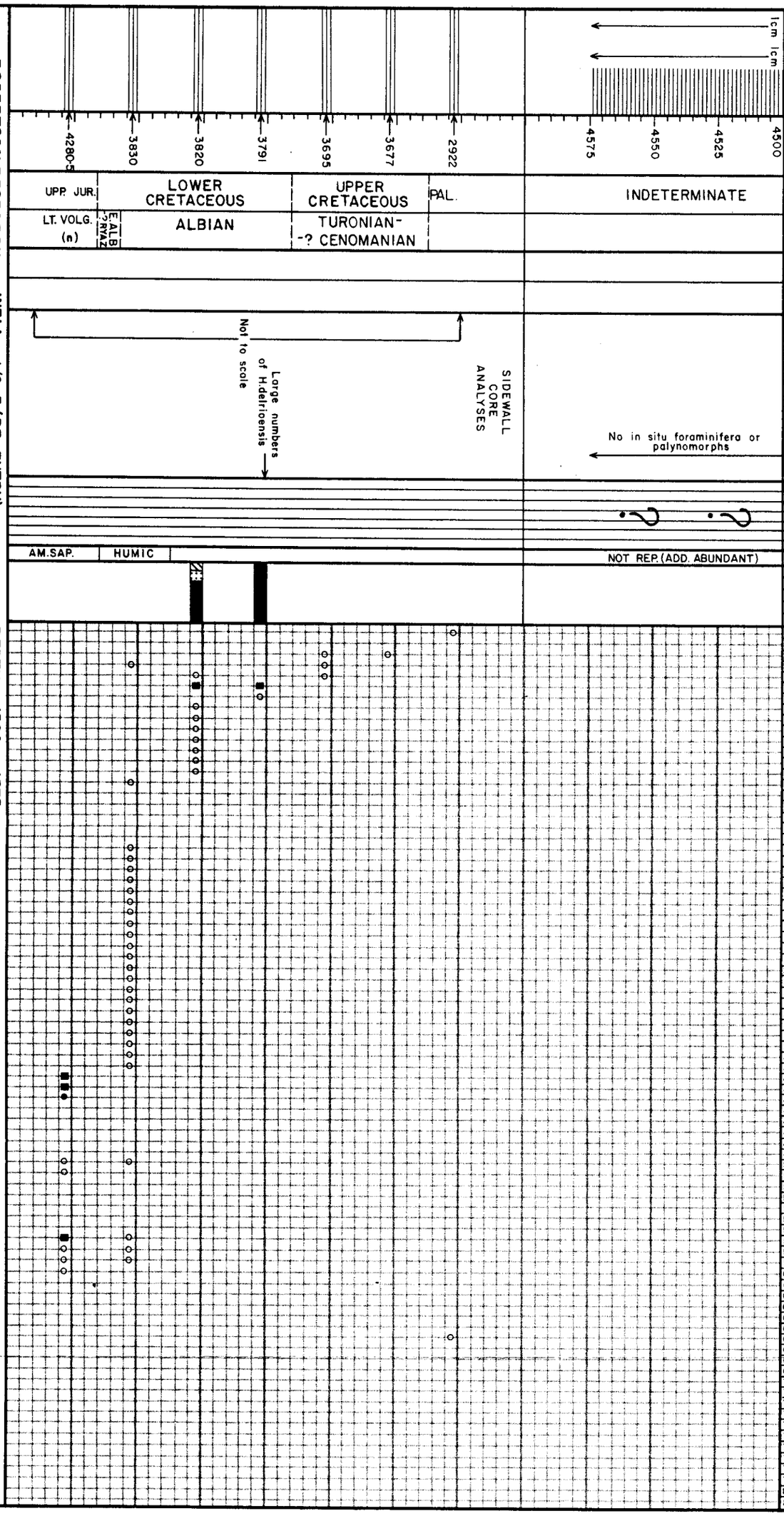
DEPTH :– 4500m-4575m
SHEET 7 OF 7 SIDEWALL CORES
ANALYST :– JU,DJS,CND

DRAWING NO. :– 398/1546/4316
DATE :– DECEMBER 1978

SCALE 1 : 2,000
ENCLOSURE 9

For legend see Enclosure 1

BIOSTRATIGRAPHICAL ANALYSIS CHART



1	Barren of foraminifera	FORAMINIFERA
2		
3	Archaeoglobigerina/Rugoglobigerina spp.	
4	Recurvoides sp.	
5	Hedbergella spp.	
6	Hedbergella delrioensis *	
7	Hedbergella brittonensis	
8	Valvulineria gracillima	
9	Lenticulina sp.	
10	Polymorphinids	
11	Tritaxia sp.	
12	Pseudonodosaria vulgata	
13	Eponides sp.	
14	Gavelinella sp.	
15	Bathysiphon sp.	
16		
17		
18		
19		
20		
21	Ctenidodinium elegantulum	MICROPLANKTON
22	Pseudoceratium sp.	
23	Oligosphaeridium pulcherrimum	
24	Chlamydophorella trabeculosa	
25	Phoberocysta neocomica	
26	Gonyaulacysta cladophora (Duxbury)	
27	Oligosphaeridium spp.	
28	Odontochitina operculata *	
29	Cleistosphaeridium sp.	
30	Cyclonephelium distinctum	
31	Lithodinia stoveri	
32	Muderongia simplex *	
33	Trichodinium speetonensis	
34	Oligosphaeridium sp.1 *	
35	Heslertonia heslertonensis	
36	Cribroperidinium sp.	
37	Hystrichodinium pulchrum	
38	Cassiculosphaeridia magna	
39	Kleithriasphaeridium sp.	
40	Chlamydophorella trabeculosa	
41	?Astrocysta cretacea	
42	Pterospermopsis spp. *	
43	Pterospermopsis aureolata *	
44	Leiospheres *	
45		
46		
47		
48		
49		
50	Bisaccates	MIOSPORES
51	Cerebropollenites mesozoicus	
52		
53		
54		
55		
56		
57	Amorphous sapropel	KEROGEN
58	Vitrinite	
59	Inertinite	
60	Exinite	
61		
62		
63		
64		
65		
66	Sponge spicule type B	OTHER FOSSILS
67		
68		
69		
70		
71		
72		
73		
74		
75		
76		
77		
78		
79		
80		
81		

ROBERTSON RESEARCH
INTERNATIONAL LIMITED

SUMMARY LOG : 1/9-3 (RE-ENTRY)

AREA : NORWEGIAN NORTH SEA

SPUD DATE PHASE II : 30. MAY, 1978

COMPANY : STATOIL

COMPLETION DATE PHASE II : 1. OCT, 1978

INTERVAL STUDIED : 2778m–4570m T. D. 4570 m

Dr. No. 398 / 1546 / 4316 SCALE 1:5000 Date : DEC. 1978

▮ Cored Interval ◣ Casing Shoe

SYSTEM	SUB-SYSTEM	STAGE / FORMATION	INTERVAL BOUNDARIES (approx.)	CASING AND CORING DETAILS	DEPTH METRES / FEET	GENERALISED LITHOLOGY	ENVIRONMENT OF DEPOSITION: TERRESTRIAL	LACUSTRINE / FLUVIATILE	DELTAIC	LITTORAL	INNER SHELF	OUTER SHELF	BATHYAL
TERTIARY — PALAEOCENE — EOCENE	LOWER EOCENE		2790m	◣ 13⅜"	2800	cmt							
			2862m										
PALAEOCENE	LOWER PALAEOCENE	DANIAN	2956·5m		2900	P							
				CORE 1	3000								
				CORE 2	3100								
			3150m										
		MAASTRICHTIAN		CORE 3	3200	NO SAMPLES							
CRETACEOUS	UPPER CRETACEOUS		3357m		3300								
		CAMPANIAN			3400								
			3471m										
		SANTONIAN CONIACIAN	3537m		3500								
		TURONIAN ?CENOMANIAN			3600								
			3790m		3700								
		ALBIAN			3800								
				◣ 9⅝"									
		EARLY ALBIAN APTIAN	3841·5m		3900	red S							
			3978m		4000	red							
	LOWER CRETACEOUS	?RYAZANIAN – BARREMIAN			4100	lcm							
					4200	lcm red S							
JURASSIC	U. JURASSIC	LT. VOLGIAN	4265m			lcm lcm							
INDETERMINATE			4280·75m		4300								
					4400								
					4500								

ENCLOSURE 10