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ROBERTSON RESEARCH INTERNATIONAL LIMITED

OILFIELDS REPORT NO. 727

THE MICROPALAEONTOLOGY AND STRATIGRAPHY

OF THE AMOCO 2/9-1 NORWEGIAN

NORTH SEA WELL

by

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Project No. RRI/IIA/723/197

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### Enclosures

Micropalaeontological Analysis Charts 1 - 11

Biostratigraphic Chart showing the distribution of the diagnostic Caenozoic and Mesozoic Foraminifera and Ostracoda in the Amoco Norway 2/9-1 North Sea Well (2 sheets).

INTRODUCTION

This report summarises the results obtained from the micropalaeontological and stratigraphical analyses which have been carried out on sample material supplied from the interval 1310' - 11650' in the Amoco Norway Oil Company's 2/9-1 North Sea Well under Project No. RRI/IIA/723/197. Under this project a total of 515 ditch cuttings samples have been analysed using standard micropalaeontological techniques.

This well is the first exploratory test to be drilled in Block 2/9 of the Norwegian concession area of the North Sea. This block occupies a position in the central part of the North Sea, a little to the south-east of the Eldfisk - Ekofisk - Tor Oilfields area. It is thus located over the deepest part of the North Sea Tertiary Basin.

Summaries of the age determinations obtained by these analyses have already been communicated in a series of telex communications which form the framework of factual information on which this final report is based. A complete summary of the stratigraphical sequence penetrated by this well is provided in Table 1 of the following Chapter (see page 2) and a detailed discussion of the stratigraphic units encountered is contained in Chapters III and IV.

The terminology adopted for the environmental conclusions postulated for each biostratigraphic unit is in accordance with the classification proposed by Hedgpeth (1957). An illustrated summary of this classification is contained in Table 2 (see page 3).

All the prepared samples, slides and recorded information appertaining to this work are now filed and curated in the confidential records section of these laboratories.

In conclusion, we wish to record our appreciation of the continuing co-operation and assistance which we have received from various members of the Amoco Oil Company with whom we have been associated during the course of this work.

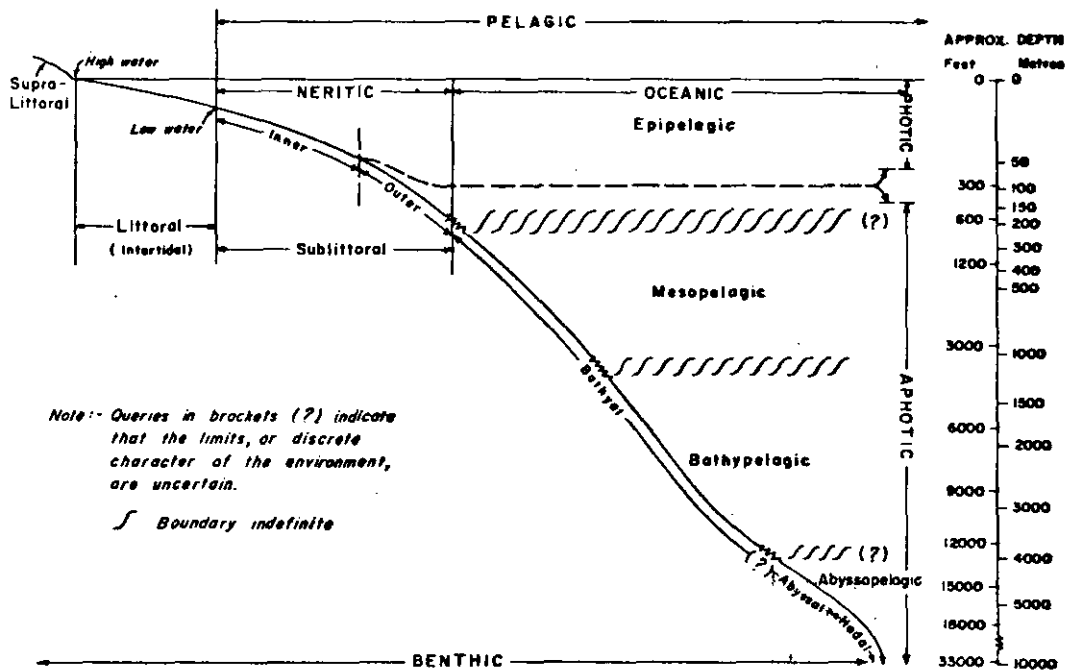
II  
SUCCESSION

TABLE 1

<u>Interval</u>	<u>Thickness</u>	<u>Stage</u>	<u>System/Subsystem</u>
1310' - 1490'	+ 180'	-	Lower Pleistocene - Pliocene
1520' - 2300'	+ 780'	-	Pliocene
2330' - 2630'	+ 300'	-	Pliocene - Upper Miocene
2660' - 5090'	+ 2430'	-	Middle Miocene
5120' - 5210'	+ 90'	-	Middle - Lower Miocene
5240' - 5840'	+ 600'	-	Lower Miocene
5870' - 7780'	+ 1910'	-	Oligocene
7800' - 8040'	+ 240'	-	Eocene
8060' - 9700'	+ 1640'	-	Lower Eocene - Palaeocene
9720' - 10060'	+ 340'	-	Palaeocene
10080' - 10390'	+ 310'	Danian	Lower Palaeocene
10410' - 11470'	+ 1060'	Maastrichtian )	Upper Cretaceous
11490' - 11650'	+ 160'	?Campanian - )	
		?Coniacian )	

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

- Neritic
- Oceanic
  - Epipelagic
  - Mesopelagic
  - Bathypelagic
  - Abyssopelagic

BENTHIC

- Supralittoral
- Littoral (Intertidal)
- Sublittoral
  - Inner
  - Outer
- 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.

### III

#### CAENOZOIC

##### INTERVAL 1310' - 1490'; Lower Pleistocene - Pliocene

###### General Lithology

This unit consists of light grey clays with subordinate amounts of fine-grained, subangular to rounded sand and shell fragments. The uppermost samples contain large amounts of cement.

###### Micropalaeontology and Stratigraphical Conclusions

A poor fauna is obtained from this interval and this is dominated by Elphidium incertum, Elphidiella hannai and Elphidium clavatum. These forms would suggest a Lower Pleistocene age. However, the presence of rare specimens of Nonion barleeanum may indicate that the Pliocene has been encountered. A Lower Pleistocene - Pliocene age is thus assigned to this unit in view of the scanty evidence available.

###### Environmental Conclusions

The poor nature of the microfauna combined with the presence of shell debris and sand would suggest a littoral to inner sublittoral environment of deposition for these sediments.

##### INTERVAL 1520' - 2300'; Pliocene

###### General Lithology

A similar lithology to that of the overlying unit is present in this section. Shell fragments are abundant in the top 60' of the sequence and fine, subrounded sand grains are the predominant accessory to the clays towards the base of the interval.

### Micropalaeontology and Stratigraphical Conclusions

A Pliocene age is indicated by the occurrence at 1520' of Cassidulina laevigata and Nonion affine. This is confirmed by the subsequent appearance of Elphidium antoninum, Cibicides lobatulus var. grossa, Cassidulina laevigata var. pliocarinata and Bulimina elongata var. subulata. Uvigerina asperula and Rotalia beccarii var. occur at the base of the sequence, the latter form being abundant.

### Environmental Conclusions

The predominance of calcareous benthonic foraminifera in relation to planktonic forms and the presence of particular shallow-water types such as Elphidium spp. and Rotalia beccarii var. would suggest an inner sublittoral environment for this interval.

### INTERVAL 2330' - 2630'; Pliocene - Upper Miocene

#### General Lithology

Clays still predominate within this unit and fine sand remains the principal trace component with the exception of the interval 2420' - 2480' where glauconite, pyrite and shell fragments are found in abundance.

### Micropalaeontology and Stratigraphical Conclusions

The poor fauna of this unit consists mainly of Pliocene forms associated with one or two individuals of Bolivina cf. beyrichi, an Upper Miocene form. A Pliocene - Upper Miocene age is therefore suggested for this sequence.

Reworked Upper Cretaceous foraminifera are noted at 2510'.

### Environmental Conclusions

The paucity of the fauna, combined with the occurrence of shell fragments and glauconite in the clays, would indicate a shallow water restricted environment, probably of inner sublittoral depths.

## INTERVAL 2660' - 5090'; Middle Miocene

### General Lithology

This sequence is composed of light grey, sandy, locally pyritic, soft clays with occasional bands of shale, limestone and dolomite. Pyrite accessories are mainly found in the interval 3110' - 3860'.

### Micropalaeontology and Stratigraphical Conclusions

The upper 900' of this unit displays a rich diversified fauna with forms such as Loxostomum sinuosum, Trifarina bradyi, Uvigerina hosiusi and Pullenia sphaeroides, indicating a Middle Miocene age. Uvigerina hosiusi is not present until 2960' and does not become abundant until 3380'. Planktonic forms become increasingly important from the latter depth, while below 3560', when poor faunas are encountered, they are often the commonest foraminiferal species present. Pyritised gastropods and Coscinodiscus species are also present. Radiolarian species and a few agglutinating foraminifera characterise the lower 90' of the sequence.

### Environmental Conclusions

The interval 2660' - 3560' displays a rich, calcareous, benthonic foraminiferal fauna, together with occasional planktonic forms. Open marine conditions prevailed and an inner to outer sublittoral environment is postulated.

A gradual change in environment occurs below 3560' with the recording of poorer faunas. Fewer species are found and, with assemblages consisting mainly of planktonic types, an outer sublittoral environment is therefore suggested.

The occurrence of radiolaria and a few deep water agglutinating foraminifera, such as Glomospira charoides in the bottom 90', would indicate an outer sublittoral to bathyal environment at the onset of the Middle Miocene.



## INTERVAL 5120' - 5210'; Middle Miocene - Lower Miocene

### General Lithology

This unit is dominated by the grey clays which are accompanied by traces of pyrite and subrounded fine sand.

### Micropalaeontological and Stratigraphical Conclusions

Although most of the forms present here are similar to those recorded from the overlying Middle Miocene, the appearance at 5120' of Ehrenbergina serrata may suggest that the Lower Miocene has been penetrated. We have, therefore, assigned a Middle - Lower Miocene age to this interval.

### Environmental Conclusions

The agglutinating foraminifera are less significant in this sequence, planktonic foraminifera and calcareous benthonic forms being the main faunal constituents. These facts would infer an outer sublittoral environment with open marine conditions.

## INTERVAL 5240' - 5840'; Lower Miocene

### General Lithology

The principal component is again the grey clay but with the persistent occurrence of traces of light brown shales. Small quantities of darker brown shale occur at the base of the unit.

### Micropalaeontology and Stratigraphical Conclusions

The upper 330' of the unit is characterised by very poor faunas. However, a Lower Miocene age is indicated by the appearance of Globorotalia scitula among the few species present. Further evidence is found to substantiate a Lower Miocene age in the lower half of the sequence where Uvigerina tenuispustulata, Globorotalia

praescitula, Globigerinoides triloba triloba and Globigerinoides triloba immatura are noted.

#### Environmental Conclusions

An outer sublittoral environment with open marine conditions is again indicated by the occurrence of planktonic and calcareous benthonic foraminifera. However, agglutinating deep water forms prevail at the bottom of the sequence and would thus suggest a change to an outer sublittoral - bathyal environment around 5800'.

#### INTERVAL 5870' - 7780'; Oligocene

##### General Lithology

The sequence is dominated by grey clay with traces of light brown to dark brown shale occurring in the upper 800'. Minor amounts of pyrite are found below 7320'.

##### Micropalaeontology and Stratigraphical Conclusions

The microfauna is dominated by agglutinating foraminifera throughout the sequence. An Oligocene age is first indicated by the occurrence of Siphonodosaria hirsuta at 5870', and this is subsequently supported by the appearance of Sigmoilina tenuis, Globigerina ouachitaensis, Cibicides ungerianus and Asterigerina gfrichi. The section below 7440' is probably of Middle - Lower Oligocene age since Rotaliatina bulimoides occurs below this depth. Several species of Coscinodiscus are present throughout the sequence.

##### Environmental Conclusions

A bathyal environment is postulated for this interval on account of the dominance of deep water agglutinating foraminifera.

## INTERVAL 7800' - 8040'; Eocene

### General Lithology

Grey clay predominates here and is accompanied by occasional bands of dark grey micaceous shale. Traces of fine quartz and pyrite are also present throughout the sequence.

### Micropalaeontology and Stratigraphical Conclusions

Agglutinating foraminifera dominate the microfauna within this unit. The appearance of Cyclamina challinori at 7800' is indicative of an Eocene age, and the subsequent appearance of Trochammina globigeriniformis, Uvigerina cf. farinosa and Globorotalia aff. centralis supports this determination.

### Environmental Conclusions

As in the above unit, the large number of agglutinating foraminifera present infers a bathyal environment of deposition.

## INTERVAL 8060' - 9700'; Lower Eocene - Palaeocene

### General Lithology

This sequence is characterised by the alternation of several bands of shale and limestone within the grey clay. Traces of light grey to green shale are present in the upper 400', while grey-brown shales occur below 8420'. Buff coloured limestone fragments are noted throughout this upper part and become the dominant accessory between 8640' and 8980'. Light grey micaceous shales, still with occasional limestone fragments, accompany the clays over the lower 700' of the interval.

### Micropalaeontology and Stratigraphical Conclusions

The top of the interval is marked by the appearance of dark, green-stained

foraminifera, including such forms as Verneuilina subeocaena at 8060' and Spiroplectammina spectabilis at 8260'. These forms are characteristic of the Lower Eocene to Palaeocene. Poor faunas are found in the lower 700' of the section.

#### Environmental Conclusions

The relatively poor fauna found consisted solely of agglutinating foraminifera and would appear to indicate a restricted bathyal environment.

#### INTERVAL 9720' - 10060'; Palaeocene

##### General Lithology

Light grey, micaceous shales and grey clays dominate this interval. Traces of light grey, banded tuffs and tuffaceous shales mark the top 200' of this unit. Fine-grained, subrounded quartz and buff coloured dolomite are minor accessories.

##### Micropalaeontology and Stratigraphical Conclusions

The appearance of Globigerina triloculinoides at 9720' marks the top of the Palaeocene. The subsequent appearance of Coscinodiscus sp.1 at 9740' adds further proof as to the age, as does the presence of tuffs and tuffaceous shales. Overall the microfauna is dominated by the agglutinating foraminifera.

##### Environmental Conclusions

The predominance of agglutinating foraminifera and the presence of very few planktonic forms point to a restricted bathyal environment as in the overlying unit. Volcanic activity took place during the Palaeocene, as is evidenced by the presence of tuffs.

## INTERVAL 10080' - 10390'; Danian, Lower Palaeocene

### General Lithology

Grey clays with bands of purple and green shales mark the top of this sequence, but greyish-white chalk becomes the dominant lithology below 10180'. From 10340' white, fairly hard, brittle chalk occurs. Occasional traces of shale are also present.

### Micropalaeontology and Stratigraphical Conclusions

The dominant deep water agglutinating forms of the interval above give way to calcareous benthonic foraminifera at the top of the interval. Gavelinella vombensis, a Danian form, occurs at 10080'. This species is followed by Anomalinoides velascoensis and Alabamina midwayensis at 10120' and Lamarckina paleocenica at 10180'. A number of reworked Upper Cretaceous foraminifera are present in the lower half of the sequence, including Globotruncana contusa, Heterohelix globulosa, Gavelinella costata, Pseudotextularia elegans and Rugoglobigerina rugosa rugosa. The agglutinating species which also occur could be present due to caving, especially in the chalk sections.

### Environmental Conclusions

The occurrence of planktonic foraminifera and diverse benthonic foraminifera, together with the appearance of chalk at 10160', indicates an outer sublittoral environment with good open marine connections for this sequence. The clays at the top of the interval may mark a transition from the bathyal conditions of the Palaeocene to the outer sublittoral environment of the Chalk.

## IV

### CRETACEOUS

INTERVAL 10410' - 11470'; Maastrichtian, Upper Cretaceous

#### General Lithology

Hard, cream coloured chalk persists throughout this unit. Occasional traces of shale and buff coloured limestone in variable amounts are probably the result of caving. Soft pink chalk is present below 11450'.

#### Micropalaeontology and Stratigraphical Conclusions

A well-developed Upper Cretaceous fauna of Maastrichtian age is first encountered in the sample at 10410'. Pseudotextularia elegans fructicosa, Rugoglobigerina rugosa rotundata and R. rugosa rugosa are present in considerable numbers, and this sample also contains Stensibina pommerana, Pseudotextularia acervulinoides, P. elegans elegans, together with a variety of other benthonic species characteristic of the younger Maastrichtian section.

Over the succeeding 360' of section considerable variety can be noted among the individual samples. Residues alternate between being moderately rich or poorly fossiliferous, whilst at the same time the dominant forms within individual samples change without apparent reason. In the topmost samples of this interval Rugoglobigerina rugosa rugosa, R. rugosa cf. rotundata and Pseudotextularia elegans fructicosa predominate. Between 10500' and 10600' it is Pseudotextularia elegans fructicosa, P. elegans elegans, Globotruncana contusa and Praebulimina carseyae which are the dominant species. At 10630' and again at 10750' Gavelinella vombersis occurs in conspicuous numbers, whilst the succeeding sample at 10770' is notable for the numbers of Lenticulina and Haplophragmoides it contains.

From 10780' - 10900' a sequence of distinctly richer microfaunas is encountered. Although there is a fair representation of planktonic and agglutinating species within these faunas, the major part is comprised of a varied assemblage of benthonic foraminifera. Important stratigraphic markers occurring within the Maastrichtian section down to 10900' include Bolivinoides draco draco, B. draco miliaris, Rugoglobigerina rugosa rotundata, Bolivina incrassata incrassata, Globotruncana arca, Praeglobotruncana citae, Gavelinopsis voltziana, Reussella szajnochae, R. cristata, Angulogavelinella bettenstaedti and Orbignyna ovata.

At around 10870' increasing quantities of Tertiary caved material become conspicuous in the samples, and from 10930' samples are heavily contaminated by elements of these younger faunas. Samples over the remaining 500' and more of this interval are similarly affected. From 10990' - 11110' only a few elements of Maastrichtian fauna are included in the samples, and again from 11330' - 11410' samples are composed mainly of Tertiary caved materials. No important new Upper Cretaceous forms were noted over this lower part of the interval which is assumed to be of older Maastrichtian age.

#### Environmental Conclusions

The uniform presence of chalk throughout this interval indicates little change from the depositional environment postulated for the overlying Danian section, and a continuing outer sublittoral environment is thought to have prevailed during Maastrichtian times. The presence in fluctuating numbers of planktonic foraminifera suggests that, whilst marine connections were generally maintained over this period, they may at times have been partially restricted.

INTERVAL 11490' - 11650'; ?Campanian - ?Coniacian, Upper Cretaceous

General Lithology

The soft pink chalk is underlain by soft grey chalk which first appears at around 11540'. Caving in the form of grey-green shales is prevalent over the last 100' of this section.

Micropalaeontology and Stratigraphical Conclusions

The basal 160' of section in this well provides residues very similar in content to those described from the lower part of the Maastrichtian interval. Tertiary caving continues to be conspicuous, tending to mark the Cretaceous fraction which, for the most part, is only poor to moderate in its state of preservation. Agglutinating species predominate and these are associated with a limited number of planktonic forms and occasional benthonic specimens.

The presence of one or two specimens of Globotruncana marginata and G. cf. marginata, coupled with the general appearance of the in situ faunas, give rise to the assumption that these beds are at least older than Maastrichtian. However, since there is no evidence for supposing them to be older than Senonian, a tentative age designation of questionable Coniacian - Campanian age is considered appropriate. To some extent the presence of pink-stained chalk and chert, first noted at 11470', substantiates that this short interval is most probably pre-Maastrichtian in age.

Environmental Conclusions

The restricted microfaunas encountered in this basal section provide only limited inferences for assessing the existing environment of deposition. However, the continuing chalk lithology would suggest little change from the outer sublittoral environment already noted in the later Upper Cretaceous and early Tertiary. The relative abundance of planktonic foraminifera indicates a maintenance of connections to open marine waters.



CONCLUSIONS

In this well drilling was completed at a total depth of 11650', and the greater part of this section comprises a massive thickness of more than 9000' of Tertiary sediments. Chalk beds are first encountered at 10160' and these continue down without interruption to the base of the section.

Most of the chalk interval is identified as belonging to the Upper Cretaceous, with 1060' covering the section from 10410' - 11470' being identified as of Maastrichtian age, and the basal 160' appearing to be of slightly older Senonian age. This is overlain by Danian Chalk. Conditions of sedimentation throughout the period of Senonian to mid-Danian time thus appear to have remained relatively stable. The intermittent appearances of faunas of planktonic foraminifera, however, suggest that connections to open marine waters were largely restricted. In late Maastrichtian and Danian times a distinct change, marked by the sudden appearance of substantial planktonic faunas, appears to have established more open marine conditions.

The Danian period witnesses a major transition between the Upper Cretaceous periods and the Tertiary era. The change in lithology from chalk to shale and clay at the top of the Danian marks the start of an uninterrupted sedimentation which continues without any major stratigraphic break throughout Tertiary times. A change in microfauna also occurs within the Danian. The open marine conditions with abundant planktonic foraminifera change into a restricted deep water, bathyal environment at the end of the Danian with a dominance of agglutinating foraminifera. These conditions persist throughout the Palaeocene, Eocene and Oligocene periods and are then followed by a period of slight shallowing to give outer sublittoral conditions in the Miocene. Further shallowing is indicated in Upper Miocene - Pliocene times by the

presence of shell fragments, sandy horizons and an impoverished fauna. The Tertiary concludes with a littoral to inner sublittoral environment of deposition persisting into the Lower Pleistocene.

Some volcanic activity is suggested at the end of Palaeocene times by the presence of tuffs and tuffaceous shales.

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**ROBERTSON RESEARCH LABORATORIES**

**MICROPALAEONTOLOGICAL ANALYSIS CHART**

DATE: 20. 12. 72 ANALYST: KJR, CMH LOCATION: Norwegian North Sea Well 2/9-1  
 FOR: Amoco Norway Oil Company CHART No. 2  
 2000' - 3000'

- LITHOLOGY**
- Limestone
  - Dolomite
  - Organic Limestone
  - Clay
  - Shale
  - Silty Sand
  - Sandstone
  - Conglomerate
  - Opresm
  - Volcanics
  - Intrastrives
  - Salt
  - Coal
  - Grist
  - Shell fragments
  - Glaucconite
  - Pyrite

**DEPTH IN FEET**

100  
200  
300  
400  
500  
600  
700  
800  
900  
1000

**SYSTEM**

PLIOCENE  
 UPPER MIOCENE - Pliocene  
 MIDDLE MIOCENE

**STAGE**

**ENVIRONMENT**

CONTINENTAL  
 BRACKISH / DELTAIC / LAGOONAL  
 LITTORAL (0 - 20')  
 INNER SUBLITTORAL (20'-150')  
 OUTER SUBLITTORAL (150'-600')  
 BATHYAL (OVER 600')

**MICROFOSSILS**

- Elphidium incertum
- Elphidium clavatum
- Elphidiella hannai
- Nonion granosum
- Cassidulina laevigata var. pliocarinata
- Quinqueloculina seminulum
- Cassidulina crassa
- Elphidium excavatum
- Bulimina marginata
- Bulimina elongata
- Bolivina sp.
- Bulimina gibba
- Buccella frigida
- Bolivina cf. spathulata
- Bulimina elongata var. subulata
- Cassidulina laevigata
- Lenticulina (Robulus) spp.
- Uvigerina asperula
- Nonion barleeanum
- Rotalia beccarii
- Rotalia beccarii var.
- Bulimina elongata var. tenera
- Hedbergella sp.
- Bolivina spathulata
- Virgulina complanata
- Glandulina laevigata
- Bolivina cf. bevrichi
- Globigerina sp.
- Polymorphinids
- Cibicides sp.
- Aurila convexa
- Triloculina circularis
- Sigmoilina celata
- Cibicides lobatulus var. grossa
- Globigerina cf. praebulloides
- Elphidium antoninum
- Nonion affine
- Bulimina aculeata
- Stensioina exsculpta gracilis
- Fissurina laevigata
- Pullenia sphaeroides
- Loxostomum sinuosum
- Trifarina bradyi
- Globigerina riveroae
- Globigerina bulloides
- Pullenia quinqueloba
- Fissurina marginata
- Globigerina bradyi
- Bulimina fusiformis var. marginata
- Nonion boucanum
- Cibicides lobatulus
- Cibicides cf. peelenensis
- Globorotalia acostaensis
- Textularid
- Cibicides scaldisiensis
- Eponides umbonatus
- Angulogerina angulosa
- Bolivina serrato-suturalis
- Uvigerina hosi
- 'Cythere' latimarginata
- Ammodiscus incertus
- Fissurina sp. 1
- Oolina hexagona

DEPTH IN FEET	SYSTEM	STAGE	ENVIRONMENT	MICROFOSSILS
100	PLIOCENE		CONTINENTAL	Elphidium incertum
100	PLIOCENE		CONTINENTAL	Elphidium clavatum
100	PLIOCENE		CONTINENTAL	Elphidiella hannai
100	PLIOCENE		CONTINENTAL	Nonion granosum
100	PLIOCENE		CONTINENTAL	Cassidulina laevigata var. pliocarinata
100	PLIOCENE		CONTINENTAL	Quinqueloculina seminulum
100	PLIOCENE		CONTINENTAL	Cassidulina crassa
100	PLIOCENE		CONTINENTAL	Elphidium excavatum
100	PLIOCENE		CONTINENTAL	Bulimina marginata
100	PLIOCENE		CONTINENTAL	Bulimina elongata
100	PLIOCENE		CONTINENTAL	Bolivina sp.
100	PLIOCENE		CONTINENTAL	Bulimina gibba
100	PLIOCENE		CONTINENTAL	Buccella frigida
100	PLIOCENE		CONTINENTAL	Bolivina cf. spathulata
100	PLIOCENE		CONTINENTAL	Bulimina elongata var. subulata
100	PLIOCENE		CONTINENTAL	Cassidulina laevigata
100	PLIOCENE		CONTINENTAL	Lenticulina (Robulus) spp.
100	PLIOCENE		CONTINENTAL	Uvigerina asperula
100	PLIOCENE		CONTINENTAL	Nonion barleeanum
100	PLIOCENE		CONTINENTAL	Rotalia beccarii
100	PLIOCENE		CONTINENTAL	Rotalia beccarii var.
100	PLIOCENE		CONTINENTAL	Bulimina elongata var. tenera
100	PLIOCENE		CONTINENTAL	Hedbergella sp.
100	PLIOCENE		CONTINENTAL	Bolivina spathulata
100	PLIOCENE		CONTINENTAL	Virgulina complanata
100	PLIOCENE		CONTINENTAL	Glandulina laevigata
100	PLIOCENE		CONTINENTAL	Bolivina cf. bevrichi
100	PLIOCENE		CONTINENTAL	Globigerina sp.
100	PLIOCENE		CONTINENTAL	Polymorphinids
100	PLIOCENE		CONTINENTAL	Cibicides sp.
100	PLIOCENE		CONTINENTAL	Aurila convexa
100	PLIOCENE		CONTINENTAL	Triloculina circularis
100	PLIOCENE		CONTINENTAL	Sigmoilina celata
100	PLIOCENE		CONTINENTAL	Cibicides lobatulus var. grossa
100	PLIOCENE		CONTINENTAL	Globigerina cf. praebulloides
100	PLIOCENE		CONTINENTAL	Elphidium antoninum
100	PLIOCENE		CONTINENTAL	Nonion affine
100	PLIOCENE		CONTINENTAL	Bulimina aculeata
100	PLIOCENE		CONTINENTAL	Stensioina exsculpta gracilis
100	PLIOCENE		CONTINENTAL	Fissurina laevigata
100	PLIOCENE		CONTINENTAL	Pullenia sphaeroides
100	PLIOCENE		CONTINENTAL	Loxostomum sinuosum
100	PLIOCENE		CONTINENTAL	Trifarina bradyi
100	PLIOCENE		CONTINENTAL	Globigerina riveroae
100	PLIOCENE		CONTINENTAL	Globigerina bulloides
100	PLIOCENE		CONTINENTAL	Pullenia quinqueloba
100	PLIOCENE		CONTINENTAL	Fissurina marginata
100	PLIOCENE		CONTINENTAL	Globigerina bradyi
100	PLIOCENE		CONTINENTAL	Bulimina fusiformis var. marginata
100	PLIOCENE		CONTINENTAL	Nonion boucanum
100	PLIOCENE		CONTINENTAL	Cibicides lobatulus
100	PLIOCENE		CONTINENTAL	Cibicides cf. peelenensis
100	PLIOCENE		CONTINENTAL	Globorotalia acostaensis
100	PLIOCENE		CONTINENTAL	Textularid
100	PLIOCENE		CONTINENTAL	Cibicides scaldisiensis
100	PLIOCENE		CONTINENTAL	Eponides umbonatus
100	PLIOCENE		CONTINENTAL	Angulogerina angulosa
100	PLIOCENE		CONTINENTAL	Bolivina serrato-suturalis
100	PLIOCENE		CONTINENTAL	Uvigerina hosi
100	PLIOCENE		CONTINENTAL	'Cythere' latimarginata
100	PLIOCENE		CONTINENTAL	Ammodiscus incertus
100	PLIOCENE		CONTINENTAL	Fissurina sp. 1
100	PLIOCENE		CONTINENTAL	Oolina hexagona

**ROBERTSON RESEARCH LABORATORIES**  
**MICROPALAEONTOLOGICAL ANALYSIS CHART**

DATE: 22.12.72. ANALYST: KJR, CWH. LOCATION: Norwegian North Sea Well 2/9-1  
 FOR: Amoco Norway Oil Company. CHART No. 3. 3000' - 4000'

- LITHOLOGY: Limestone, Dolomite, Oolitic Limestone, Clay, Shale, Silty Sandstone, Sandstone, Conglomerate, Gypsum, Volcanics, Pyrite, Salt, Coal, Chert.

LITHOLOGY	DEPTH IN FEET	SYSTEM	STAGE
	100		
	200		
	300		
	400		
	500		
	600		
	700		
	800		
	900		
	1000		

MIDDLE MIOCENE

- ENVIRONMENT: Continental Brackish/Deltaic/Lagoonal, Littoral (0-20'), Inner Sublittoral (20-150'), Outer Sublittoral (150-600'), Bathyal (over 600').

MICROFOSSILS

Species	100	200	300	400	500	600	700	800	900	1000
Nonion boueanum	X	X	X	X	X	X	X	X	X	X
Cibicides peelensis	X	X	X	X	X	X	X	X	X	X
Cassidulina laevigata var. pliocarinata	X	X	X	X	X	X	X	X	X	X
Bulimina gibba	X	X	X	X	X	X	X	X	X	X
Pullenia sphaeroides	X	X	X	X	X	X	X	X	X	X
Nonion affine	X	X	X	X	X	X	X	X	X	X
Angulogerina angulosa	X	X	X	X	X	X	X	X	X	X
Bulimina marginata	X	X	X	X	X	X	X	X	X	X
Sigmoilina celata	X	X	X	X	X	X	X	X	X	X
Uvigerina hosiusi	X	X	X	X	X	X	X	X	X	X
Bulimina aculeata	X	X	X	X	X	X	X	X	X	X
Rotalia beccarii var.	X	X	X	X	X	X	X	X	X	X
Trifarina bradyi	X	X	X	X	X	X	X	X	X	X
Quinqueloculina seminulum	X	X	X	X	X	X	X	X	X	X
Loxostomum sinuosum	X	X	X	X	X	X	X	X	X	X
Eponides umbonatus	X	X	X	X	X	X	X	X	X	X
Fissurina marginata	X	X	X	X	X	X	X	X	X	X
Fissurina sp. 1	X	X	X	X	X	X	X	X	X	X
Fissurina laevigata	X	X	X	X	X	X	X	X	X	X
Glandulina laevigata	X	X	X	X	X	X	X	X	X	X
Globigerina bulloides	X	X	X	X	X	X	X	X	X	X
Uvigerina canariensis	X	X	X	X	X	X	X	X	X	X
Robertina sp.	X	X	X	X	X	X	X	X	X	X
Bolivina serrato-suturalis	X	X	X	X	X	X	X	X	X	X
Oolina hexagona	X	X	X	X	X	X	X	X	X	X
Pullenia quinqueloba	X	X	X	X	X	X	X	X	X	X
Aurila convexa	X	X	X	X	X	X	X	X	X	X
'Cythere' latimarginata	X	X	X	X	X	X	X	X	X	X
Sphaeroidina bulloides	X	X	X	X	X	X	X	X	X	X
Globigerina concinna	X	X	X	X	X	X	X	X	X	X
Textularid	X	X	X	X	X	X	X	X	X	X
Globigerina bradyi	X	X	X	X	X	X	X	X	X	X
Bulimina fusiformis var. marginata	X	X	X	X	X	X	X	X	X	X
Chilostomellina sp.	X	X	X	X	X	X	X	X	X	X
Uvigerina asperula	X	X	X	X	X	X	X	X	X	X
Listerella communis	X	X	X	X	X	X	X	X	X	X
Epistomina elegans	X	X	X	X	X	X	X	X	X	X
Bulimina costata	X	X	X	X	X	X	X	X	X	X
Lagena spp.	X	X	X	X	X	X	X	X	X	X
Robertinoides sp.	X	X	X	X	X	X	X	X	X	X
Nonionella sp.	X	X	X	X	X	X	X	X	X	X
Cibicides dutemplei	X	X	X	X	X	X	X	X	X	X
Globigerina praebulloides	X	X	X	X	X	X	X	X	X	X
Vaginulinopsis sp. 3	X	X	X	X	X	X	X	X	X	X
Globorotaloides suteri	X	X	X	X	X	X	X	X	X	X
Ammodiscus incertus	X	X	X	X	X	X	X	X	X	X
Pyrgo bulloides	X	X	X	X	X	X	X	X	X	X
Lenticulina (Robulus) sp.	X	X	X	X	X	X	X	X	X	X
Praeglobbulimina ovata	X	X	X	X	X	X	X	X	X	X
Bolivina subspinescens	X	X	X	X	X	X	X	X	X	X
Marginulina akneriana	X	X	X	X	X	X	X	X	X	X

Foraminifera and Ostracoda





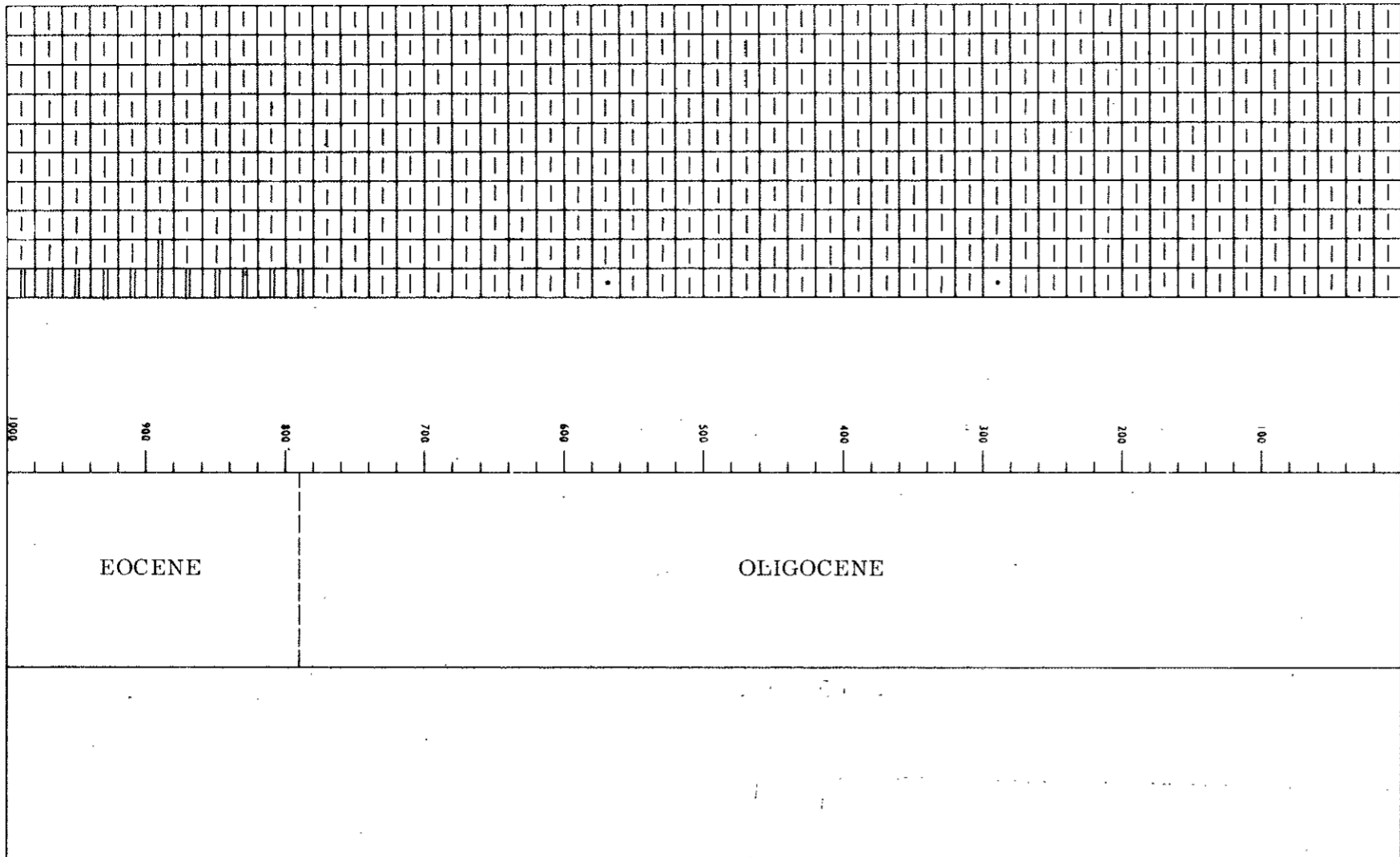




**ROBERTSON RESEARCH LABORATORIES**  
**MICROPALAEONTOLOGICAL ANALYSIS CHART**

DATE: 10.1.73. ANALYST: KJR, CWH. LOCATION: Norwegian North Sea Well 2/9-1  
 FOR: Amoco Norway Oil Company CHART No. 7. 7000' - 8000'

- LITHOLOGY: Limestone, Dolomite, Oolitic Limestone, Clay, Shale, Silty Sandy Shale, Siltstone, Sandstone, Conglomerate, Gypsum, Volcanics, Salt, Coal, Chert.



CONTINENTAL	
BRACKISH / DELTAIC / LAGOONAL	
LITTORAL (0 - 20')	
INNER SUBLITTORAL (20-150')	
OUTER SUBLITTORAL (150'-600')	
BATHYAL (OVER 600')	

ENVIRONMENT		MICROFOSSILS	
X	X	X	Ammodiscus incertus
X	X	X	Haplophragmoides carinatum
X	X	X	Glomospira charoides
X	X	X	Bathysiphon sp.
X	X	X	Cibicides sulzensis
X	X	X	Sigmoilina tenuis
X	X	X	Sigmoilina schlumbergeri
X	X	X	Sphaeroidina bulloides
X	X	X	Globigerina ciperoensis
X	X	X	Globigerina officinalis
X	X	X	Cyclammina placenta
X	X	X	Eponides umbonatus
X	X	X	Gyroidina soldanii
X	X	X	Haplophragmoides spp.
X	X	X	Cibicides dutemplei
X	X	X	Nonion sp.
X	X	X	Asterigerina girichi
X	X	X	Bulimina sp.
X	X	X	Pelosina sp.
X	X	X	Nonionella sp.
X	X	X	Globorotalia opima nana
X	X	X	Rotaliatina bulimoides
X	X	X	Nodosaria sp.
X	X	X	Gravellina narivaensis
X	X	X	Globigerina ouachitaensis
X	X	X	Anomalina sp.
X	X	X	Gyroidina girardana
X	X	X	Turrilina alsatica
X	X	X	Trochammina inflata
X	X	X	Ammobaculites cf. americanus
X	X	X	Cyclammina sp.
X	X	X	Cyclammina challinori
X	X	X	Trochammina spp.
X	X	X	Recurvoides sp.
X	X	X	Uvigerina cf. farinosa
X	X	X	Globorotalia aff. centralis
X	X	X	Lenticulina sp.
X	X	X	Eponides schreibersi
X	X	X	Trochammina globigeriniformis
X	X	X	Coscinodiscus spp.
X	X	X	Gastropoda
X	X	X	Radiolaria
X	X	X	Coscinodiscus sp. 3
X	X	X	Fish teeth

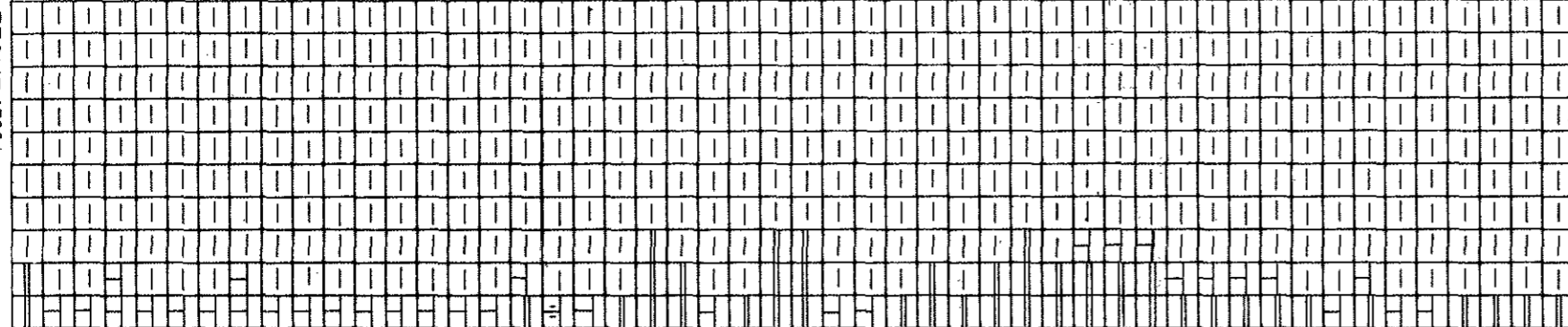
Foraminifera

Other fossils

# ROBERTSON RESEARCH LABORATORIES MICROPALAEONTOLOGICAL ANALYSIS CHART

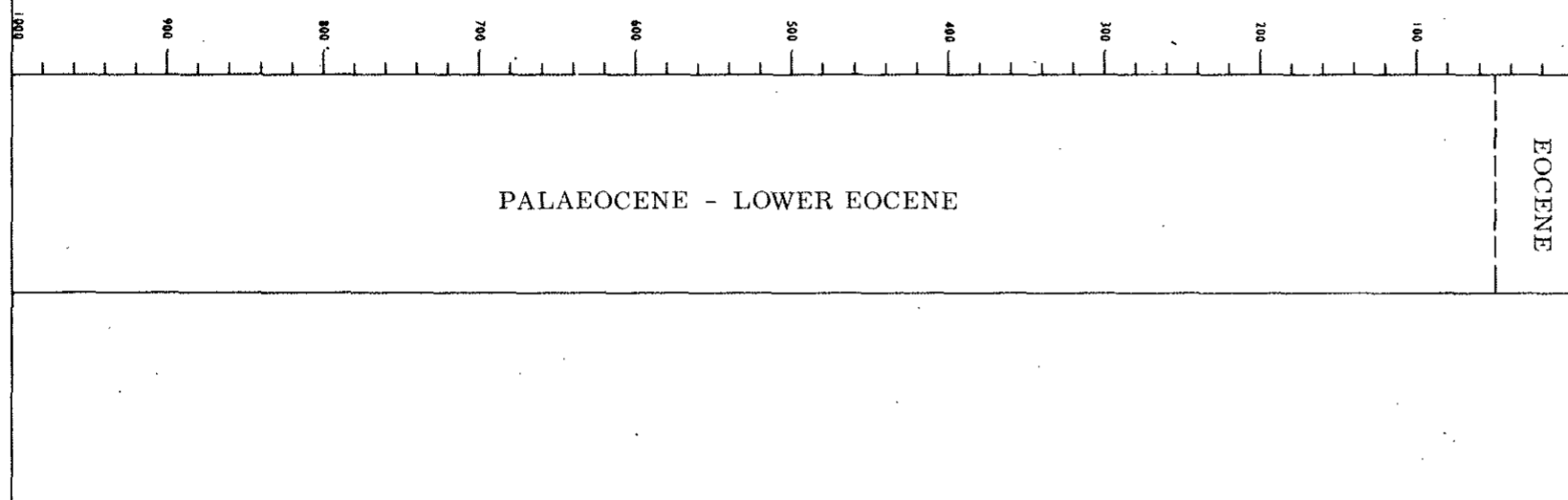
DATE: 12.1.73. ANALYST: CWH, KJR. LOCATION: Norwegian North Sea Well 2/9-1  
FOR: Amoco Norway Oil Company CHART No. 8.  
8000' - 9000'

- LITHOLOGY**
- LIMESTONE [Symbol]
  - DOLOMITE [Symbol]
  - CLAY [Symbol]
  - SHALE [Symbol]
  - SILT/SANDY SHALE [Symbol]
  - SILTSTONE [Symbol]
  - SANDSTONE [Symbol]
  - GYP/SUM [Symbol]
  - VOLCANICS [Symbol]
  - INTRUSIVES [Symbol]
  - SALT [Symbol]
  - COAL [Symbol]
  - CHERT [Symbol]



DEPTH IN FEET SYSTEM STAGE

PALAEOCENE - LOWER EOCENE



- ENVIRONMENT**
- CONTINENTAL
  - BRACKISH / DELTAIC / LAGOONAL
  - LITTORAL (0-20')
  - INNER SUBLITTORAL (20'-150')
  - OUTER SUBLITTORAL (150'-600')
  - BATHYAL (OVER 600')

MICROFOSSILS

Depth (ft)	Fossil
1000-1010	Pelosina sp.
1010-1020	Globigerina officinalis
1020-1030	Haplophragmoides carinatum
1030-1040	Glomospira charoides
1040-1050	Haplophragmoides spp.
1050-1060	Ammodiscus incertus
1060-1070	Cyclammina spp.
1070-1080	Sigmolilina tenuis
1080-1090	Sphaeroidina bulloides
1090-1100	Gravellina narivaensis
1100-1110	Cyclammina sp. 2
1110-1120	Cribrostomoides sp. 2
1120-1130	Trochammina spp.
1130-1140	Recurvooides sp.
1140-1150	Cyclammina placenta
1150-1160	Gyroidina girardana
1160-1170	Cyclammina challinori
1170-1180	Bulimina alsatica
1180-1190	Trochammina globigeriniformis
1190-1200	Cribrostomoides sp. 1
1200-1210	Nonion sp.
1210-1220	Bigerina sp.
1220-1230	Verneuilina subeocaena
1230-1240	Globigerina linaperta
1240-1250	Cyclammina sp. 1
1250-1260	Spiroplectammina spectabilis
1260-1270	Trochammina inflata
1270-1280	Hormosina sp.
1280-1290	Cibicides proprius
1290-1300	Trochammina sp.
1300-1310	Bulimina sp.
1310-1320	Cyclammina exigua
1320-1330	Globigerina cf. patagonica
1330-1340	Cytherella sp.
1340-1350	Globigerina cf. triangularis
1350-1360	Globigerina varianta
1360-1370	Trachyleberidea cf. aranea
1000-1010	Radiolaria sp.
1010-1020	Coccolithus spp.
1020-1030	Fish teeth
1030-1040	Coccolithus sp. 1

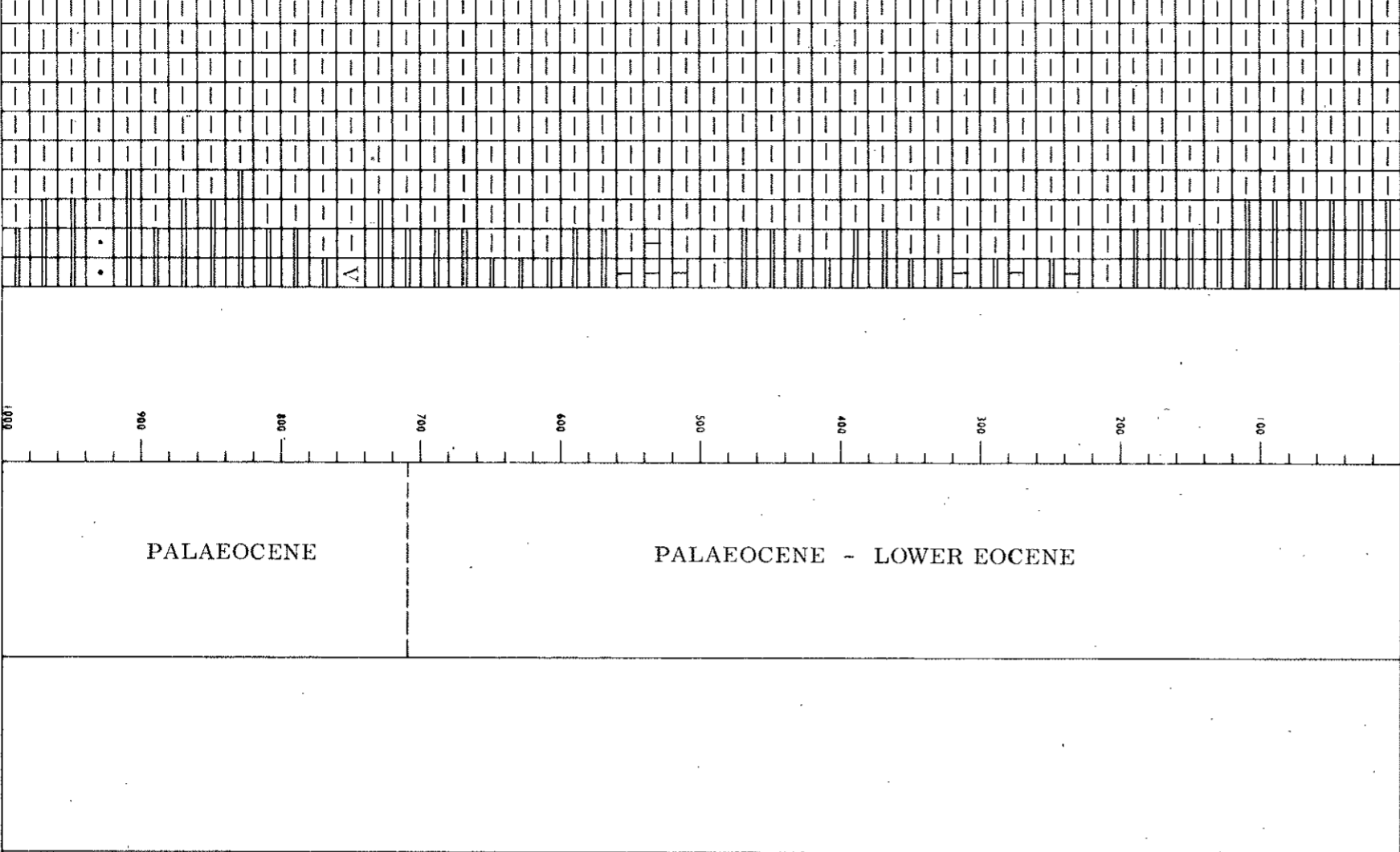
Foraminifera and Ostracoda

Other fossils

**ROBERTSON RESEARCH LABORATORIES**  
**MICROPALAEONTOLOGICAL ANALYSIS CHART**

DATE: 18.1.73. ANALYST: KJR, CWH. LOCATION: Norwegian North Sea Well 2/9-1  
 FOR: Amoco Norway Oil Company CHART No. 9. 9000' - 10000'

- Limestone
- Dolomite
- Oolitic limestone
- Clay
- Shale
- Silty sandy shale
- Siltstone
- Sandstone
- Conglomerate
- Gypsum
- Volcanics
- Intrusives
- Salt
- Coal
- Chert



- CONTINENTAL
- BRACKISH / DELTAIC / LAGOONAL
- LITTORAL (0-20')
- INNER SUBLITTORAL (20-150')
- OUTER SUBLITTORAL (150'-600')
- BATHYAL (OVER 600')

**MICROFOSSILS**

Depth (ft)	System	Stage	Environment	Foraminifera and Ostracoda	Other fossils
1000	PALAEOCENE		LITTORAL	<i>Cyclammina challinori</i>	
950				<i>Verneuilina subeoacena</i>	
900	PALAEOCENE - LOWER EOCENE		INNER SUBLITTORAL	<i>Ammodiscus incertus</i>	
850				<i>Cyclammina sp. 2</i>	
800				<i>Glomospira charoides</i>	
750				<i>Trochammina spp.</i>	
700				<i>Pelosina sp.</i>	
650				<i>Haplophragmoides spp.</i>	
600				<i>Cibicides spp.</i>	
550				<i>Cyclammina sp. 1</i>	
500				<i>Trochammina globigeriniformis</i>	
450				<i>Trochammina inflata</i>	
400	<i>Trachyleberidea sp.</i>				
350	<i>Gravellina narivaensis</i>				
300	<i>Spiroplectammina spectabilis</i>				
250	<i>Globigerina triloculinoides</i>				
200					
150					
100					
50					
0					

Foraminifera and Ostracoda

Other fossils

**ROBERTSON RESEARCH LABORATORIES**

**MICROPALAEONTOLOGICAL ANALYSIS CHART**

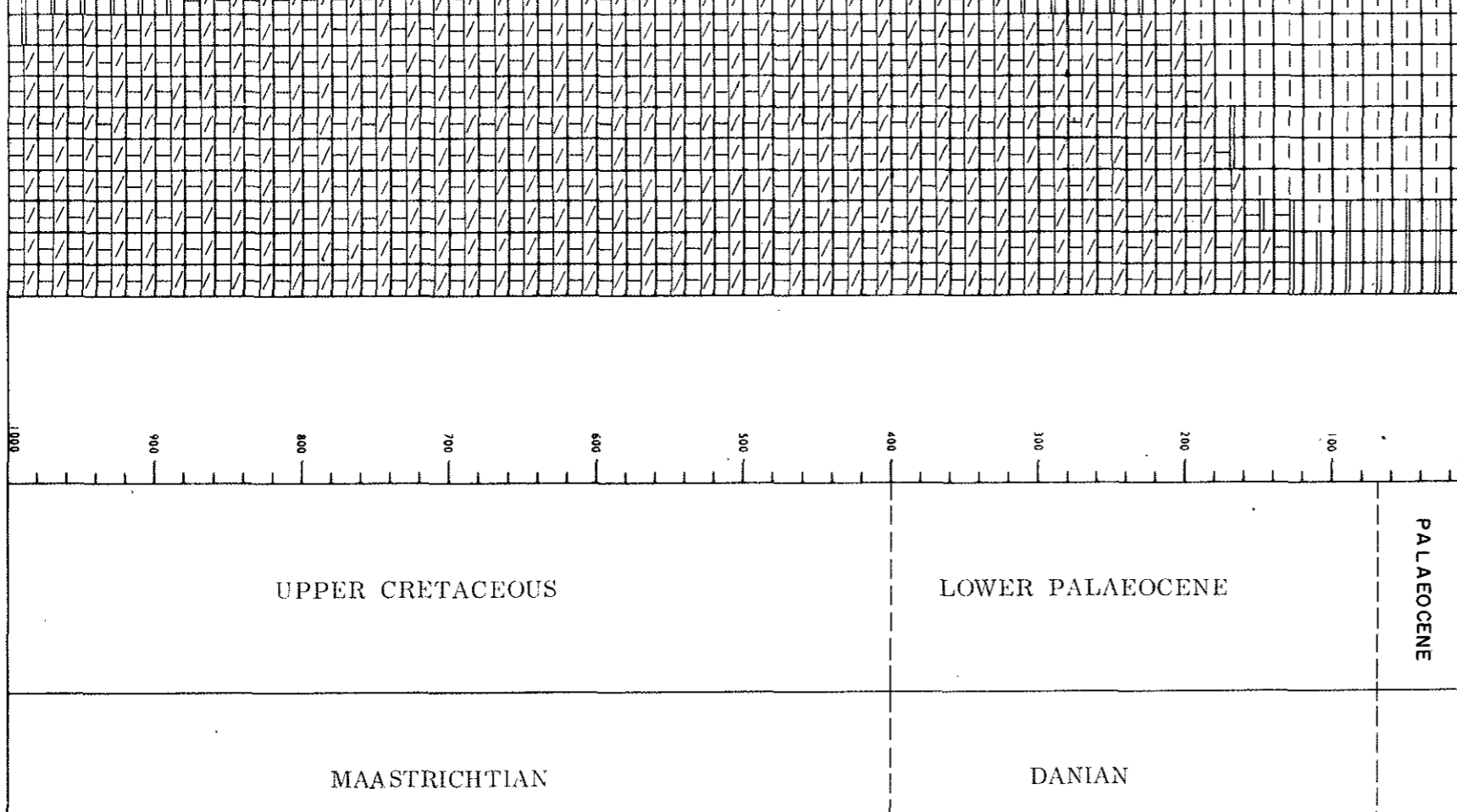
DATE: 19. 1. 73 ANALYST: CWH, KJR, JAS LOCATION: Norwegian North Sea Well 2/9-1  
 FOR: Amoco Norway Oil Company CHART No. 10 DEPTH: 10 000' - 11 000'

- LITHOLOGY**
- LIMESTONE
  - DOLOMITE
  - CONGLOMERATE
  - CLAY
  - SHALE
  - SILTY SANDY SHALE
  - SILTSTONE
  - SANDSTONE
  - CONGLOMERATE
  - GYPSUM
  - VOLCANICS
  - INTRUSIVES
  - SALT
  - COAL
  - CHERT
  - Mafic limestone
  - White chalk

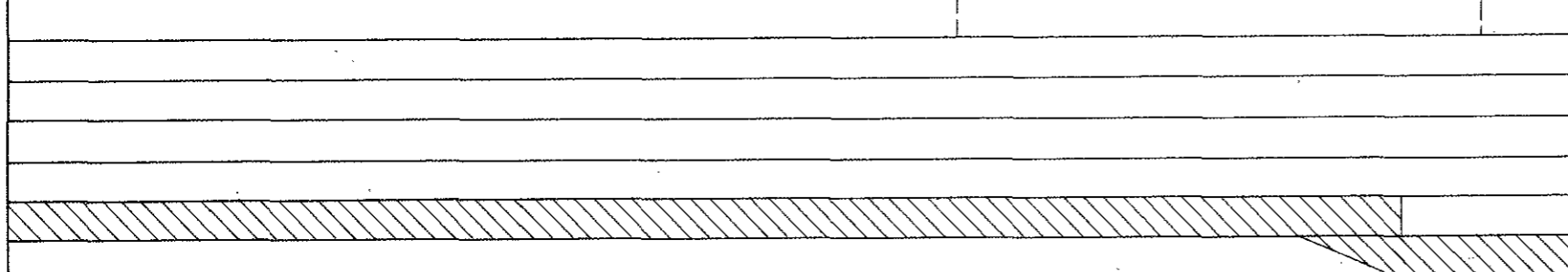
**DEPTH IN FEET**

**SYSTEM**

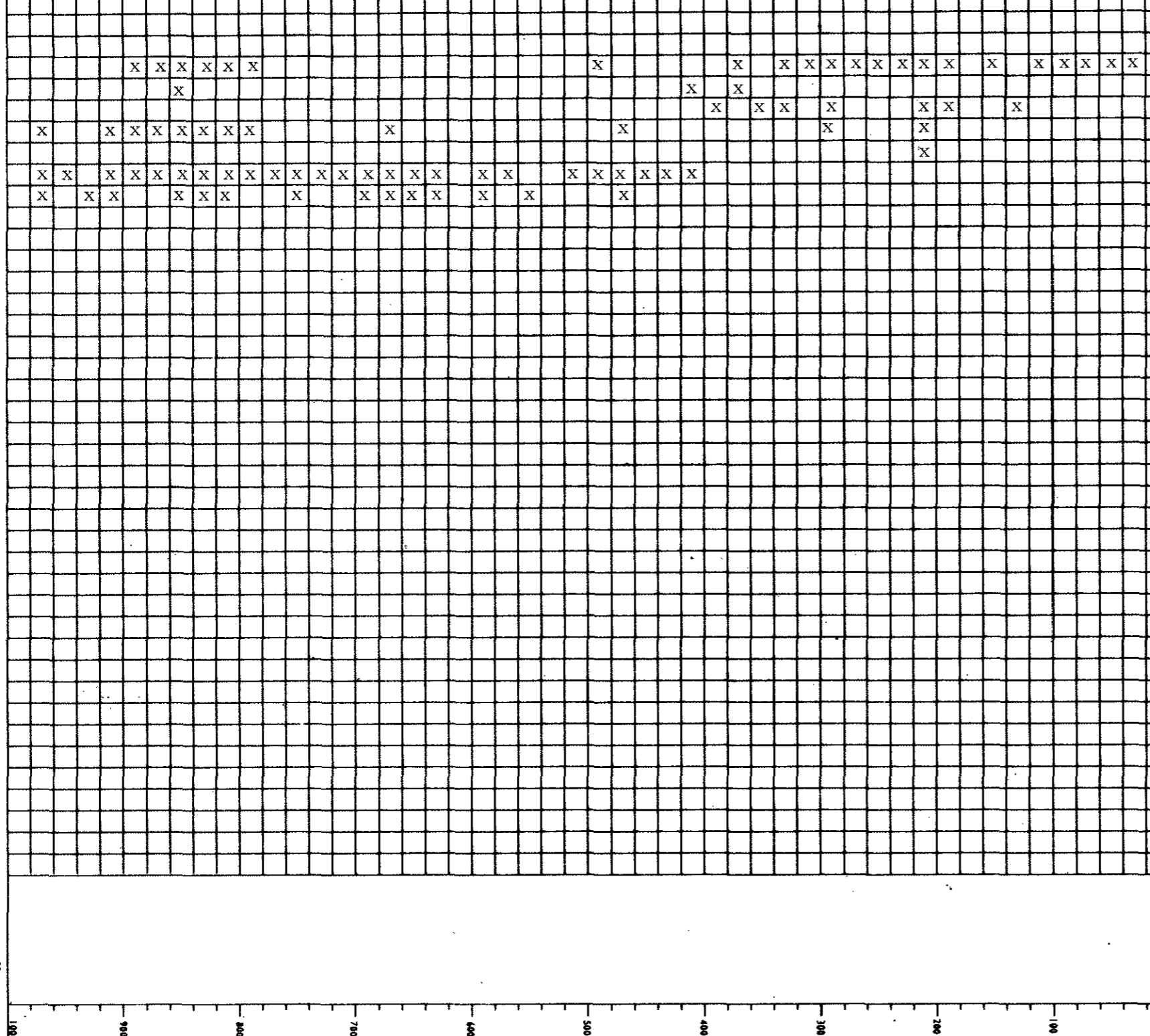
**STAGE**



- ENVIRONMENT**
- CONTINENTAL
  - BRACKISH/Deltaic/LAGOONAL
  - LITTORAL (0-20')
  - INNER SUBLITTORAL (20'-150')
  - OUTER SUBLITTORAL (150'-600')
  - BATHYAL (OVER 600')



- MICROFOSSILS**
- Ammodiscus incertus
  - Spiroplectammina spectabilis
  - Cyclammina challinori
  - Haplophragmoides spp.
  - Glomospira charoides
  - Trochammina spp.
  - Vermuilina subeocena
  - Globigerina triloculinoides
  - Gavelinella cf. vombensis
  - Anomalinoides velascoensis
  - Alabamina midwavensis
  - Eponides frankei
  - Globotruncana contusa
  - Lamarekina palaeocena
  - Heterohelix globulosa
  - Chilostomella sp.
  - Gyroldina subangulata
  - Bairdia sp.
  - Gavelinella costata
  - Gavelinella cf. nobilis
  - Pseudotextularia elegans
  - Marssonella sp.
  - Rugoglobigerina rugosa rugosa
  - Allomorphina halli
  - Globigerina danica
  - Pseudotextularia elegans fructicosa
  - Stensioina pommerana
  - Rugoglobigerina rugosa rugosa
  - Rugoglobigerina rugosa cf. rotundata
  - Gavelinella vombensis
  - Pseudotextularia acervulinoides
  - Præbulimina ventricosa
  - Tritaxilina laevigata
  - Pseudotextularia elegans fructicosa
  - Lenticulina spp.
  - Nodosariidae
  - Pullenia spp.
  - Pseudotextularia elegans elegans
  - Eponides spp.
  - Gyroldinoides sp.
  - Bolivina draco draco
  - Bulimina spp.
  - Tritaxia dubia
  - Rugoglobigerina rugosa rotundata
  - Globigerinelloides aspera
  - Bolivina incrassata incrassata
  - Valvulinera sp.
  - Globotruncana contusa
  - Anomalinoides sp.
  - Arenobulimina sp.
  - Lagena sp.
  - Ellipsoglandulina sp.
  - Globotruncana arca
  - Præbulimina carsevae
  - Heterohelix spp.
  - Gavelinopsis voltziana
  - Lagena cf. hexagona
  - Guttulina spp.
  - Præglobotruncana citae
  - Gyroldinoides nitida
  - Polymorphinids
  - Bolivina draco miliaris
  - Cibicides sp.
  - Gavelinella pertusa
  - Allomorphina sp.
  - Gavelinella spp.
  - Lenticulina pseudovortex
  - ?Gumbelitra sp.
  - Gavelinella cf. clementiana
  - Cibicides beaumontiana
  - Osangularia sp.
  - Reussella szajnochae
  - Gyroldinoides cf. globosa
  - Globorotalites sp.
  - Hedbergella sp.
  - Angulogavelinella sp.
  - Bathysiphon sp.
  - Orbignyina ovata
  - ?Ataxophragmium sp.
  - Gavelinella cf. involuta
  - Ammodiscus sp.
  - ?Lenticulina aff. trinitatis
  - ?Osangularia sp.
  - Pullenia cretacea
  - Glomospira sp.
  - Præbulimina sp.
  - Tritaxilina sp.
  - Patellina sp.
  - Anomalinoides hyphalus
  - Marssonella oxycona
  - Discopulvinulina sp.
  - Cyclammina sp.
  - Angulogavelinella bettenstaedti
  - Spiroplectammina baudouiniana
  - Ataxophragmium sp.
  - Reussella cristata
  - Dentalina sp.
  - Lagena acuticosta
  - Reussella sp.
  - Spirillina sp.



- Other fossils**
- Radiolaria
  - Fish teeth
  - Coscinodiscus sp. 1
  - Bryozoan fragments
  - Coscinodiscus sp. 2
  - Ostracoda
  - Echinoid debris

ROBERTSON RESEARCH LABORATORIES

MICROPALAEONTOLOGICAL ANALYSIS CHART

DATE 29.1.73. ANALYST KJH, JAS, JWC. LOCATION Norwegian North Sea Well 2/9-1  
FOR Amoco Norway Oil Company CHART No. 11  
11000' - 11650'

- LIMESTONE SILTSTONE S SALT
DOLOMITE SANDSTONE COAL
DOLITIC LIMESTONE CONGLOMERATE C CHERT
CLAY GYP-SUM White chalk
SHALE VOLCANICS Pink chalk
SILT-SANDY X N-TUSIVES

LITHOLOGY

DEPTH IN FEET

SYSTEM

STAGE

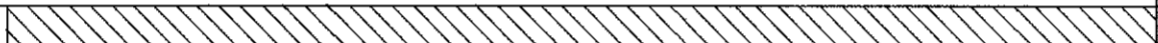
UPPER CRETACEOUS

MAASTRICHTIAN

?CAMPAIAN
?CONIACIAN

- CONTINENTAL
BRACKISH / DELTAIC / LAGOONAL
LITTORAL (0-20')
INNER SUBLITTORAL (20-150')
OUTER SUBLITTORAL (150-600')
BATHYAL (OVER 600')

MICROFOSSILS



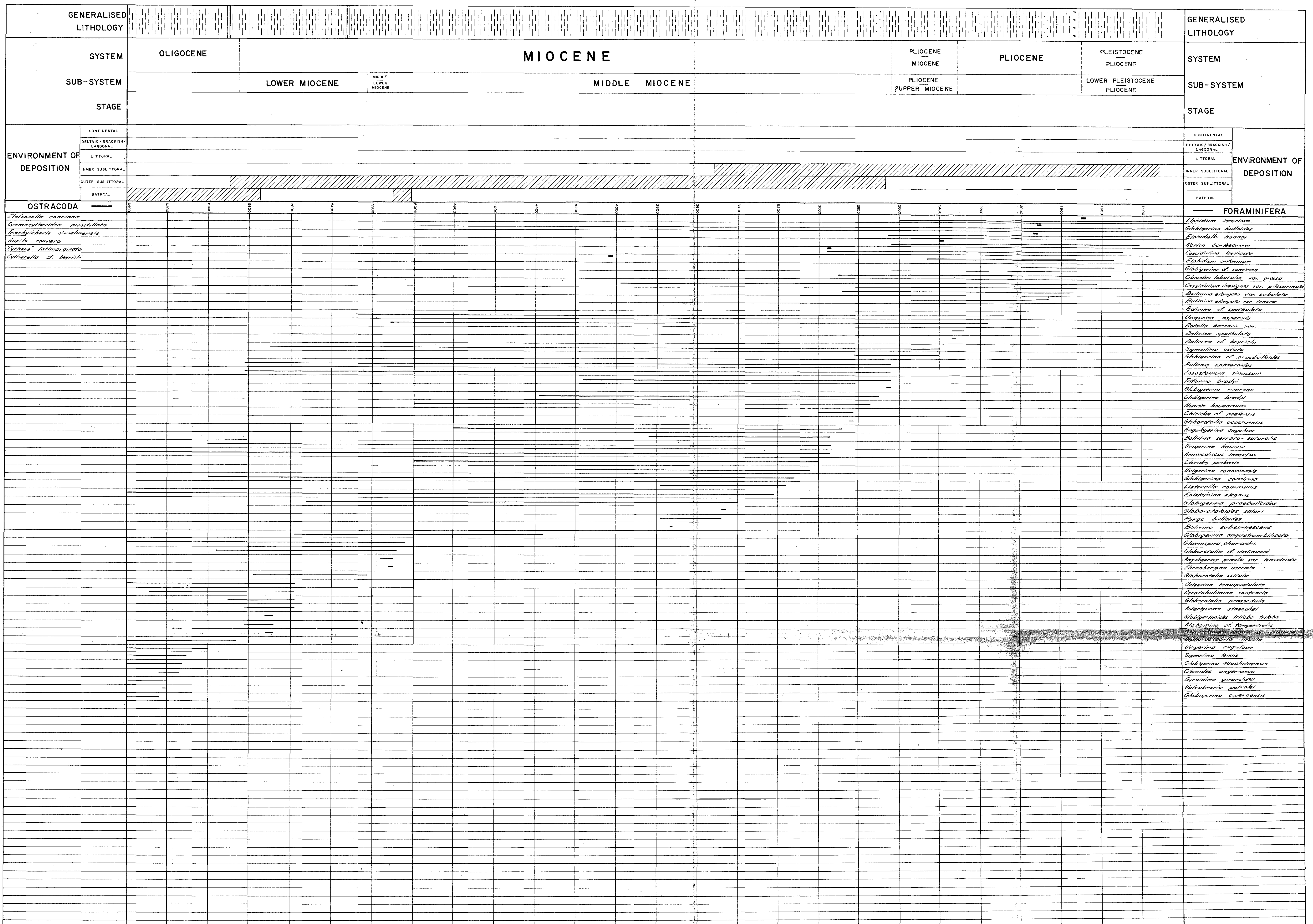
Grid table with columns for depth (100-1500 feet) and rows for various microfossil species. The table contains 'X' marks indicating the presence of fossils at specific depths and stages.

Species list including: Bathysiphon sp., Pullenia aff. cretacea, Rugoglobigerina sp., Gavelinella spp., Haplophragmoides spp., Rugoglobigerina rugosa rugosa, Gavelinopsis cf. voltziana, ?Globotruncana linneiana cf. linneiana, Ammodiscus sp., ?Eponides sp., Orbigynna ovata, ?Globigerinelloides aspera, Pseudotextularia elegans elegans, Praebulimina ventricosa, Glomospira sp., Gavelinella vombensis, Lenticulina spp., Anomalinoidea velascoensis, Lagena sp., Gavelinella costata, Gyroidinoides sp., Textularia sp., Praebulimina carseyae, Bolivinoidea draco miliaris, Pullenia sp., Rugoglobigerina rugosa cf. rotundata, ?Anomalinoidea sp., Nodosariidae, Arenobulimina sp., Reophax sp., ?Heterohelix sp., Globigerinelloides aspera, Gyroidinoides nitida, Globotruncana marginata, Tritaxia sp., Globotruncana sp., Spiroplectammina sp., Tritaxilina sp., Reussella szajnochae, Rugoglobigerina spp., Clavulinoidea cf. disjuncta, Globotruncana cf. marginata, Eponides sp., Ostracoda, Radiolaria, Echinoid debris, Bryozoan fragments.

Foraminifera

Other fossils



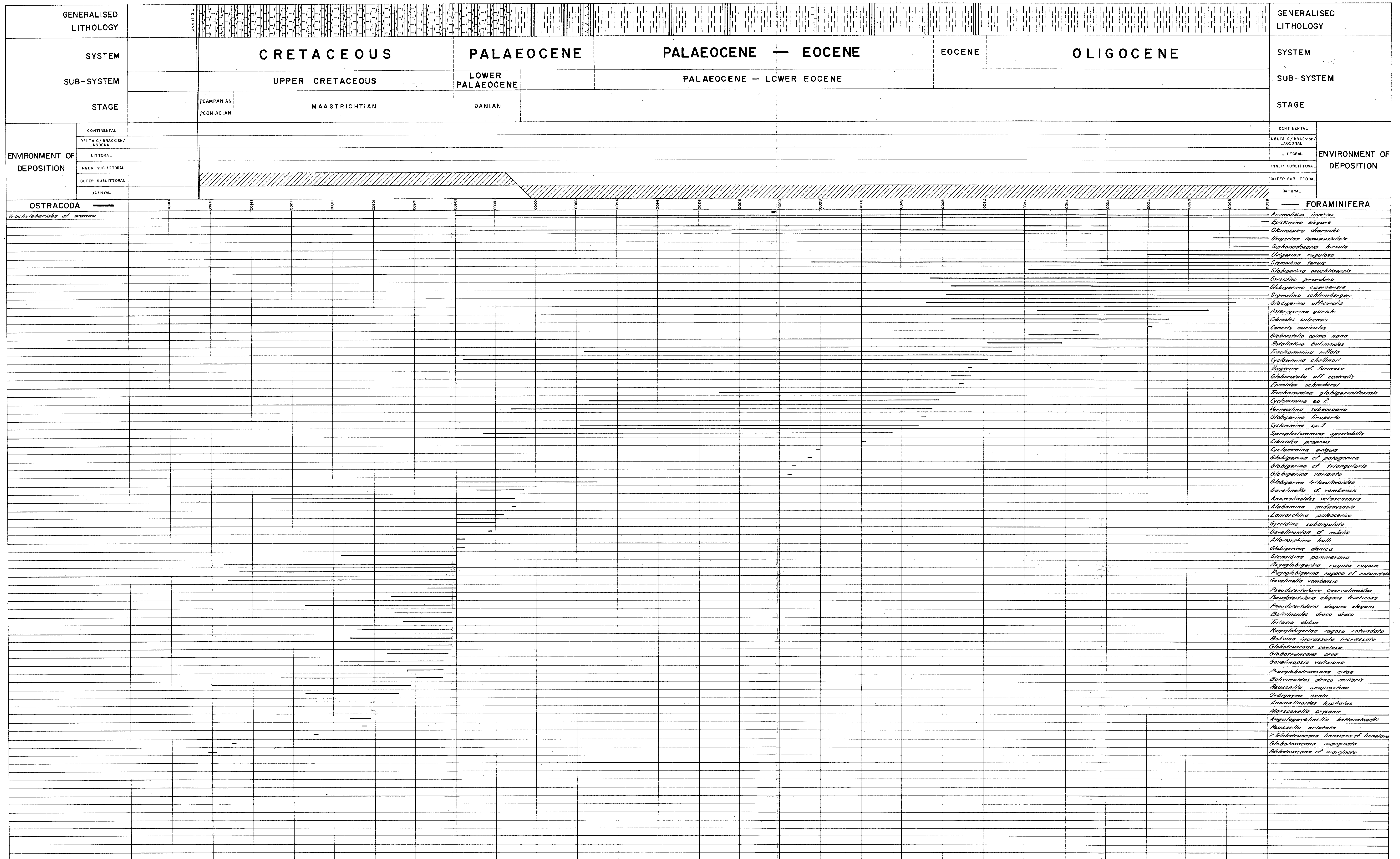


BIOSTRATIGRAPHIC CHART SHOWING THE DISTRIBUTION OF THE DIAGNOSTIC CAENOZOIC AND MESOZOIC FORAMINIFERA AND OSTRACODA IN THE AMOCO NORWAY 2/9-1 NORTH SEA WELL

SHEET 1 OF 2

by ROBERTSON RESEARCH LABORATORIES  
Ty'n-y-Coe'd, Llanrhos, Llandudno

For key to lithology symbols see Micropalaeontological Analysis Chart



BIOSTRATIGRAPHIC CHART SHOWING THE DISTRIBUTION OF THE DIAGNOSTIC CAENOZOIC AND MESOZOIC FORAMINIFERA AND OSTRACODA IN THE AMOCO NORWAY 2/9-1 NORTH SEA WELL

SHEET 2 OF 2

by  
 ROBERTSON RESEARCH LABORATORIES  
 'Ty'n-y-Coed', Llanrhos, Llandudno  
 For key to lithology symbols see *Microfaunal Analysis Chart*