ROBERTSON RESEARCH INTERNATIONAL LIMITED

AMOCO NORWAY 2/11 - 6 WELL AND 2/11 - 6 SIDETRACK: BIOSTRATIGRAPHY OF THE INTERVALS 180m – 3970m T.D. AND 3607.5m – 4075m T.D.

TECHNICAL REPORT

ROBERTSON RESEARCH INTERNATIONAL LIMITED

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AMOCO NORWAY 2/11 - 6 WELL AND 2/11 - 6 SIDETRACK: BIOSTRATIGRAPHY OF THE INTERVALS 180m – 3970m T.D. AND 3607.5m – 4075m T.D.

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1. The youngest sediments examined in these wells are sands, silts and clays of Pleistocene age, assigned to the Nordland Group.

2. A relatively complete sequence of Pleistocene to Early Eocene sediments is present.

3. The boundary between the Nordland and Hordaland Groups is placed at 1792m.

4. Clays and shales of the Hordaland Group are present to the top of the Late Palaeocene.

5. The top of the Late Palaeocene is recognised on the incoming of volcanics at 3564m(log). Clays and shales, assigned to the Balder and Sele Formations of the Rogaland Group occur throughout the Late Palaeocene. The underlying Early Palaeocene, Danian is characterised by the incoming of calcareous shales of the Maureen Formation Equivalent.

6. An unconformity separates the Danian from the underlying Late Cretaceous, Chalk Group resulting in the absence of late and 'mid' Maastrichtian sediments.

7. A sequence of Late Cretaceous, Chalk Group deposits of early Maastrichtian to Turonian age is then present with a further stratigraphic break noted on log evidence between the early Campanian to ?Santonian and Coniacian to Turonian deposits.

7. Within the 2/11-6 S.T. the Chalk Group sediments of Late Cretaceous age are separated by another unconformity from the underlying sediments of Early Cretaceous age, assigned to the Cromer Knoll Group. Cenomanian and late Albian deposits are absent.

II

INTRODUCTION

This report summarises the results of the micropalaeontological, nannofossil, palynological and stratigraphic analyses which have been carried out on material received from the section 180m - 3970m T.D. and 3607.5m - 4075m T.D. of the 2/11-6 and 2/11-6 Sidetrack Amoco Norway Wells respectively. The work was carried out under Project No. RRPS/823/A/10258.

The following analyses were carried out:

1. 2/11-6

Lithology: 468 ditch cuttings and 33 core samples from the entire section.
Micropalaeontology: 349 ditch cuttings and 24 core samples from the entire section.
Nannofossils: 24 ditch cuttings and 14 core samples from the interval 3600m - 3970m.

2. 2/11-6 Sidetrack

Lithology: 168 ditch cuttings and 6 sidewall core samples from the entire section.
Micropalaeontology: 64 ditch cuttings and 6 sidewall core samples from the entire section.
Nannofossils: 34 ditch cuttings and 6 sidewall core samples from the interval 3637.5m - 4075m.
Palynology: 9 ditch cuttings and 1 sidewall core from the interval 4032.5m - 4075m.
X-Ray Diffraction: 4 sidewall core samples from the interval 3797m-4020m.

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 these wells can be seen on pages 4 and 28.

All rock colour references in this report conform to the "Rock-Color Chart" distributed by the Geological Society of America. The lithological descriptions of the core samples (2/11-6) and sidewall core samples (2/11-6 Sidetrack) can be seen in Appendices 1 and 2 respectively.

It should be noted that 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 Amoco Norway with whom we have been associated during the course of this work.

Robertson Research staff involved in this study were:

John Church	-	Cretaceous Micropalaeontology
Paul Connell	-	Cenozoic Micropalaeontology
Nigel Duxbury	-	Lithostratigraphy
Paul Frame	-	Cretaceous Micropalaeontology and Project Co-ordinator
Nick Miles	-	Palynology
Chris Mortimer	-	Nannofossils

III(1) 2/11-6 SUCCESSION

Age		Tops (in metres)
Pleistocene		180 (top not seen)
Pliocene		460
Late - Middle Miocene		1020
Early Miocene		1770
Late Oligocene		1980
Early Oligocene - Middle? Eocene		2560
Middle Eocene - Early Eocene		2700
Late Palaeocene		3564 (log)
Early Palaeocene	Danian	3640 (log)
---------- Unconformity ----------		
Late Cretaceous	early Maastrichtian	3690 (log)
	late Campanian	3693 (core)
	early Campanian - ? Santonian	3702 (core)
	---------- Unconformity ----------	
	Coniacian - Turonian	3716 (log)
	Turonian	3750 - 3970 T.D.

This breakdown is based on the analysis of both ditch cuttings and core samples. Wireline logs were also available.

III(2) LITHOSTRATIGRAPHY

The lithostratigraphic nomenclature used in this report is taken from Deegan and Scull (1977). Wireline log data were available.

LITHOSTRATIGRAPHIC UNITS

NORDLAND GROUP: 180m - 1792m; Age: Pleistocene to Early Miocene.

The dominant lithology in the uppermost part of the section, between 180m and 295m are sands, which are colourless to moderate orange pink, medium to coarse grained, subangular to subrounded and moderately well sorted. Throughout this interval, trace amounts of shiny, nodular pyrite and numerous broken shell fragments occur. Between 260m and 300m soft, moderate reddish brown lignite occurs in trace quantities.

Below 295m clays and claystones are inferred to be the dominant lithologies. This assumption is made on wireline log evidence and because of small sample amounts present in the ditch cuttings. Most of the clays and claystones present are thought to be washed out in the sample preparation process. The clays noted are moderately soft, blocky, light grey to medium light grey and below 400m weakly calcareous. A sample gap is present between 490m and 690m. Below 700m, sand is noted as a subordinate lithotype. The sand is fine to medium grained, colourless to light grey, translucent, subangular to subrounded and contains trace amounts of broken shell debris. Shiny nodular pyrite and soft, dark green reniform glauconite are also evident in trace amounts. Below 1040m, lenses of sand are interpreted from wireline log responses and the presence of small amounts of sand in the ditch cuttings. Trace amounts of pyrite rods, indicating burrowing activity, are evident below 1160m.

Towards the base of the group, at 1625m, thin laminations of soft black carbonaceous material are present within the subfissile claystones and shales. At 1720m, and 1745m thin dolomite stringers are noted. There are moderately hard, moderate reddish brown and sucrosic.

HORDALAND GROUP 1792m(log) - 3564m(log). Age: Early Miocene to Middle - Early Eocene.

The top of this group is based upon wireline log evidence and a slight colour change in the claystones and subfissile shales, which are the dominant lithologies throughout the group. They are moderately soft, medium grey to light grey, micromicaceous, weakly calcareous and locally silty. Dolomite stringers are evident in the uppermost 200m of the group whilst limestone stringers occur below 2150m. The dolomites are hard, light brownish grey and sucrosic, whilst the limestones are moderately soft, light grey and cryptocrystalline. A localised sand unit, is thought to occur between 2360m and 2370m, the sand being very fine grained, light grey, subrounded and well sorted. It should be noted, however, that evidence for such a sand unit is not substantiated by the wireline log data.

Trace amounts of shiny, nodular pyrite occur throughout the section whilst sphaerosiderite is noted at the very base of the group. Turbodrilling took place below 2232, making lithological interpretation difficult.

ROGALAND GROUP 3564m(log) - 3690m(log). Age: Late - Early Palaeocene, Danian.

Although it is not possible to break down the group into all its separate formations, an attempt was made using ditch cuttings and wireline log evidence to subdivide the section into the following formations.

Balder and Sele Formations 3564m(log) - 3640m (log). Age: Late Palaeocene.
The top of this formation is marked by the incoming of volcanic tuffaceous material which is moderately hard, medium grey to medium dark grey and very argillaceous. The whole section is dominated by claystones and subfissile shales which are moderately soft, medium light grey to light olive grey, micromicaceous and occasionally silty. Shiny nodular pyrite is evident in trace amounts throughout the section.

Maureen Formation Equivalent 3640m(log) - 3690m(log). Age: Early Palaeocene, Danian.
The top of the formation is marked by the incoming of calcareous shales and an

associated wireline log response. The shales are moderately soft to moderately hard, subfissile, medium grey, micromicaceous and occasionally silty. Below 3670m, the shales are occasionally red in colour.

CHALK GROUP 3690m(log) - 3970m T.D. Late Cretaceous, early Maastrichtian to Turonian.
This group can be divided into two formations using wireline log information with core piece evidence.

?Tor Formation 3690m(log) -3716m (log). Age: early Maastrichtian to early Campanian - ?Santonian.
This group consists entarely of chalky limestones, the top being based on the incoming of the limestones backed by wireline log information. Throughout the formation, the chalky limestone is soft to moderately soft, pinkish grey to yellowish grey and locally cryptocrystalline. Thin laminations of black calcareous shales occur within the limestones and stylolites are common. Towards the base of the interval, the limestones become argillaceous, a feature not usually associated with the formation and for this reason, the lithologies are only tentatively assigned to the Tor formation.

Hod formation 3716m(log) - 3970m T.D. Age: Late Cretaceous, Coniacian - Turonian to Turonian.
The top of this formation is placed on wireline log evidence. The top few metres consist of an argillaceous limestone which is moderately soft, pinkish grey, cryptocrystalline and locally chalky. Between 3718.25m and 3724m, the limestone is moderately hard, bluish grey to light olive grey and locally argillaceous. Below 3724m, the limestones are moderately soft to moderately hard, light grey to pinkish grey occasionally chalky and locally argillaceous. Traces of moderately hard, dark grey micaceous shale are noted at 3785m.

At 3830m, moderately hard, light brown, cryptocrystalline dolomite, typical of a basal Hod section is noted. At 3895m, hard, very light-grey to white cryptocrystalline chert is evident in small amounts. At 3897.5m, very dark grey, calcareous shales are present for some 10m, representing a minor lithotype within the limestone.

III(3) BIOSTRATIGRAPHY

(i) TERTIARY

INTERVAL 180m - 460m; PLEISTOCENE (top not seen)

Lithostratigraphic Unit:
Nordland Group (part).

Environment: marine, inner shelf.

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

- the appearance of Elphidium incertum at 190m.
- the subsequent occurrence of the Nonion granosum/Protelphidium orbiculare group at 220m and below.
- the occurrence of the ostracod species Rabilimis mirabilis at 440m.
- the absence of diagnostic pre-Pleistocene taxa.

MICROPALAEONTOLOGY

The occurrence of Elphidium incertum and Nonion granosum/Protelphidium orbiculare within the poor, sparse microfaunas of this interval is indicative of a Pleistocene age. The presence of the cold-water ostracod Rabilimis mirabilis further supports this age assignment. A shallow marine environment is suggested by the microfaunas and the abundant echinoid debris.

INTERVAL 460m - 1020m; PLIOCENE

Lithostratigraphic Unit:
Nordland Group (part).

Environment: marine, inner shelf.

The upper limit and age assigned to this interval are based on the following micropalaeontological criteria:

- the appearance of Cibicides lobatulus var. grossa and Cassidulina laevigata var. pliocarinata at 460m.
- the appearance of Cibicides scaldisiensis at 490m.
- the occurrence of Nonion affine and Cibicides pseudoungerianus at 900m.

MICROPALAEONTOLOGY

The top of the Pliocene is indicated by the appearance of Cibicides lobatulus var. grossa together with Cassidulina laevigata var. pliocarinata at 460m. This is suppported by the subsequent occurrence of Cibicides scaldisiensis and Nonion affine. Down to 900m the microfaunas are of moderate to low diversity comprising species of Cibicides and Elphidium. Below 900m the microfauna is much more diverse and includes Cibicides pseudoungerianus, Monspeliensina pseudotepida, Nonion boueanum, Globigerina spp. and a single occurrence of Eponides umbonatus at 1010m. The diversity and composition of the fauna shows affinities with Late Miocene assemblages, though all the foraminifera mentioned above are known to range up into the Early Pliocene.

INTERVAL 1020m - 1770m; LATE - MIDDLE MIOCENE

Lithostratigraphic Unit:
Nordland Group (part).

Environment: marine, outer shelf later shallowing to inner shelf.

The upper limit and age of this interval are based on the following micropalaeontological criteria:

- the appearance of Cibicides peelensis at 1020m.
- the subsequent occurrence of Loxostomum sinuosum (1060m), Angulogerina gracilis (1430m), Pseudoclavulina (1690m) and Globigerina angustiumbilicata (1720m).

MICROPALAEONTOLOGY

The first downhole occurrence of Cibicides peelensis at 1020m is regarded as confirming the Late Miocene age of the upper part of this interval, though as noted above the diverse microfauna in the lower part of the overlying interval also shows Late Miocene affinities.

The occurrence of the Loxostomum sinuosum/Eponides umbonatus Assemblage is indicated by the common occurrence of the nominate taxa below 1060m and a reduction in faunal diversity which is accompanied by severe corrosion of the microfauna and red-brown staining.

The Angulogerina gracilis Assemblage is recognised below 1430m by the appearance of the nominate taxon. The abundant and diverse microfaunas found at the top of this interval, above the casing point at 1450m, are probably cavings from the overlying assemblage since the interval assigned to the A. gracilis Assemblage below the casing point is comparatively sparse. Planktonic foraminifera are noted at 1510m, however, none of the species present are particularly age diagnostic, though the presence of Globorotalia continuosa suggests that sediments at this depth may be assignable to a Middle Miocene age.

Below 1540m the microfaunas contain a significant component of agglutinated foraminifera that characterises the Glomospira charoides/Bathysiphon sp./Pseudoclavulina sp. Assemblage. Bathysiphon sp. is absent from this microfauna, thus suggesting outer shelf rather than upper bathyal depositional conditions.

Planktonic foraminifera again become important below 1680m and this, together with an influx of "Bolboforma" sp., is suggestive of an early Middle Miocene age.

INTERVAL 1770m - 1980m; EARLY MIOCENE

Lithostratigraphic Unit:
Nordland Group (part): 1770m - 1792m;
Hordaland Group (part): 1792m - 1980m.

Environment: marine, outer shelf.

The upper limit and age of this interval are based on the following micropalaeontological criteria:

- the occurrence of Praeorbulina glomerosa at 1770m.
- the subsequent occurrence of Globorotalia scitula (1780m), Sphaeroidinellopsis seminulina (1870m), Asterigerina staeschei (1900m) and Globorotalia zealandica (1960m).

MICROPALAEONTOLOGY

The top of this interval is based on the occurrence of Praeorbulina glomerosa at 1770m. According to Blow (1979) this species has a very short range from late Early Miocene (Zone N. 8) to earliest Middle Miocene (Zone N. 9).

The Globorotalia scitula gp/Globigerina angustiumbilicata Assemblage recognised above 1870m is characterised by planktonic foraminifera including the nominate taxa together with Globigerina woodi, G. praebulloides and Globorotalia cf. siakensis.

Below 1870m the microfauna is characterised by calcareous benthonic foraminifera of the Asterigerina staeschei/Sphaeroidinellopsis seminulina Assemblage which includes the nominate taxa together with species of Bulimina, Lenticulina and Cibicides.

INTERVAL 1980m - 2560m; LATE OLIGOCENE

Lithostratigraphic Unit:
Hordaland Group (part).

Environment: marine, outer shelf to upper bathyal later shallowing to outer shelf.

The upper limit and age assigned to this interval are based on the following micropalaeontological criteria:

- the appearance at 1980m of Globorotalia opima nana, Asterigerina gürichi and Globigerina ciperoensis.
- the subsequent occurrence of Sigmoilina schlumbergeri (2160m) and Turrilina alsatica (2440m).

MICROPALAEONTOLOGY

Globorotalia opima nana is not considered to range above the top of Zone N.3 (Blow 1969) and its occurrence here is taken as marking the top of the Oligocene. This age assignment is supported by the simultaneous appearance of Asterigerina gürichi and Globigerina ciperoensis.

Microfaunas characteristic of the Haplophragmoides spp. Assemblage appear consistently below 2060m and comprise the nominate taxon together with species of Cyclammina, Bathysiphon, Trochammina and Ammodiscus.

The Sigmoilina schlumbergeri Assemblage is recognised below 2160m by the appearance of the nominate taxon. Agglutinated foraminifera are the dominant component of the microfauna with scattered occurrences of planktonic and calcareous benthonics. Baggatella cf. altiuscula, Gyroidina girardana and Turrilina alsatica are all found throughout this interval together with small pyritised diatoms including the characteristic Oligocene form Coscinodiscus sp. 4. (2350m).

INTERVAL 2560m - 2700m; EARLY OLIGOCENE - MIDDLE? EOCENE

Lithostratigraphic Unit:
Hordaland Group (part).

Environment: marine, outer shelf to upper bathyal.

The upper limit and age assigned to this interval are based on the following micropalaeontological criteria:

- the occurrence of Rotaliatina bulimoides at 2560m.
- the stratigraphic position overlying recognised Middle Eocene sediments.

MICROPALAEONTOLOGY

The microfauna of this interval is dominated by long-ranging agglutinated foraminifera. Rotaliatina bulimoides only occurs at 2560m, and provides the only reliable evidence for the penetration of Early Oligocene sediments. The agglutinated foraminifera of this interval are assigned to the Trochammina globigeriniformis/Trochammina sp. X/Cystammina sp. Assemblage based on the co-occurrence of these taxa below 2590m. The common occurrence of species of Bathysiphon and Cyclammina indicates that deposition took place in deep water of outer shelf to upper bathyal depths.

INTERVAL 2700m - 3564m(log); MIDDLE EOCENE - EARLY EOCENE

Lithostratigraphic Unit:
Hordaland Group (part).

Environment: marine, outer shelf to upper bathyal.

The upper limit and age of this interval are based on the following micropalaeontological criteria:

- the appearance of Ammobaculites sp.1 at 2700m.
- the subsequent appearance of Spiroplectammina spectabilis (2740m) and Karreriella apicularis (2790m).
- the influx of spongodiscid radiolaria at 3340m and 3410m.
- the stratigraphic position overlying Late Palaeocene sediments.

MICROPALAEONTOLOGY

The appearance of Ammobaculites sp. 1 at 2700m and Spiroplectammina spectabilis at 2740m confirms the penetration of Middle Eocene sediments, although neither of these two forms is thought to range up to the top of the Middle Eocene. The microfaunas continue to be dominated by long-ranging agglutinated foraminifera. Planktonic foraminifera of the Globigerina triloculinoides Assemblage were not found in this well, though they are present in adjacent well sections. In the absence of this distinctive Assemblage the top of the Early Eocene cannot be determined. However, the presence of two influxes of spongodiscid radiolaria, at 3340m and 3410m, is typical of the lowermost Eocene and suggests that some Early Eocene sediments are present in the well. But the possibility that some of the uppermost Early Eocene is missing cannot be entirely ruled out.

INTERVAL 3564m(log) - 3640m(log); LATE PALAEOCENE

Lithostratigraphic Unit:
Rogaland Group (part);
Balder and Sele Formations.

Environment: marine, outer shelf to upper bathyal.

The upper limit and age of this interval are based on the following criteria:

- a log break at 3564m.
- the presence of volcanic deposits in the uppermost part of the interval.

MICROPALAEONTOLOGY

The top of this interval is placed on the log break at 3564m together with the presence of volcanic tuffaceous material in the interval. The only micropalaeontological evidence for a Late Palaeocene age occurs much higher in the section at 3255m and is based on the single occurrence of the pyritised diatom Coscinodiscus sp. 1. However, considering the log evidence these specimens must be reworked.

NANNOFOSSILS

The four samples analysed from this interval proved to be barren of calcareous nannofossils.

INTERVAL 3640m(log) - 3690m(log); EARLY PALAEOCENE, DANIAN

Lithostratigraphic Unit:
Rogaland Group (part);
Maureen Formation Equivalent.

Environment: marine, inner to outer shelf.

.he upper limit and age assigned to this interval are based on the following criteria:

- a log break and associated lithological change at 3640m.
- the occurrence of Globorotalia planocompressa at 3645m.
- the presence of Globorotalia pseudobulloides and Globigerina trivialis at 3660m.
- the influx of calcareous nannofossils at 3660m, including Chiasmolithus danicus and Prinsius dimorphosum.

MICROPALAEONTOLOGY

The top of this interval is placed on the log break and lithological change at 3640m. The first micropalaeontological evidence for the age of the interval occurs at 3645m with the single occurrence of Globorotalia planocompressa, a form characteristic of the early Danian P.1 Zone, but known to range into P.2 (Blow, 1979). A Danian age is also suggested by the occurrence of Globorotalia pseudobulloides and Globigerina trivialis at 3660m. However, in view of these only very sparse occurrences of Danian species and their poor preservation, the possibility that they are reworked cannot be entirely ruled out.

NANNOFOSSILS

The two uppermost samples of this interval were barren of calcareous nannofossils. However, at 3660m a small influx of calcareous nannofossils is noted, including Chiasmolithus danicus and Prinsius dimorphosum, suggesting that sediments of Early Palaeocene, Danian age have been penetrated at this depth. A number of Late Cretaceous species were also recorded at this horizon and, more particularly, at 3670m, but these are presumed to have resulted from reworking. The presence of Cruciplacolithus tenuis (if in situ) and the absence of Chiasmolithus danicus at 3670m, indicate that sediments at this level may be assigned to the N.P.2 Zone of Martini (1971). The sample examined at 3680m yielded a very poor nannofloral assemblage containing only Arkhangelskiella cymbiformis, which suggests that sediments of Late Cretaceous age may have been reached at this depth. However, in view of log and microfaunal evidence and the poor nannofloral assemblage recorded at this level, a Danian age has been preferred.

III(3) (ii) CRETACEOUS

INTERVAL 3690m(log) - 3693m(core); LATE CRETACEOUS, EARLY MAASTRICHTIAN

Lithostratigraphic Unit:
Chalk Group (part);
?Tor Formation (part).

Environment: marine, inner to outer shelf.

The upper limit and age assigned to this interval are based on the log break at 3690m and the following micropalaeontological and nannofossil criteria:

- the presence of the Rugoglobigerina/Archaeoglobigerina complex (commmon), Stensioina pommerana, Reussella szajnochae szajnochae, Globigerinelloides asper and Heterohelix spp. from 3690m.
- the association of the nannofossil species Cribrosphaera ehrenbergi, Arkhangelskiella cymbiformis, Kamptnerius magnificus, Prediscosphaera cretacea, Reinhardtites levis and Gartnerago obliquum.
- correlation with the 2/11-6 sidetrack hole and other wells in the area.

The upper limit of this interval is marked by a stratigraphic break with no late or positive mid Maastrichtian sediments being present.

MICROPALAEONTOLOGY

Common foraminifera were recovered from this interval with both calcareous benthonic and planktonic species represented, the latter particularly by the Rugoglobigerina/Archaeoglobigerina complex and Globigerinelloides asper.

The occurrence of common Rugoglobigerina/Archaeoglobigerina complex at 3690m together with Reussella szajnochae szajnochae and Stensioina pommerana indicates an early Maastrichtian age for the interval. This is supported by regional information and correlation with the corresponding interval in the 2/11-6 Sidetrack.

Late and mid-Maastrichtian faunas were absent suggesting that an unconformity separates this interval from the overlying Early Palaeocene sediments.

NANNOFOSSILS

The sample analysed at 3690m yielded a moderately well preserved nannofloral assemblage, consisting of what are considered to be the first in situ, Late Cretaceous calcareous nannofossils encountered in this well. The species association of Cribrosphaera ehrenbergi, Arkhangelskiella cymbiformis, Kamptnerius magnificus and Prediscosphaera cretacea at this horizon suggests that sediments of Maastrichtian age have been penetrated. However, the appearance of Gartnerago obliquum and Reinhardtites levis also at 3690m may indicate that sediments of early Maastrichtian age have been reached at this depth, and tends to agree with the age of the corresponding section in the 2/11-6 Sidetrack Hole.

The few Danian species recorded are presumed to be due to caving.

INTERVAL 3693m(core) - 3702m(core); LATE CRETACEOUS, LATE CAMPANIAN

Lithostratigraphic Unit:
Chalk Group (part);
?Tor Formation (part);

Environment: marine, inner to outer shelf.

The upper limit and age assigned to this interval are based on the following micropalaeontological and nannofossil criteria:

- the presence of Globotruncana sp.1 (3693m core).
- the subsequent incoming of Globotruncana marginata (3697.7m core).
- the first downhole occurrence of the nannofossil species Broinsonia parca (3693m core).
- the outgoing of Reinhardtites levis at 3702m(core).

MICROPALAEONTOLOGY

Moderately common foraminifera were recovered from this interval. Calcareous benthonic species are predominant with only rare planktonic and agglutinated species present.

The incoming of Globotruncana sp.1 at 3693m(core) together with the subsequent occurrence of Globotruncana marginata at 3697.7m(core) suggest a late Campanian age for the interval. The interval is assigned to the Globotruncana marginata Assemblage.

NANNOFOSSILS

The two core samples examined over this interval at 3693m and 3702m yielded rich, well preserved nannofloral assemblages including abundant Prediscosphaera cretacea. The core at 3693m also contained abundant Arkhangelskiella cymbiformis and common Cribrosphaera ehrenbergi, together with the first downhole occurrence of Broinsonia parca. This latter evidence coupled with the outgoing of Reinhardtites levis at 3702m(core) suggest that over the interval 3693m(core) to 3702m(core) sediments of early Maastrichtian to late Campanian age have been encountered.

INTERVAL 3702m(core) - 3716m(log); LATE CRETACEOUS, EARLY CAMPANIAN -?SANTONIAN

Lithostratigraphic Unit:
Chalk Group (part);
?Tor Formation (part).

Environment: marine, inner to outer shelf.

The upper limit and age assigned to this interval are based on the following micropalaeontological and nannofossil criteria:

- the presence of Tritaxia dubia (3702m core).
- the subsequent occurrence of Stensioina cf. praeexsculpta, S. exsculpta granulata? and S. cf. exsculpta (3709.5m core).
- the absence of the nannofossil species Reinhardtites levis.

MICROPALAEONTOLOGY

Ditch cuttings samples from this interval contained only a very poor foraminiferal fauna. However, slightly better recovery was obtained from the core samples available. As in the overlying interval calcareous benthonic species again predominate with only rare planktonic and agglutinated foraminifera.

The presence of Tritaxia dubia from 3702m(core) allows the recognition of the Tritaxia dubia Assemblage. This indicates an early Campanian age for the interval. The subsequent occurrence of Stensioina cf. praeexsculpta together with S. cf. exsculpta and S. exsculpta granulata? at 3709.5m(core), may also indicate that the Stensioina Assemblage of Santonian age is present from that depth. However, as these specimens are only tentatively identified (the first positively identified forms occurring much lower in the well) only a broad Tritaxia dubia - ?Stensioina Assemblage of early Campanian to ?Santonian age is assigned to the interval. Nannofossil evidence also suggests that the Santonian may not be present in this interval (see below).

NANNOFOSSILS

The two samples analysed at 3709.5(core) and 3712.2m(core) contained rich moderately well preserved nannofloral assemblages, including abundant

Prediscosphaera cretacea. The absence of Reinhardtites levis in both cores suggests that sediments older than late Campanian age have been penetrated at these depths. This supports the early Campanian age determination based on microfossils. No evidence for any Santonian deposits was recorded.

INTERVAL 3716m(log) - 3750m; LATE CRETACEOUS, CONIACIAN - TURONIAN

Lithostratigraphic Unit:
Chalk Group (part);
Hod Formation (part).

Environment: marine, outer shelf.

The upper limit and age assigned to this interval are based upon the following criteria

- the log break at 3716m.
- the abundance of the nannofossil species Watznaueria barnesae from 3723.75m(core) and its association with Eiffellithus eximius, Tranolithus orionatus and abundant Prediscosphaera cretacea.
- the subsequent incoming of a variety of Globotruncana spp.

The upper limit of this interval is believed to be marked by a stratigraphic break as suggested by biostratigraphic, lithostratigraphic and log evidence.

MICROPALAEONTOLOGY

Ditch cuttings and core pieces were found to be poorly fossiliferous in the uppermost section of this interval i.e. 3718.25m to 3734m. Below 3734m common foraminifera were recovered, particularly planktonic species such as Rugoglobigerina/Archaeoglobigerina complex, Globotruncana marginata and Globigerinelloides asper.

The upper limit of this interval is based on the log break and associated lithological change at 3716m(log). The first micropalaeontological evidence for the age of the interval occurs at 3728m(core) with the incoming of an increasing variety of Globotruncana spp. and the common occurrence of G. marginata and the Rugoglobigerina/Archaeoglobigerina complex. This, together with the subsequent presence of the Globotruncana linneiana group and G. cf. imbricata (3735.7m core), allows recognition of the Globotruncana marginata/Radiolaria - Globotruncana Assemblage, suggesting a Coniacian to Turonian age for the interval.

It is possible that at least part of this interval and of the overlying early Campanian to ?Santonian section could be missing, particularly in view of the very poor evidence for the presence of any Santonian sediments. It is difficult on the poor microfaunas, however to satisfactorily identify the exact depth at which this stratigraphic break occurs.

NANNOFOSSILS

The sample analysed at 3716.25m(core), yielded a quite rich, well preserved nannofloral assemblage including abundant Prediscosphaera cretacea together with common Kamptnerius magnificus and Lucianorhabdus cayeuxii. The first stratigraphic downhole occurrence of Broinsonia enormis together with Eiffellithus eximius and, to a lesser extent, Cylindralithus asymmetricus in this sample indicates that sediments of an early Campanian or older age have been reached. This assemblage whilst not diagnostic of the age assigned to the interval is consistent with it. The core sample at 3719.25m contained a very poorly preserved nannofloral assemblage with no age diagnostic species recorded. The poor nature of the assemblage may indicate that sediments of Coniacian to Turonian age have been reached at this depth.

The first good nannofloral evidence for the age of the interval occurs at 3723.75m(core) with the appearance of abundant Watznaueria barnesae in association with Eiffellithus eximius and Tranolithus orionatus together with abundant Prediscosphaera cretacea. This and the relatively constant nannofloral assemblages recorded from 3723.75m(core) down to 3750m indicates a general Coniacian - Turonian age for this interval.

INTERVAL 3750m - 3970m T.D.; LATE CRETACEOUS, TURONIAN

Lithostratigraphic Unit:
Chalk Group (part);
Hod Formation (part).

Environment: marine, outer shelf.

The upper limit and age assigned to this interval are based on the following micropalaeontological and nannofossil criteria:

- the incoming of common, mainly small radiolaria at 3750m, and its correlation to a similar event in the 2/11-6 Sidetrack Hole.
- the association of the nannofossil species Watznaueria barnesae (abundant) Helicolithus trabeculatus and common Eiffellithus eximius, together with the last downhole occurrence of Micula staurophora at 3750m.
- the last downhole occurrence of Kamptnerius magnificus at 3770m.
- an influx of large spherical and flattened radiolaria at 3810m.
- the presence of Praeglobotruncana cf. stephani (3830m).

MICROPALAEONTOLOGY

Foraminifera were common through most of this interval, but a decline in abundance is noted below 3900m.

The incoming of common to abundant small radiolaria at 3750m provides a good correlation point to a similar influx of radiolaria in the sidetrack hole at 3742.25m where it is positively dated as Turonian on the presence of the marker species Praeglobotruncana cf. stephani. (This marker species is first recorded much lower in the section of this present well (see below)). The small radiolaria occur persistently down to 3810m where an influx of large spherical to disc shaped radiolaria occurs. This feature suggests that the sections 3750m to 3810m and 3810m to 3970m represent local biostratigraphic units IV and V of the Turonian, as described in the Robertson Research International Report on the Valhall Structure (Oilfields Report No. 2227, 1976). Further support for a Turonian age comes from the recognition of the Praeglobotruncana cf. stephani Assemblage from 3830m, based on the presence of the nominate taxon from that depth. As noted above, the first downhole occurrence of the P. cf. stephani Assemblage in this well is considerably lower than in the Sidetrack

Hole. This is not thought to reflect any difference in stratigraphy between the two wells.

NANNOFOSSILS

The sample at 3750m contains a rich and well preserved nannofloral assemblage including abundant Watznaueria barnesae and Helicolithus trabeculatus together with common Eiffellithus eximius. This species association, coupled with the last downhole occurrence of Micula staurophora (if in situ), from regional information suggests that sediments of Turonian age have been penetrated at this depth. The last downhole occurrence of Kamptnerius magnificus (if in situ) at 3770m adds further support to this age determination.

Over the interval 3770m to 3970m, relatively constant nannofloral assemblages were recorded including abundant Watznaueria barnesae in association with Gartnerago obliquum, Prediscosphaera cretacea, Eiffellithus eximius and Tranolithus orionatus providing further evidence for a general Turonian age for the interval.

The continued occurrence of Eiffelithus eximius (if in situ) down to 3970m indicates that sediments at this depth are no older than early Turonian in age.

IV(1) 2/11-6 S.T. SUCCESSION

Age		Tops (in metres)
Late Palaeocene		3607.5 (top not seen)
Early Palaeocene	Danian	3637.5
---Unconformity---		
Late Cretaceous	early Maastrichtian	3685 (log)
	late Campanian to early Campanian - ?Santonian	3702.5
	---Unconformity---	
	Coniacian - Turonian	3706(log)
	Turonian	3742.5
---Unconformity---		
Early Cretaceous	middle Albian - Aptian	4027(log)
	early Aptian	4042.5
	Barremian	4047.5 - 4075 T.D.

This breakdown is based on both ditch cuttings and sidewall core samples. Wireline logs were also available.

IV(2) LITHOSTRATIGRAPHY

The lithostratigraphic nomenclature used in this report is taken from Deegan and Scull (1977). Wireline log data were available for use in this study. It should be noted that turbo-drilling between 3626m and 3643m inhibited lithological interpretation.

LITHOSTRATIGRAPHIC UNITS

ROGALAND GROUP: 3607.5m - 3685m(log). Age: Late Palaeocene to Early Palaeocene, Danian.

Although it is not possible from ditch cutting and wireline log evidence to make a detailed breakdown of the group, the following subdivisions are tentatively suggested.

Balder and Sele Formations: 3607.5m - 3637.5m(log). Age Late Palaeocene. The top of the section studied is contaminated with cement down to 3622.5m where subfissile to fissile shales become dominant. The shales are moderately hard, medium grey to medium dark grey and micromicaceous. Shiny, nodular pyrite is evident in trace amounts. It should be noted that no volcanic rocks were recognised. Wireline log data and ditch cutting samples suggest that this interval comprises both Balder and Sele formations.

Maureen Formation Equivalent: 3637.5m(log) - 3685m(log). Age: Early Palaeocene, Danian.
The top of this formation is based on the incoming of calcareous shales with subordinate amounts of ?reworked chalky limestone and wireline log evidence. The shales are medium grey to medium dark grey, subfissile, moderately hard, micromicaceous and calcareous, whilst the limestone is chalky, white to very light grey, moderately hard, blocky and locally microcrystalline.

CHALK GROUP: 3685m(log) - 4027m(log). Age: Late Cretaceous, early Maastrichtian - Turonian.
This group can be divided up into two formations using wireline log information supported by ditch cutting evidence.

Tor Formation: 3685m(log) - 3706m(log). Age early Maastrichtian to late Campanian to early Campanian - ?Santonian.
The top of this formation is picked on wireline log evidence and the incoming of in situ chalky limestones. It should be noted, however, that many claystone cavings are evident in the uppermost 15m of the formation. The limestones are moderately hard, very light grey to pinkish grey, chalky and locally microcrystalline.

Hod Formation: 3706m(log) - 4027m(log). Age: Coniacian - Turonian to Turonian. The top of this formation, which is picked on wireline log evidence, consists of a moderately soft, chalky limestone which is locally argillaceous. Between 3712m and 3725m, moderately hard, light grey, cryptocrystalline limestone is noted. At and below 3725m the limestones are moderately soft and locally chalky. Calcareous shale is noted from 3895m to 3900m; it is moderately soft, subfissile, dark grey and calcareous. Below 3900m occasional traces of shale are still evident down to the base of the group. Below 4000m, the limestones are seen to become increasingly argillaceous and trace amounts of shiny, nodular pyrite are noted.

CROMER KNOLL GROUP: 4027m(log) - 4075m T.D. Age: Early Cretaceous, middle Albian - Aptian to Barremian.
From the small section of the group studied in this well, it is not feasible to break the group down into individual formations.

The top is marked by a distinctive wireline log break, supported by the incoming of more calcareous shales and argillaceous limestones which are occasionally chalky, moderately soft and medium light grey. Trace amounts of shiny, nodular pyrite, soft, dark green, reniform glauconite and reddish brown, sideritic dolomite are noted at and below 4035m.

IV(3) BIOSTRATIGRAPHY

(i) TERTIARY

INTERVAL 3607.5m - 3637.5m; LATE PALAEOCENE (top not seen)

Lithostratigraphic Unit:
Rogaland Group (part).
Balder and Sele Formations.

Environment: marine, outer shelf to upper bathyal.

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

- the stratigraphic position of the interval.
- regional information and correlation to the 2/11-6 Main Hole.

MICROPALAEONTOLOGY

All samples analysed from this interval proved to be barren of foraminifera. A Late Palaeocene age has, however, been assigned based on the stratigraphic position of the interval above Early Palaeocene, Danian sediments. Further support for this determination comes from regional information and correlation to the corresponding interval in the 2/11-6 Main Hole.

INTERVAL 3637.5m - 3685m(log); EARLY PALAEOCENE, DANIAN

Lithostratigraphic Unit:
Rogaland Group (part);
Maureen Formation Equivalent.

Environment: marine, inner to outer shelf.

The upper limit and age assigned to this interval are based on the following micropalaeontological criteria:

- the presence of Globorotalia cf. pseudobulloides (3637.5m).
- the subsequent occurrence of Globorotalia compressa? (3662.5m).
- regional information and correlation with the 2/11-6 Main Hole.

MICROPALAEONTOLOGY

All samples analysed from this interval were poorly fossiliferous or barren, the latter being particularly the case above 3657.5m. Below 3657.5m the microfaunas recovered are principally of agglutinated species. Some Cretaceous reworking is recorded at 3662.5m.

The presence of Globorotalia cf. pseudobulloides at 3637.5m together with the subsequent occurrence of Globorotalia compressa? (3662.5m) suggest an Early Palaeocene, Danian age for the interval, although reworking of the specimens cannot be entirely ruled out. Due to the paucity of the microfaunas it is not possible to subdivide the Danian into the P. Zones of Blow (1979). Further support for the determination comes from both correlation with the corresponding section of the 2/11-6 Main Hole and from regional information. A log feature has also been noted near the top of the Danian interval in the 2/11-6 Main Hole and Sidetrack. This appears to be a good correlative point between the wells at or near the top of the Danian.

NANNOFOSSILS

The two samples analysed from this interval proved to be barren of calcareous nannofossils.

IV(3) (ii) CRETACEOUS

INTERVAL 3685m(log) - 3702.5m; LATE CRETACEOUS, EARLY MAASTRICHTIAN

Lithostratigraphic Unit:
Chalk Group (part);
Tor Formation (part).

Environment: marine, inner to outer shelf.

The upper limit and age assigned to this interval are based on the following criteria:

- The log break and associated lithological change at 3685m and correlation with the 2/11-6 Main Hole.
- the incoming of Stensioina pommerana, Brizalina incrassata cf. gigantea and the Rugoglobigerina/Archaeoglobigerina complex (3692.5m).
- an influx of Late Cretaceous nannofossils (3692.5m) including Reinhardtites levis and Broinsonia parca.

The upper limit of this interval is marked by a stratigraphic break with no late or middle Maastrichtian sediments being recorded.

MICROPALAEONTOLOGY

Common foraminifera were recorded from this interval. The upper limit of this interval has been placed at 3685m on a distinct log break and lithological change at that depth. The first micropalaeontological evidence for the age of the interval occurs slightly lower in the section, at 3692.5m, with the incoming of Stensioina pommerana, Brizalina incrassata cf. gigantea and the Rugoglobigerina/Archaeoglobigerina complex indicating a Late Cretaceous, 'mid' to early Maastrichtian age. A more restricted early Maastrichtian age has, however, been assigned from the nannofossil evidence (see below).

NANNOFOSSILS

An influx of late Cretaceous nannofossils is noted at 3692.5m including Arkhangelskiella cymbiformis, Kamptnerius magnificus, Micula staurophora and common Prediscosphaera cretacea. The moderately preserved nannofloral assemblage recorded at 3692.5m also yielded Broinsonia parca and Reinhardtites levis suggesting that sediments of early Maastrichtian age have been reached at this depth.

INTERVAL 3702.5m - 3706m(log); LATE CRETACEOUS, LATE CAMPANIAN TO EARLY CAMPANIAN - ?SANTONIAN

Lithostratigraphic Unit:
Chalk Group (part);
Tor Formation (part).

Environment: marine, inner to outer shelf.

The upper limit and age assigned to this interval are based on the following criteria:

- the incoming of Globotruncana marginata (3702.5m).
- correlation with the 2/11-6 Original Hole.

MICROPALAEONTOLOGY

Foraminifera are common in this interval with calcareous benthonic species predominant. Planktonic and agglutinated species are rare.

The presence of Globotruncana marginata from 3702.5m, allows the recognition of the Globotruncana marginata Assemblage, which suggests a late Campanian age for the interval. No older marker species were recovered within this interval and the early Campanian - Santonian markers used in the main hole, occur in the sidetrack just below the top Coniacian - Turonian unconformity as determined by Amoco on density log evidence. This means that the early Campanian to ?Santonian as recognised in the main hole may be missing in the sidetrack or more likely that the marker species are caved. This probably results from the fact that only ditch cuttings samples were analysed in the sidetrack whereas both core and ditch cuttings material were available from the original hole. In view of these problems and taking into account the age of the corresponding sections in the original hole, a broad late Campanian to early Campanian - ?Santonian age is assigned to the interval.

NANNOFOSSILS

The only sample analysed for calcareous nannofossils, at 3702.5m, yielded a moderately preserved nannofloral assemblage. The species association recorded at this depth indicates a general early Maastrichtian to late Campanian age for the sample.

INTERVAL 3706m(log) - 3742.5m; LATE CRETACEOUS, CONIACIAN - TURONIAN

Lithostratigraphic Unit:
Chalk Group (part);
Hod Formation (part).

Environment: marine, outer shelf.

The upper limit of this interval is drawn on a log break at 3706m based on information supplied by the client and correlation with the original well.

The first biostratigraphic evidence for sediments of this age occurs at 3722.5m based on the following micropalaeontological and nannofossil evidence:

- the increased number and variety of species of Globotruncana.
- the association of the nannofossil species Eiffellithus eximius, Prediscosphaera cretacea and Tranolithus orionatus.

The upper limit of this interval is believed to be marked by a stratigraphic break with part of the Coniacian to Turonian and part or all of the early Campanian and Santonian missing.

It should be noted (as discussed in the previous interval) that the first biostratigraphic evidence for deposits of early Campanian - ?Santonian age occurs from 3707.5m but from the log evidence this is presumed to be the result of caving. If these forms are considered in place then the top Coniacian - Turonian could occur between 3707.5 and 3722.5m.

MICROPALAEONTOLOGY

The first downhole occurrence of the early Campanian marker Tritaxia dubia in the upper part of this interval (3707.5m) would suggest that early Campanian sediments have been penetrated from that depth. However, from density log evidence supplied by the client the top Coniacian - Turonian boundary is placed just above this marker at 3706m. It is considered, therefore, that the species is probably caved at this depth. The first micropalaeontological evidence for the age of the interval occurs at 3722.5m with the incoming of a variety of Globotruncana species including G. linneiana tricarinata, G. cf. coronata and G. arca. This, together with the incoming of small radiolaria and common

Globotruncana marginata, allow the recognition of the Globotruncana marginata/Radiolaria - Globotruncana Assemblage, which suggests a Coniacian to Turonian age for the interval.

NANNOFOSSILS

The occurrence of Eiffellithus eximius in the sample analysed at 3710m would indicate an early Campanian or older age at this depth, which, while not diagnostic of the age assigned to this interval, is consistent with it. The first nannofossil evidence for sediments of Coniacian - Turonian age having been penetrated occurs at 3722.5m, but is not as obvious as in the main hole, although the overall nannofloral assemblage does show many similarities. The rich and moderately well preserved nannofloral assemblage at 3722.5m contained abundant Prediscosphaera cretacea, together with Eiffellithus eximius and Tranolithus orionatus which are also found in the main hole at the top of the Coniacian - Turonian, together with an abundance of Watznaueria barnesae. This abundance of Watznaueria barnesae is, however, recorded lower in the sidetrack, than the main hole.

INTERVAL 3742.5m - 4027m(log); LATE CRETACEOUS, TURONIAN

Lithostratigraphic Unit:
Chalk Group (part);
Hod Formation (part).

Environment: marine, outer shelf.

The upper limit and age of this interval are based on the following micropalaeontological and nannofossil criteria:

- the presence of Praeglobotruncana cf. stephani (3742.5m).
- the nannofossil assemblage recorded from 3742.5m including abundant Watnaueria barnesae with Tranolithus orionatus, Eiffellithus eximius, Prediscosphaera cretacea and Gartnerago obliquum.
- the last downhole occurrence of the nannofossil species Micula staurophora at 3762.5m.
- an influx of large, spherical and flattened radiolaria at 3802.5m.
- the last downhole occurrence of the nannofossil Kamptnerius magnificus (3911m SWC) and the first occurrence of Parhabdolithus asper (4023.5m SWC).

MICROPALAEONTOLOGY

Foraminifera, particularly planktonic species, are common throughout most of the interval. A decline in abundance is only noted below 3900m.

The occurrence of Praeglobotruncana cf. stephani from 3742.5m allows the recognition of the P. cf. stephani Assemblage. This suggests a Turonian age for the interval. P. cf. stephani is also used to indicate the presence of local biostratigraphic unit IV as described in Robertson Research International Limited Report No. 2227(1976) on the Valhall Structure. Similarly the influx of large spherical and flattened, disc shaped radiolaria at 3802.5m allows the recognition of unit V in the lower part of the interval. Both units are indicative of a Turonian age.

NANNOFOSSILS

The first nannofossil evidence to indicate that sediments of Turonian age have been penetrated, occurs at 3742.5m. The moderately well preserved nannofloral assemblage recorded at this depth contained abundant Watznaueria barnesae in association with Tranolithus orionatus, Prediscosphaera cretacea, Eiffellithus eximius and Gartnerago obliquum indicating a Turonian age for the sample. The last downhole occurrence of Micula staurophora (if in situ), at 3762.5m, together with the relatively constant nannofloral assemblages noted throughout the interval and the last downhole occurrence of Kamptnerius magnificus in the sidewall core at 3911m (a species known to have its last downhole occurrence within the Turonian), provides further confirmation of a Turonian age. Over the interval 3922.5m to 4023.5m, relatively sparse and poorly preserved nannofloral assemblages were recorded. However, the outgoing of Eiffellithus eximius at 4020m(SWC) suggests that the sediments at this depth are no older than early Turonian. The first downhole occurrence of Parhabdolithus asper at 4023.5m(SWC), which also yielded a rich and well preserved nannofloral assemblage including abundant Watznaueria barnesae, suggest that sediments of early Turonian age have been reached at this horizon.

INTERVAL 4027m(log) - 4042.5m; EARLY CRETACEOUS, MIDDLE ALBIAN - APTIAN

Lithostratigraphic Unit:
Cromer Knoll Group (part).

Environment: marine, inner to outer shelf.

The upper limit and age assigned to this interval are based on the following criteria:

- a log break at 4027m and the associated lithological change.
- a distinct increase in agglutinated foraminifera from 4032.5m.

The upper limit of this interval is marked by a stratigraphic break with no sediments of Cenomanian or late Albian age being recorded.

MICROPALAEONTOLOGY

The upper limit of this interval is placed on the marked log break at 4027m and the associated lithological change at that depth.

The first micropalaeontological evidence for the age of the interval occurs at 4032.5m where the increased presence of agglutinating foraminifera, in particular Glomospira gordialis and Glomospira sp., suggests that the Recurvoides/Glomospira Assemblage of middle Albian to Aptian age is developed.

Late Cretaceous cavings occur throughout.

NANNOFOSSILS

The two samples analysed for calcareous nannofossils within this interval yielded very poor nannofloral assemblages, with no significant age diagnostic species being noted. No age determination has been possible, therefore on the basis of the calcareous nannofossils.

PALYNOLOGY

A very sparse palynoflora was recovered from the sample analysed at 4032.5m. The assemblage, whilst not diagnostic of the age assigned to this interval, is consistent with it.

INTERVAL 4042.5m - 4047.5m; EARLY CRETACEOUS, EARLY APTIAN

Lithostratigraphic Unit:
Cromer Knoll Group (part).

Environment: marine, inner to possible outer shelf.

The upper limit and age assigned to this interval are based on the following micropalaeontological and palynological criteria:

- the incoming of common to abundant Hedbergella infracretacea and H. delrioensis at 4042.5m.
- the presence, at 4042.5m, of the dinoflagellate Ellipsoidictyum imperfectum group (abundant).

MICROPALAEONTOLOGY

The two samples analysed from this interval are dominated by planktonic foraminifera particularly Hedbergella delrioensis and H. infracretacea. Rare arenaceous and calcareous benthonic species are also present.

The predominance of the nominate taxon in these samples is characteristic of the Hedbergella infracretacea Assemblage of early Aptian age.

NANNOFOSSILS

Of the two samples analysed for nannofossils in this interval, the sample at 4042.5m yielded only a single specimen of Watznaueria barnesae from which no age determination is possible.

The second sample at 4045m contained a moderately preserved, fairly rich assemblage, including common Biscutum sp. and Parhabdolithus asper together with abundant Watznaueria barnesae. The last downhole occurrences of Parhabdolithus angustus and P. achlyostaurion (if in situ) indicate that sediments of Aptian age are present at this depth. This adds some support to the more restricted early Aptian age based on foraminiferal evidence.

PALYNOLOGY

The ditch cuttings sample at 4042.5m yielded a diverse and well preserved dinoflagellate dominated assemblage. The presence of abundant Ellipsoidictyum imperfectum group is indicative of an age no younger than the Aptian, Dingodinium albertii Zone (OI).

INTERVAL 4047.5m - 4075mT.D.; EARLY CRETACEOUS, BARREMIAN

Lithostratigraphic Unit:
Cromer Knoll Group (part).

Environment: marine, inner shelf.

The upper limit and age assigned to this interval are based on the following micropalaeontological and nannofossil criteria:

- a slight increase in the number of calcareous benthonic foraminifera at 4047.5m.
- an influx of nannofossils at 4050m including Micrantholithus hoschulzi, Nannoconus elongatus, N. abundans and N. truitti.
- the occurrence of Gavelinella barremiana at 4072.5m.
- the presence of Nannoconus steinmanni at 4075m.

MICROPALAEONTOLOGY

The presence of an increased abundance and diversity of calcareous benthonic species suggests a broad Barremian to Neocomian age for this interval, although its upper limit is difficult to define on the microfaunas. The incoming of ostracods from 4055m and the presence of Gavelinella barremiana from 4072.5m is consistent with this determination. A more restricted Barremian age can be assigned to the interval based on the nannofossil evidence as described below.

NANNOFOSSILS

The five samples examined for calcareous nannofossils from this interval, all yielded rich, well preserved nannofloral assemblages, containing abundant Watznaueria barnesae and common to abundant Biscutum sp. and Parhabdolithus asper. The marked influx of species new to the well at 4050m, including Micrantholithus haschulzi, Nannoconus elongatus, Nannoconus abundans and Nannoconus truitti suggests that sediments of Barremian age have been penetrated at this depth. The occurrence in the sidewall core at 4070m of Chiastozygus litterarius and Corollithion achylosum indicates that down to this depth the sediments are no older than late Hauterivian. However, the appearance of Nannoconus steinmanni at 4075m (a species which is reported to have it's first downhole occurrence within the Barremian) together with the fairly constant and rich nannofloral assemblages recorded, allow a general

Barremian age to be assigned to the interval.

PALYNOLOGY

The palynofloras recovered from the seven ditch cuttings samples analysed from this interval are considered to be caved. The only sidewall core analysed, 4070m, proved to be barren of palynomorphs.

(2/11-6 and 2/11-6 Sidetrack)

GEOLOGICAL HISTORY

Barremian - middle Albian	The oldest sediments encountered are argillaceous limestones and calcareous shales of the Cromer Knoll Group, deposited under gradually deepening inner to outer shelf conditions.
late Albian - Cenomanian	ABSENT: as a result of non-deposition or deposition with subsequent erosion.
Turonian - Coniacian	Sedimentation continued in the Late Cretaceous with the deposition of limestones of the Chalk Group under outer shelf conditions.
?Santonian - early Maastrichtian	A possible break in deposition and/or erosion of sediments occurs between the Coniacian and ?Santonian followed by further carbonate deposition (Chalk Group) under slightly shallower deep inner to outer shelf environmental conditions.
middle - late Maastrichtian	ABSENT: as a result of non-deposition or deposition with subsequent erosion.
Early Palaeocene, Danian - Late Palaeocene	Subsidence of the North Sea Basin during this period led to an increasingly argillaceous input and the deposition of the calcareous shales of the Maureen Formation Equivalent, under inner to outer shelf conditions. This subsidence also resulted in reworking of the Late Cretaceous carbonates found within this Formation. Subsidence coninued into the latest

	Danian and Late Palaeocene resulting in the deposition of the clays and shales of the Rogaland Group under deeper, outer shelf to upper bathyal conditions.
Early Eocene - Early Oligocene	Deep water, argillaceous deposits assigned to the Hordaland Group occur throughout this period,but with minor arenaceous input and occasional carbonate deposition also present.
Late Oligocene	Subsidence of the basin ceased and gradual shallowing is indicated with the establishment of outer shelf conditions during this period.
Early Miocene - Pleistocene	Outer shelf, argillaceous deposition (Hordaland Group) continued throughout the Early Miocene, with a further shallowing of conditions occurring in the Middle to Late Miocene and Pliocene with the depositon of claystones and minor sands (Nordland Group) under an inner shelf to outer shelf environment. With the Pleistocene colder marine conditions were established and coarser, more arenaceous sediments were deposited.

VI

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APPENDIX 1

Core Piece Descriptions (2/11-6 Original Hole)

Depth (metres)	Core No.	Type of Analysis	Lithology
3693	1	M/N	CHALKY LIMESTONE: moderately soft, but firm, greyish yellow to light olive brown, cryptocrystalline, dark grey to black, ?carbonaceous laminations, chalky texture. SHALE: moderately hard, medium grey, fissile, carbonaceous fragments, waxy.
3693.7	1		CHALKY LIMESTONE: moderately soft, with some harder fragments, yellowish grey to pinkish grey, chalky texture.
3694	1		CHALKY LIMESTONE: moderately soft but firm, yellowish grey to pinkish grey, cryptocrystalline, chalky texture, also present is CALCAREOUS SHALE: moderately hard, greyish black to black, fissile, very calcareous.
3695.2	1		CHALKY LIMESTONE: moderately soft, occasionally firm, yellowish grey to pinkish grey, black streaky carbonaceous? material, chalky texture, also present is CALCAREOUS SHALE: as 3694m.
3696.5	1		CHALKY LIMESTONE: moderately soft to friable and locally moderately hard, yellowish grey, ?carbonaceous, very chalky texture.
3696.9	1		CHALKY LIMESTONE: moderately soft, pinkish grey to yellowish grey, black carbonaceous streaks visible, bioclastic spheres present, chalky

			texture. Thin laminations of black CALCAREOUS SHALE.
3697.7	1	M	CHALKY LIMESTONE WITH SHALY PARTINGS: soft, pinkish grey to yellowish grey, cryptocrystalline, chalky texture. Thin black SHALE: laminations (calcareous) dissect the sample.
3702	2	M/N	CHALKY LIMESTONE: moderately soft, but firm, yellowish grey to pinkish grey, occasional thin black laminations, chalky texture.
3702.25	2		CHALKY LIMESTONE: as 3702m.
3703.6	2		CHALKY LIMESTONE: moderately soft but firm, yellowish grey, thin dendritic fracture pattern, microfossils evident, chalky texture.
3705.3	2		CHALKY LIMESTONE: as 2703.6m with slightly darker patches of argillaceous material.
3709.3	2		CHALKY LIMESTONE: very soft, friable, yellowish grey to pinkish grey, locally medium dark grey, chalky texture.
3709.5	2	M/N	CHALKY LIMESTONE: very soft to friable, very light grey to yellowish grey, chalky texture .
3709.9	3	M	CLAYSTONE: soft, firm, light olive grey to greenish grey, slightly micaceous.
3710	3	M	CHALKY LIMESTONE: moderately hard, brittle, white to very light grey, slight chalky texture.
3712.2	3	M/N	ARGILLACEOUS LIMESTONE WITH SHALE: limestones moderately hard, pinkish grey to light brownish

			grey, argillaceous, carbonaceous, cryptocrystalline. SHALE: hard, dark grey, sub-fissile, waxy.
3716.25	4	M/N	ARGILLACEOUS LIMESTONE: moderately soft but firm, variable yellowish grey, pinkish grey to light brownish grey, cryptocrystalline, very slight chalky texture.
3718.25	4	M	LIMESTONE: moderately hard, yellowish grey to pinkish grey, locally argillaceous, cryptocrystalline, slight chalky texture.
3719.25	4	M/N	LIMESTONE: moderately hard to hard, light bluish grey to light grey, cryptocrystalline.
3722.75	5	M	LIMESTONE: moderately hard, very light grey to bluish white, cryptocrystalline, slightly chalky texture.
3723.75	5	M/N	LIMESTONE: moderately hard, yellowish grey to light olive grey, cryptocrystalline, slightly argillaceous.
3725	6	M/N	LIMESTONE: moderately soft, yellowish grey to light olive grey, cryptocrystalline, streaky carbonaceous material, slightly argillaceous, faint hairline fractures.
3726	6	M	LIMESTONE: as 3725m.
3727	6	M/N	LIMESTONE: as 3725m with a slight chalky texture.
3728	6	M	LIMESTONE: moderately soft, yellowish grey to pinkish grey, cryptocrystalline, dendritic hairline fracture pattern, slightly chalky

			texture.
3728.65	6	M/N	CHALKY LIMESTONE: soft, yellowish grey, occasional hairline fractures, very chalky texture.
3734	7	M/N	CHALKY LIMESTONE: moderately soft, yellowish grey to pinkish grey, occasional hairline fracture, cryptocrystalline, chalky texture.
3734.75	7	M	CHALKY LIMESTONE: moderately soft, bluish white to very light grey, cryptocrystalline, chalky texture.
3735.70	7	M/N	CHALKY LIMESTONE: moderately soft, light bluish grey to light grey, black streaks of ?carbonaceous material, occasional fine hairline cracks, chalky texture.
3736.65	7	M	CHALKY LIMESTONE: as 3735.70m but yellowish grey to pinkish grey.
3737.5	7	M/N	CHALKY LIMESTONE: soft, pinkish grey, numerous hairline fractures, traces black ?carbonaceous material, cryptocrystalline, very chalky texture.
3739.6m	7	M	CHALKY LIMESTONE: as 3737.5m.
3741.1	7	M/N	CHALKY LIMESTONE: moderately soft, light bluish grey to light grey, microcrystalline, hairline fractures, chalky texture, cryptocrystalline.

KEY

M = Micropalaeontology

N = Calcareous Nannofossils

APPENDIX 2

Sidewall Core Descriptions (2/11-6 Sidetrack Hole)

Depth (metres)	Core No.	Rec. (mm)	Qual.	Type of Analysis	Lithology
3797	15	16	Good	M/N/XRD	CHALKY LIMESTONE: soft, firm, white to light grey, cryptocrystalline, pyritic, chalky texture.
3810	14	15 + frgs.	Good	M/N/XRD	CHALKY LIMESTONE: soft, white to yellowish grey, cryptocrystalline, chalky texture.
3911	6	Frgs.	Good	M/N/XRD	CHALKY LIMESTONE: as 3810m.
4017	5	-	-	-	EMPTY.
4020	4	Frgs.	Good	M/N/XRD	LIMESTONE: soft to moderately soft, very light grey to medium light grey, argillaceous, banded appearance, cryptocrystalline.
4023.5	3	Frgs.	Fair	M/N	CHALKY LIMESTONE: soft to moderately soft, white to yellowish grey and locally brownish grey, cryptocrystalline, glauconitic and faintly pyritic, chalky texture.
4070	1	Frgs.	Fair	M/N/P	LIMESTONE: moderately soft, yellowish grey to light olive grey, locally greenish - ?glauconitic, faintly pyritic, cryptocrystalline, slightly chalky texture.

KEY

M = Micropalaeontology

N = Calcareous Nannofossils

P = Palynology

Frgs. = Fragments

XRD = X-Ray Diffraction

APPENDIX 3

X-Ray Diffraction Analysis on Samples from 3797m to 4020m of the 2/11-6 (Sidetrack)

INTRODUCTION

Amoco (Norway) commissioned an X-Ray diffraction study on four sidewall core samples, from the interval 3797m to 4020m in the 2/11-6 sidetrack well, on encountering lower porosity rocks than expected in the section under study. The X-Ray diffraction analysis was used to identify any clay minerals present, which may be reducing the porosity, and to assess their relative percentages and characteristics (i.e. expanding or non-expanding clay). The four samples, 3797m, 3810m, 3911m and 4020m, have been analysed by X-Ray diffraction (XRD) using both bulk sample and clay fraction (<2μm) separates.

To remove the carbonate material, the samples were treated with acetic acid. The resulting insoluble residue was the fraction subjected to XRD analysis.

In addition to the XRD analysis, the samples were also analysed for uranium content in order that any wireline gamma ray measurements could be assessed for a respone due to the presence of uranium rather than clay. All of the samples contained <0.5ppm and, hence, any high gamma ray measurements are likely to be due to the presence of clays.

ANALYTICAL TECHNIQUES

(i) Acid Insoluble Residue Analysis

The acid insoluble residue was determined as the weight % remaining from the bulk sample after digestion with 10% acetic acid at 60°C. This material was then analysed by bulk sample XRD to determine the percentages of any minerals present (Table 1).

(ii) Clay Content Analysis

The clay size fraction (<2μm) contained in the bulk sample residue was removed from each sample by centrifugation and dispersed in deionised water. The results of XRD analyses on these samples are given in Table 2.

(iii) Uranium Analysis

The uranium content of the samples was assessed as a weight % by fluorimetric analysis.

(iv) X-Ray Diffraction Analysis

The orientated clay fraction mounts were analysed using Ni filtered Cu radiation produced at 40Kv and 40mA. A slit system of $\frac{1}{4}^{o}$ (divergence), 0.2mm (receiving), 1^{o} (scatter), was used throughout. Detection was by means of a proportional counter and the results were recorded on conventional chart paper. A scan rate of $1^{o}2\theta$ min.$^{-1}$ was used, with a corresponding chart speed of 10mm min.$^{-1}$. To prevent excessive 'noise', a time constant of 2 sec. was introduced between counter and chart.

NOTES ON THE IDENTIFICATION AND PARAGENESIS OF CLAYS

Prior to the results of X-Ray diffraction analysis on each sample, a brief description of the clay species present is given, with special reference to XRD identification and possible paragenesis.

Smectite — Smectite is a group of minerals identified, in XRD analysis, by the presence of a 14Å basal reflection (followed by a rational sequence of basal reflections). The 14Å reflection shifts on glycolation to 17.2Å and collapses to 10Å on heating to 380°C. The glycolation shift and subsequent collapse indicates that this is an expanding clay, i.e. one which can take up water between its structural layers. Smectite is formed as an alteration product of eruptive igneous rocks, e.g. tuffs, volcanic ash, as a hydrothermal product or in soils on the weathering of basic igneous rocks under alkaline conditions.

Illite — Illite is identified, in XRD analysis, by the presence of a 10Å basal peak (followed by a rational sequence of basal reflections). It is a non-expanding clay and is, therefore, unaffected by glycolation. Formation of illite is by the alteration of silicates such as feldspars or other clay species under alkaline conditions (Deer, et al, 1962).

Kaolinite — Kaolinite is characterised, in XRD traces, by a prominent peak at 7 to 7.2Å (followed by a rational sequence of basal reflections). It is a non-expanding clay and is, therefore, unaffected by glycolation. Kaolinite may be the alteration product of the weathering of feldspars (mainly in acid igneous rocks) or be precipitated directly into pore spaces under acid conditions.

Mixed Layer Minerals

Mixed layer minerals are described either as regularly or randomly interstratified. In the case of regularly interstratified clays, there is a rational sequence of basal reflections, whereas in randomly interstratified clays, no rational sequence of bases is apparent. The XRD peaks reflect the average spacing of the component layers in these clays. Clear identification of these mixed layer minerals is often difficult. If a greater proportion of one component is present then there will be a peak shift towards the 'ideal' composition.

The only identified mixed layer mineral present in this study is smectite/illite, which is a mixture of expanding and non-expanding phases. The smectite shows a peak at 14Å and the illite at 10Å. The mixed phase shows a single peak at 17Å.

RESULTS

X-Ray Diffraction Analysis Results

None of the samples examined showed any XRD traces indicating well-formed clay mineral structures. Hence, all of the trace peaks were poorly defined. The results of a semi-quantitative analysis of the diffraction patterns appear in Tables 1 and 2. The figures in the tables are relative and they cannot be taken as absolute values. The quality of the traces was such that, in sample 3810m for instance, the expanding smectitic material cannot account for the whole of the extracted clay fraction. The material other than expanding clays and quartz is presumably composed of amorphous (or very poorly crystallised) materials. There are insufficient data available to enable further quantification of these results.

3797m

This sample contains an appreciable quartz content, although the XRD trace indicates that this is poorly crystallised. The crystalline clay minerals consist entirely of randomly interstratified, expanding species which exhibit few characteristics which would enable a positive identification. The minerals show no reflections in the untreated, or heated, state and after glycolation a single peak appears at 17Å. These features indicate the presence of interstratified smectite/illite with a high proportion of smectite layers.

TABLE 1 BULK SAMPLE COMPOSITION

Sample	% Acid Insol. Res.	% Quartz	% Clay (<2µm)	% Others
3797m	34	12.5	6.8	14.7
3810m	22.3	9.6	8.8	3.9
3911m	14.1	6.5	3.3	4.3
4020m	58.5	25.7	6.4	26.4

N.B. "% Others" is the total percentage of amorphous constituents and trace (<1%) amounts of minerals.

TABLE 2 CLAY MINERALOGY

		Relative Percentages of Clays					
		Non-Expanding Clays			Expanding Clays		
Sample	Clay (<2µm) %	Kaolinite %	Illite %	Chlorite %	Smectite %	Mixed Layer Minerals %	Total Expanding Clays %
3797m	6.8	-	-	-	-	100 (6.8)	100 (6.8)
3810m	8.8	-	-	-	90 (7.9)	10 (0.9)	100 (8.8)
3911m	3.3	-	-	-	-	-	-
4020m	6.4	49 (3.1)	24 (1.5)	-	7 (0.5)	20 (1.3)	27 (1.8)

Figures in parentheses are the percentages of clays contained in the individual bulk samples.

3810m — This sample again shows an appreciable quartz content, although the XRD trace indicates that the quartz is well crystallised. The crystalline clay minerals consist of two major species. Smectite is evident from a 14Å basal reflection which on glycolation shifts to 17Å. Smectite is moderately well crystallised, but shows no rational sequence of basal reflections, suggesting that it may in fact be a randomly interstratified mineral with a very high proportion of smectite layers. Expanding interstratified minerals are also present, but these are very poorly formed, from XRD traces, and present no identifiable features.

3911m — The XRD analysis indicates that the clay size components in sample are of quartz composition. They may be clay size detrital quartz grains, clay size authigenic quartz grains or they may have been generated during sample preparation by the accidental crushing of larger quartz grains.

4020m — This sample contains a varied suite of clay minerals. Kaolinite is the predominant species and is moderately well crystallised. Very poorly crystallised illite is also present, together with associated interstratified phases, the latter showing some signs of expansion. Some (0.5%) smectite is present as well as an appreciable amount of quartz.

CONCLUSIONS

3797m and 3810m — These samples are similar in composition and are taken together. Both contain a high proportion of insoluble residue (34% and 22.3% respectively). Bulk sample analysis indicates that quartz is the chief insoluble mineral, whilst clays account for around 8% of the samples. All of the clays are expanding species and are chiefly smectite or mixed layer smectite/illite. The presence of illites in the smectite/illite suggests that the material is derived from the breakdown of basic igneous rocks or detrital igneous rock constituents.

3911m — This sample contains 3.3% clay size (<2μm) material, although the X-Ray diffractogram indicates that this clay size material is of quartz composition. This material may be derived as clay size detrital quartz, as authigenic quartz or as clay size quartz fragments accidentally produced during sample preparation.

4020m The final sample contains the most varied suite of clay minerals in this study. About 27% of the clays (1.72% of the sample) are mixed layer smectite/illites or expanding minerals and are probably derived from a similar source to those in sample 3797m. The remaining clays, 73% (4.68% of the sample), consist of well crystallised kaolinite (49% of the clay, 3.14% of the sample) and poorly crystallised illite. The poor crystallinity of the illite suggests that it is derived and probably detrital. The good crystallinity of the kaolinite suggests that it is authigenic. Authigenic kaolinite requires acidic conditions to crystallise and in carbonate rocks is most common as a cement in fractures, microfractures or infilling vugular or mouldic pores. The expanding clays in this sample only account for 27% of the clays in contrast to the first two clay bearing samples which contained 100% expanding minerals.

The frequency of quartz and detrital clay in these samples indicates input of terrestrial material into an area of carbonate deposition. The clays appear chiefly to be derived from the weathering of igneous material. The clay mineralogy shows them to be chiefly expanding species, which may account for 27% to 100% of the clays present. The presence of the clays, presumably in the matrix of the rock, and especially expanding species, may explain the low porosities in these samples.

Deer, W.A., Howie, R.A., and Zussman, J., 1962. Rock Forming Minerals (5 volumes) Longmans, London (Vol. 3 - Sheet Silicates).

LITHOLOGIES

Clay	
Shale/mudstone	
Siltstone	
Sand/sandstone, very fine to medium grained	
Sand/sandstone, coarse grained to granules	
Conglomerate (with sand matrix)	
Conglomerate (without sand matrix)	
Coal/lignite	
Breccia	
Limestone (undifferentiated)	
Chalky limestone	
Dolomitic limestone	
Calcareous dolomite	
Dolomite	
Chert	
Anhydrite/gypsum	
Salt (halite)	
Potassium salts	
Concretions/nodules	Py
Igneous rocks, undifferentiated	
Basement, undifferentiated	
Granite	

Qualifiers

Argillaceous	
Silty/sandy	
Pebbly	
Carbonaceous	
Calcareous	I
Dolomitic	
Red sediments	red

GRAIN TYPES

Oolith	
Fossils in general	
Bioclastic debris	
Mudflakes	

Other symbols

Sample gap	
Lost circulation material	lcm
Cement	cmt
Turbo drilling or diamond bit drilling (Samples unsuitable for good stratigraphic analysis)	tu
Casing point	◢
Core	▌
Sidewall core	◀
Sidewall core (analysed for biostratigraphy)	◀*
Sidewall core (no recovery)	◁

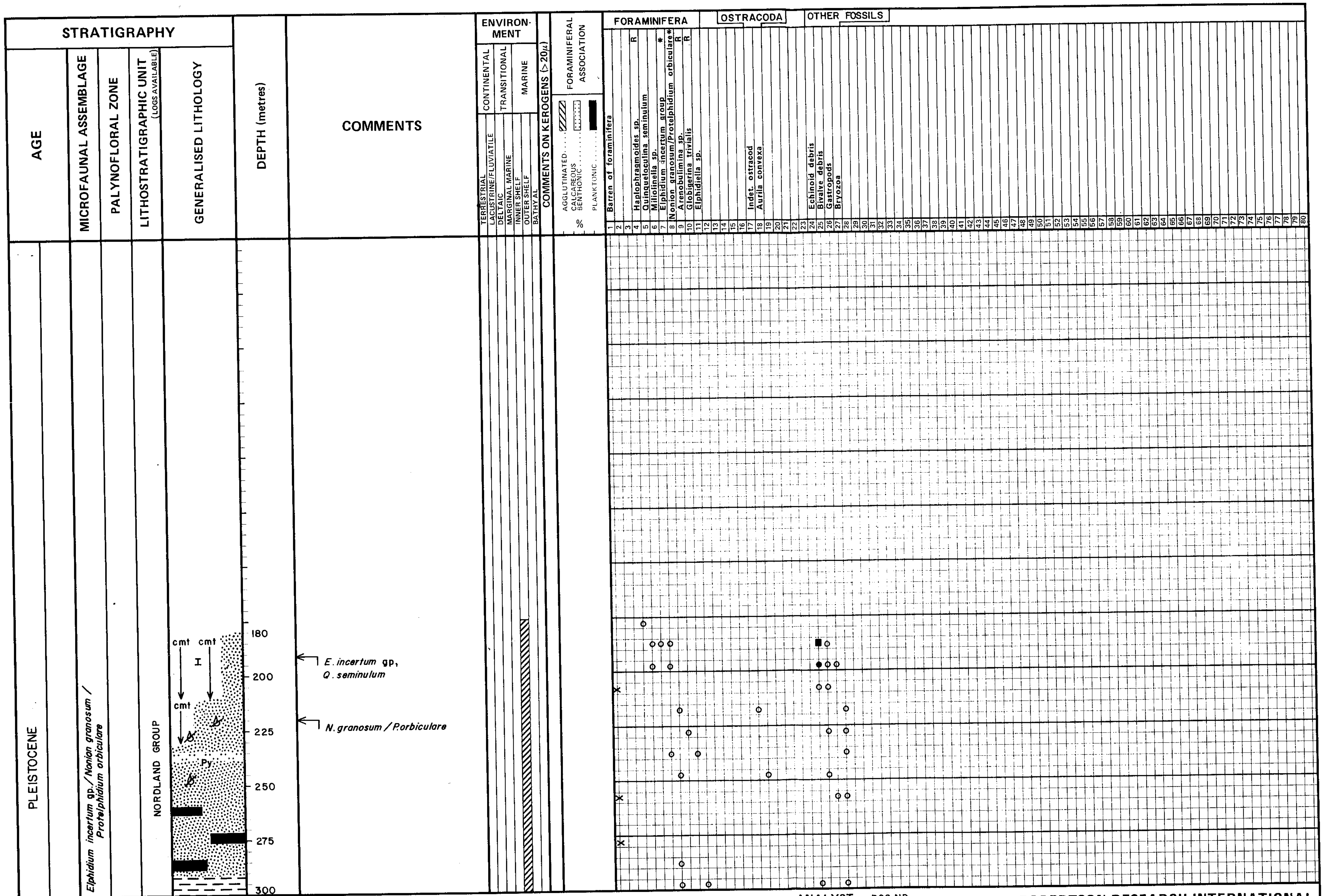
Accessories

Calcite	C
Ironstone/ferruginous deposits	Fe
Glauconite	Gl
Kaolinite	K
Phosphate	Ph
Pyrite	Py
Siderite/sphaerosiderite	S
Silica	Si

BIOSTRATIGRAPHIC SYMBOLS

Fossil Abundances	Present	o
	Common	●
	Abundant	■
Diagnostic forms		*
Caved forms		C
Reworked forms		R
Incoming of		↱
Outgoing of		↳
Unconformity/stratigraphic hiatus		∿∿∿
Faulted boundary		F—F
Late		LT., lt.
Middle		M., m.
Early		EY., ey.

FIGURE 1 – Legend (edited from Robertson Research Standard Legend).



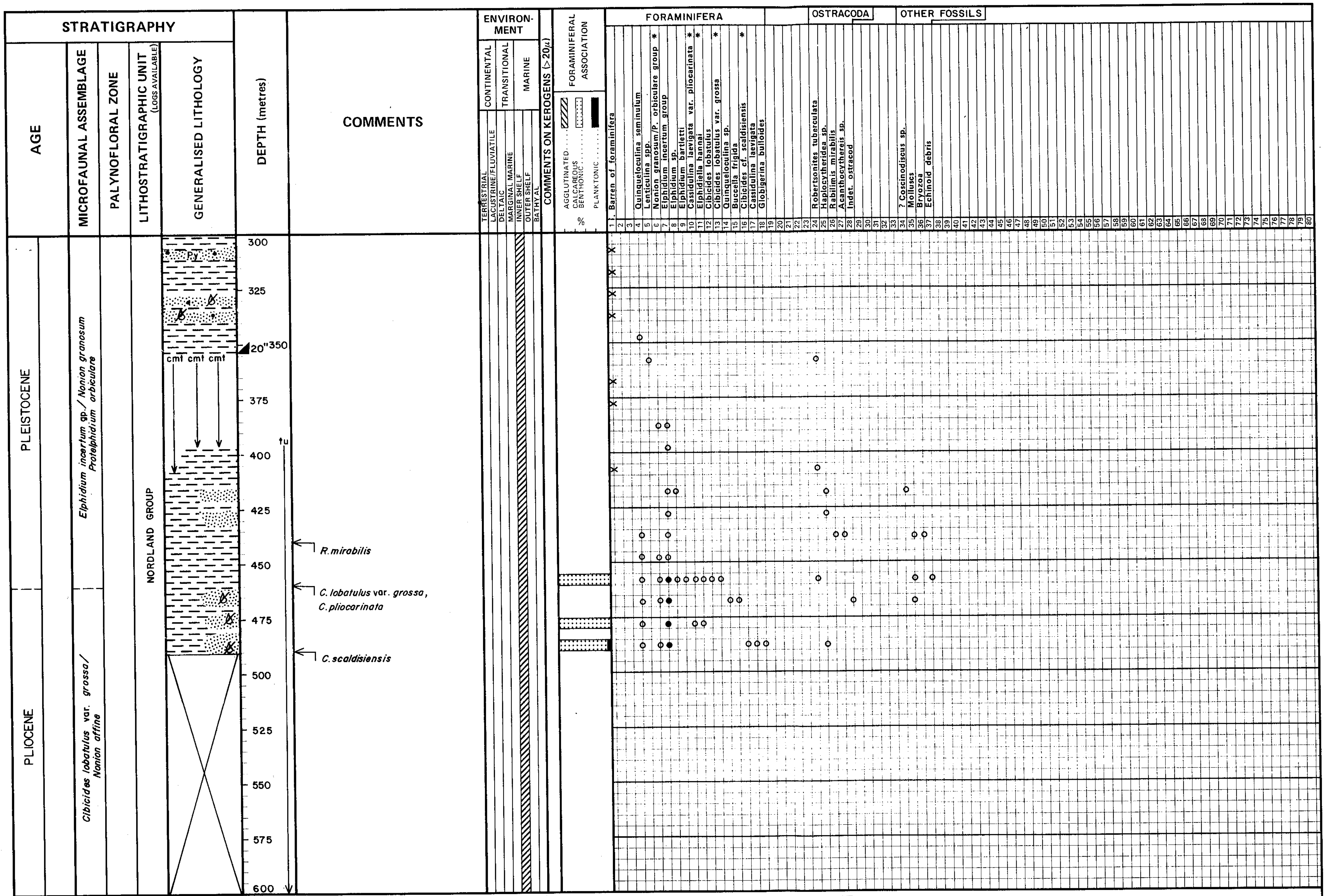
WELL:– 2/11-6
CHART:– 1 of 14
FIGURE:– 2

CLIENT:– AMOCO (NORWAY)
DEPTH:– 180-300m
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

ANALYST:– PGC, ND
DRAWING NO.:– 788P/10258/5204
DATE:– AUGUST 1982

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART



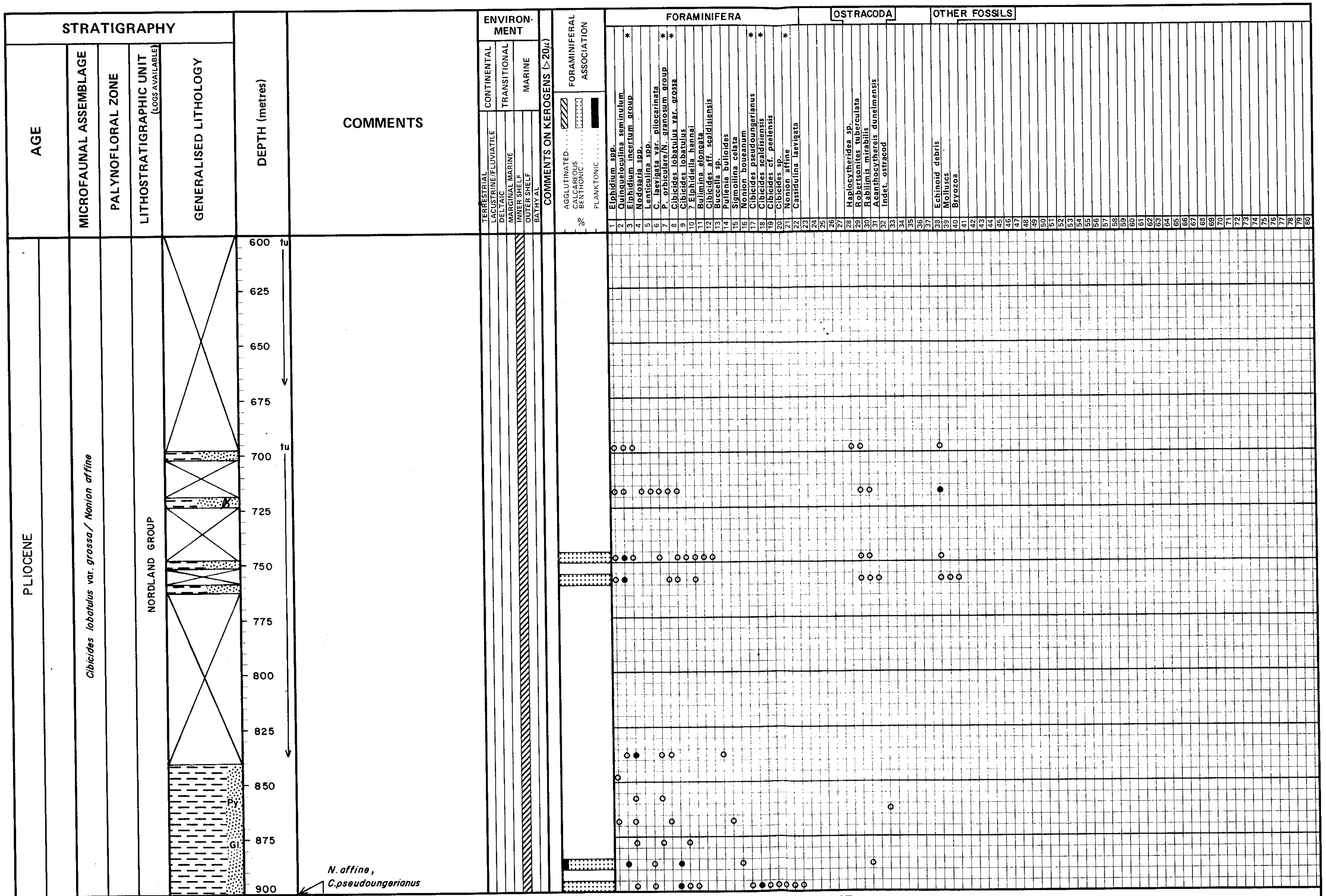
WELL:– 2/11–6
CHART:– 2 of 14
FIGURE:– 3

CLIENT:– AMOCO (NORWAY)
DEPTH:– 300–600m
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

ANALYST:– PF, ND
DRAWING NO.:– 788P/10258/5204
DATE:– AUGUST 1982

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART



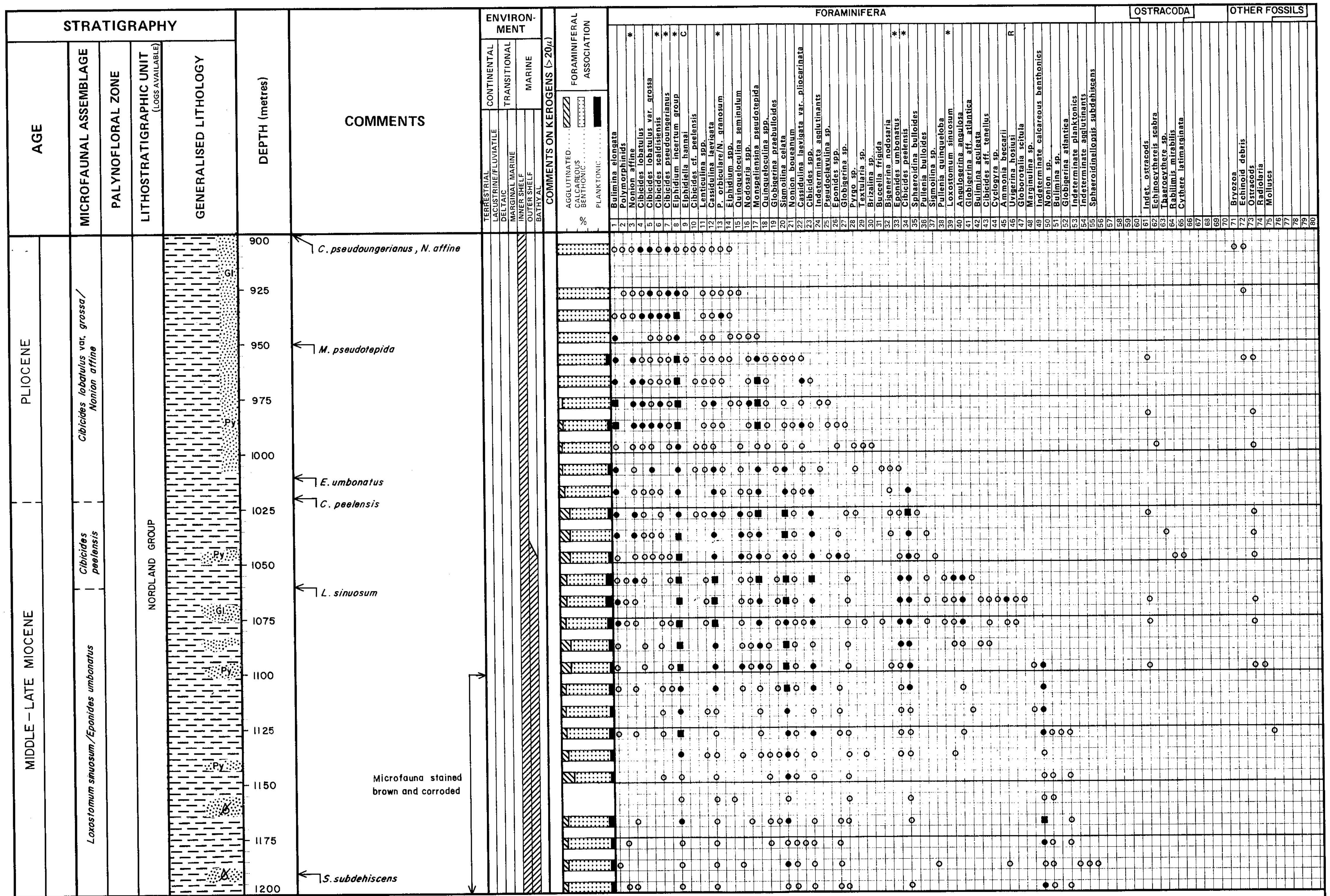
WELL:– 2/11-6
CHART:– 3 of 14
FIGURE:– 4

CLIENT:– AMOCO(NORWAY)
DEPTH:– 600-900m
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

ANALYST:– PF,ND
DRAWING NO.:– 788P/10258/5204
DATE:– AUGUST 1982

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART



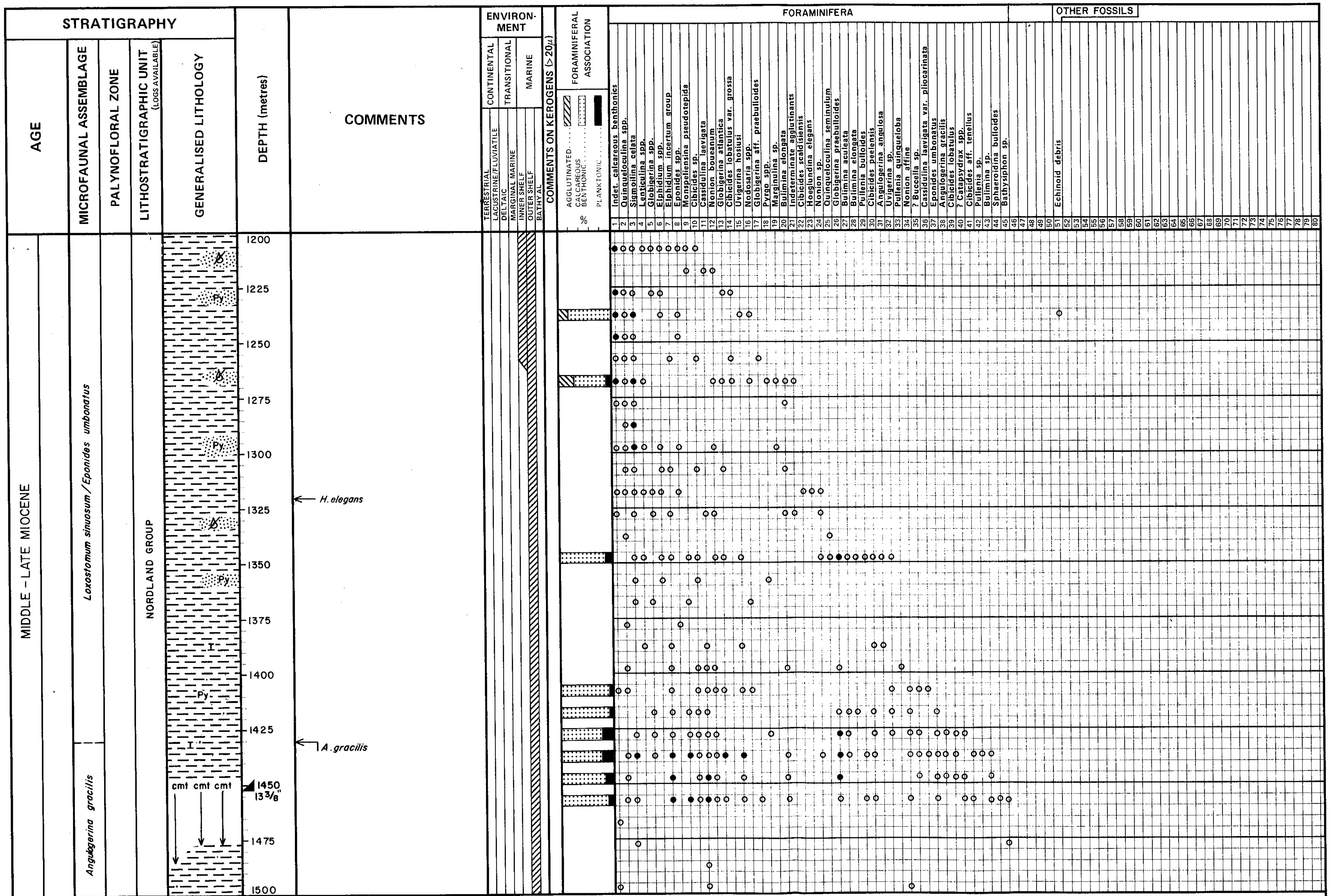
WELL:– 2/11-6
CHART:– 4 of 14
FIGURE:– 5

CLIENT:– AMOCO (NORWAY)
DEPTH:– 900m - 1200m
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

ANALYST:– PF, ND
DRAWING NO.:– 788P/10258/5204
DATE:– AUGUST 1982

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART



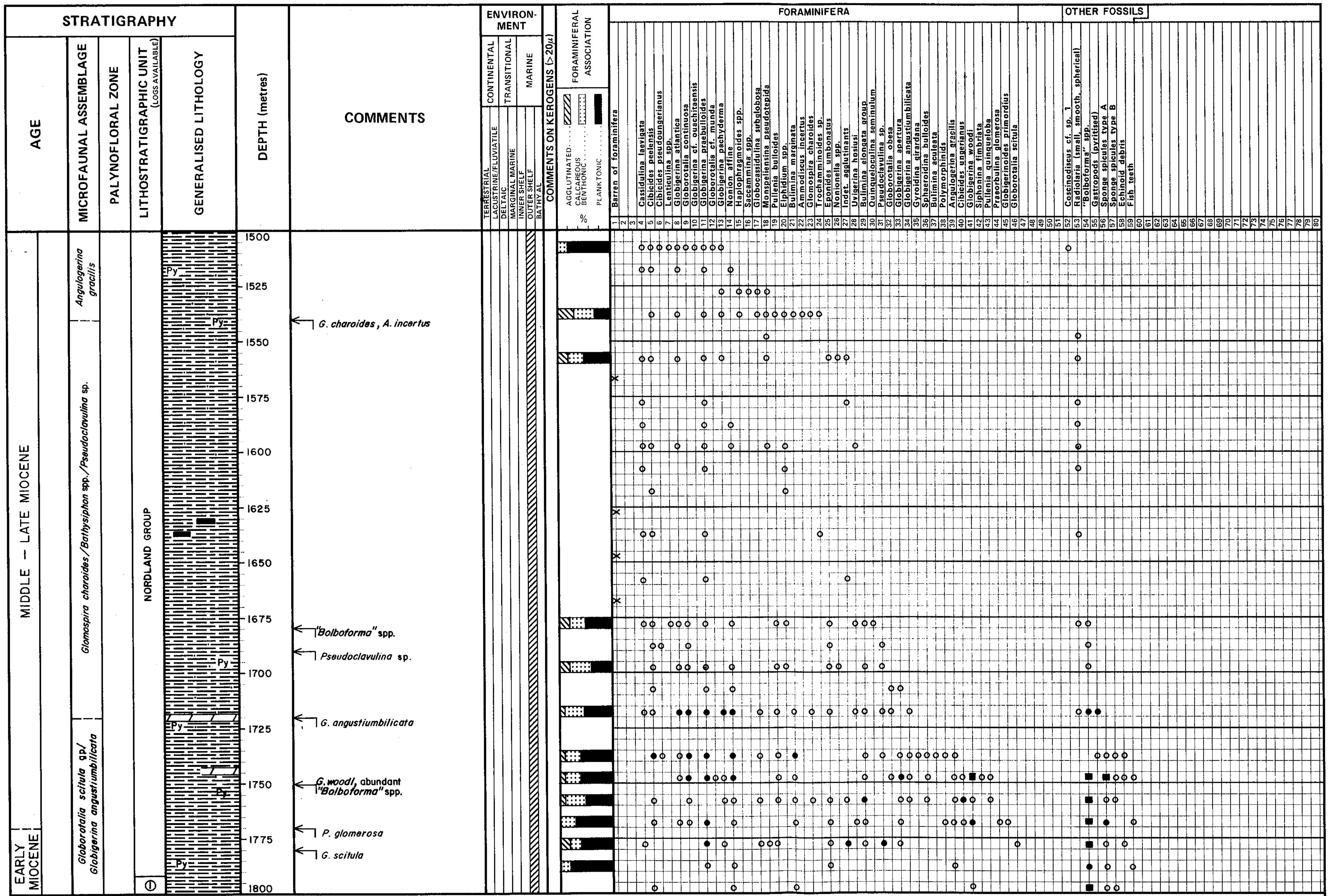
WELL:– 2/11-6
CHART:– 5 of 14
FIGURE:– 6

CLIENT:– AMOCO (NORWAY)
DEPTH:– 1200m – 1500m
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

ANALYST:– PF, ND
DRAWING NO.:– 788P/10258/5204
DATE:– AUGUST 1982

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART



WELL:– 2/11-6
CHART:– 6 of 14
FIGURE:– 7

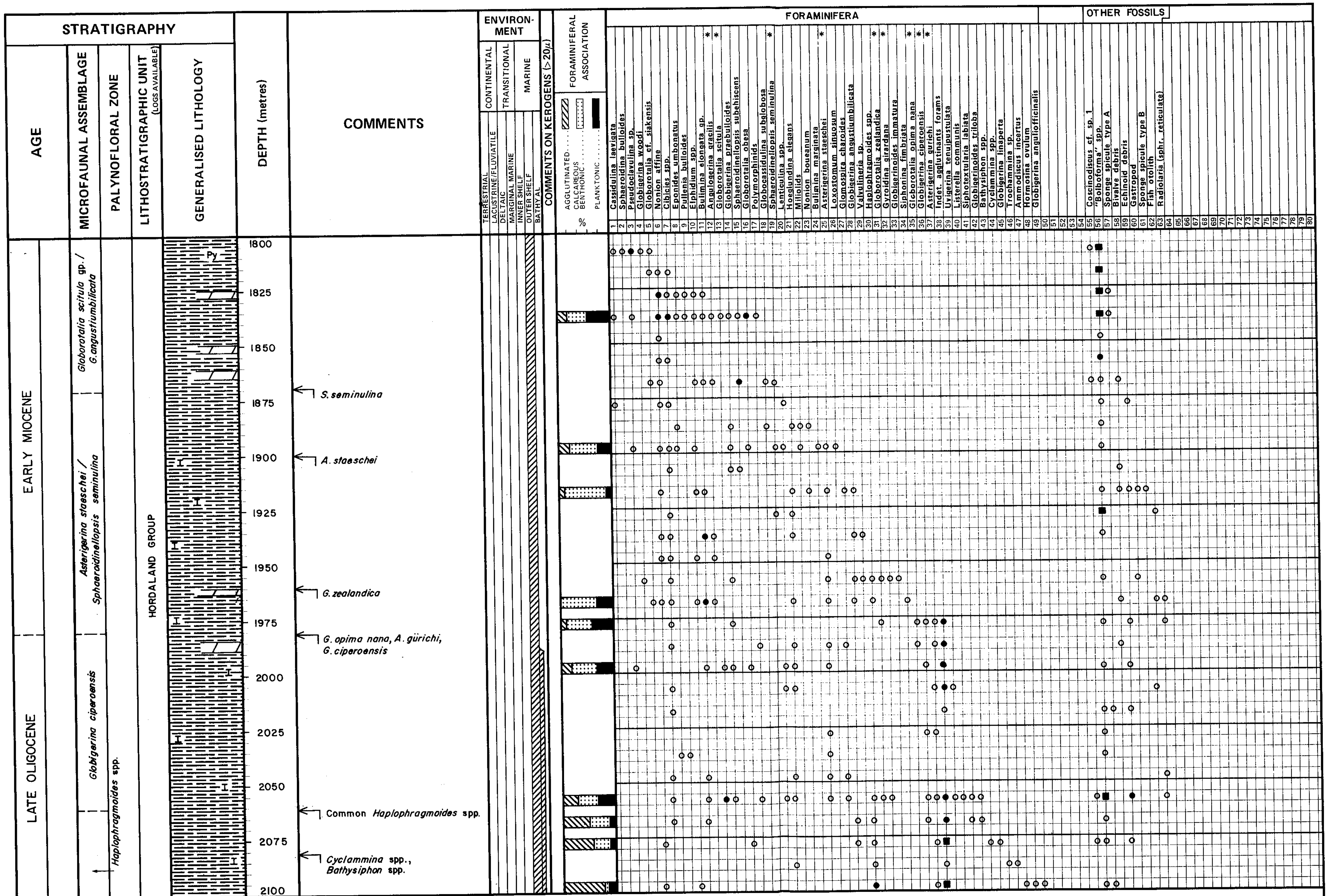
CLIENT:– AMOCO (NORWAY)
DEPTH:– 1500m – 1800m
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

ANALYST:– PGC, ND
DRAWING NO.:– 788P/10258/5204
DATE:– AUGUST 1982

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART

① HORDALAND GROUP



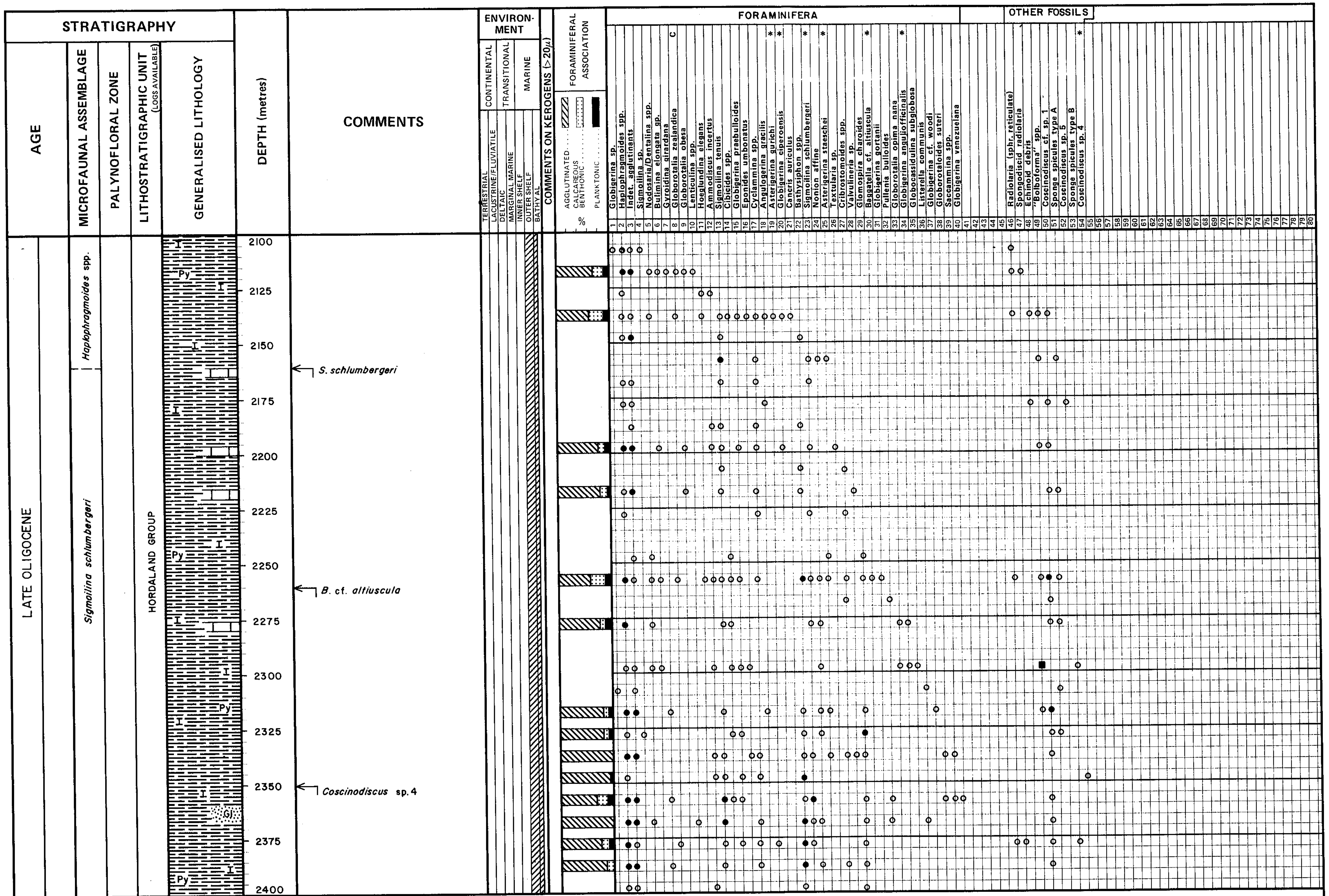
WELL:– 2/11-6
CHART:– 7 of 14
FIGURE:– 8

CLIENT:– AMOCO (NORWAY)
DEPTH:– 1800m – 2100m
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

ANALYST:– PGC, ND
DRAWING NO.:– 788P/10258/5204
DATE:– AUGUST 1982

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART



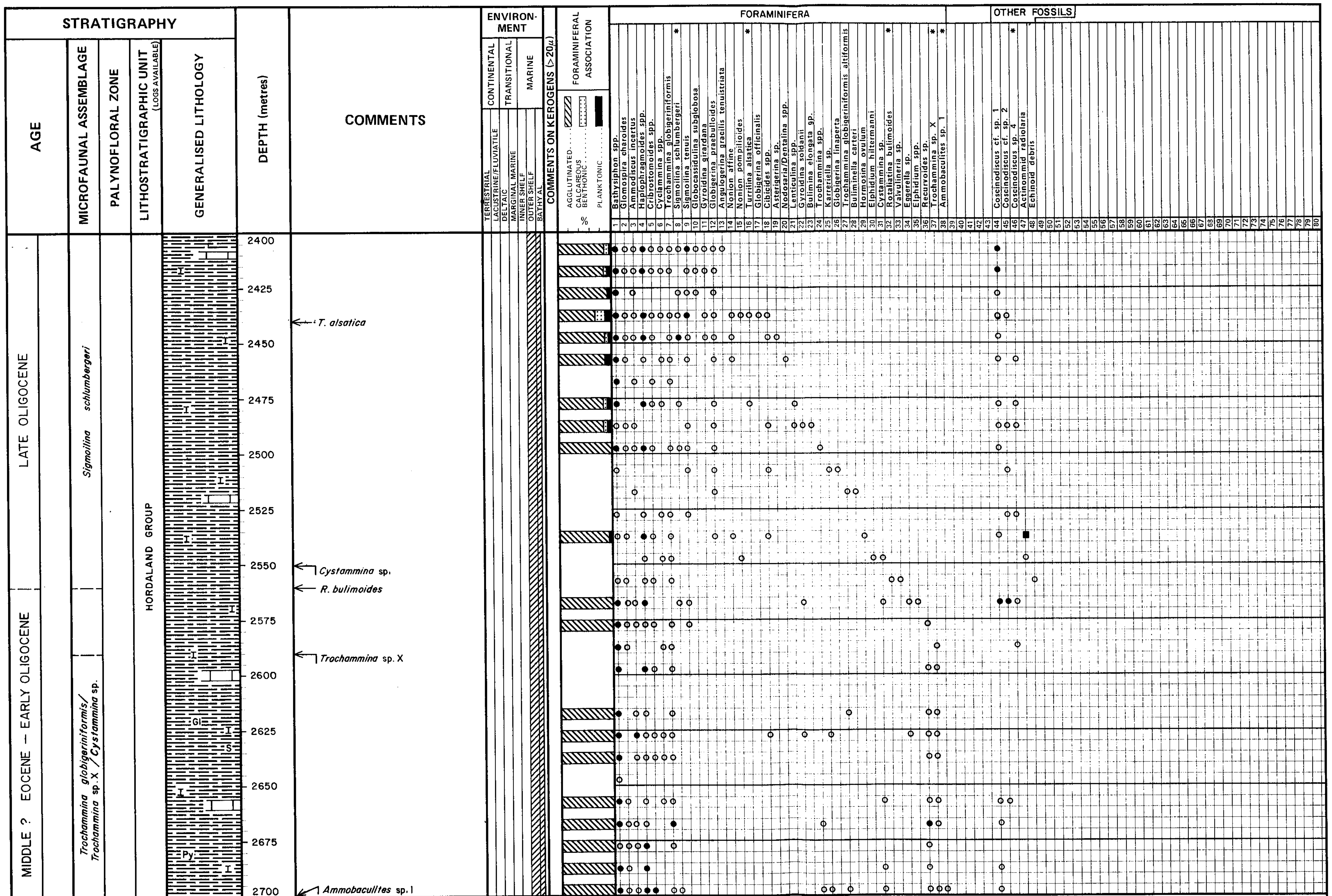
WELL:– 2/11-6
CHART:– 8 of 14
FIGURE:– 9

CLIENT:– AMOCO (NORWAY)
DEPTH:– 2100m–2400m
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

ANALYST:– PGC, ND
DRAWING NO.:– 788P/10258/5204
DATE:– AUGUST 1982

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART



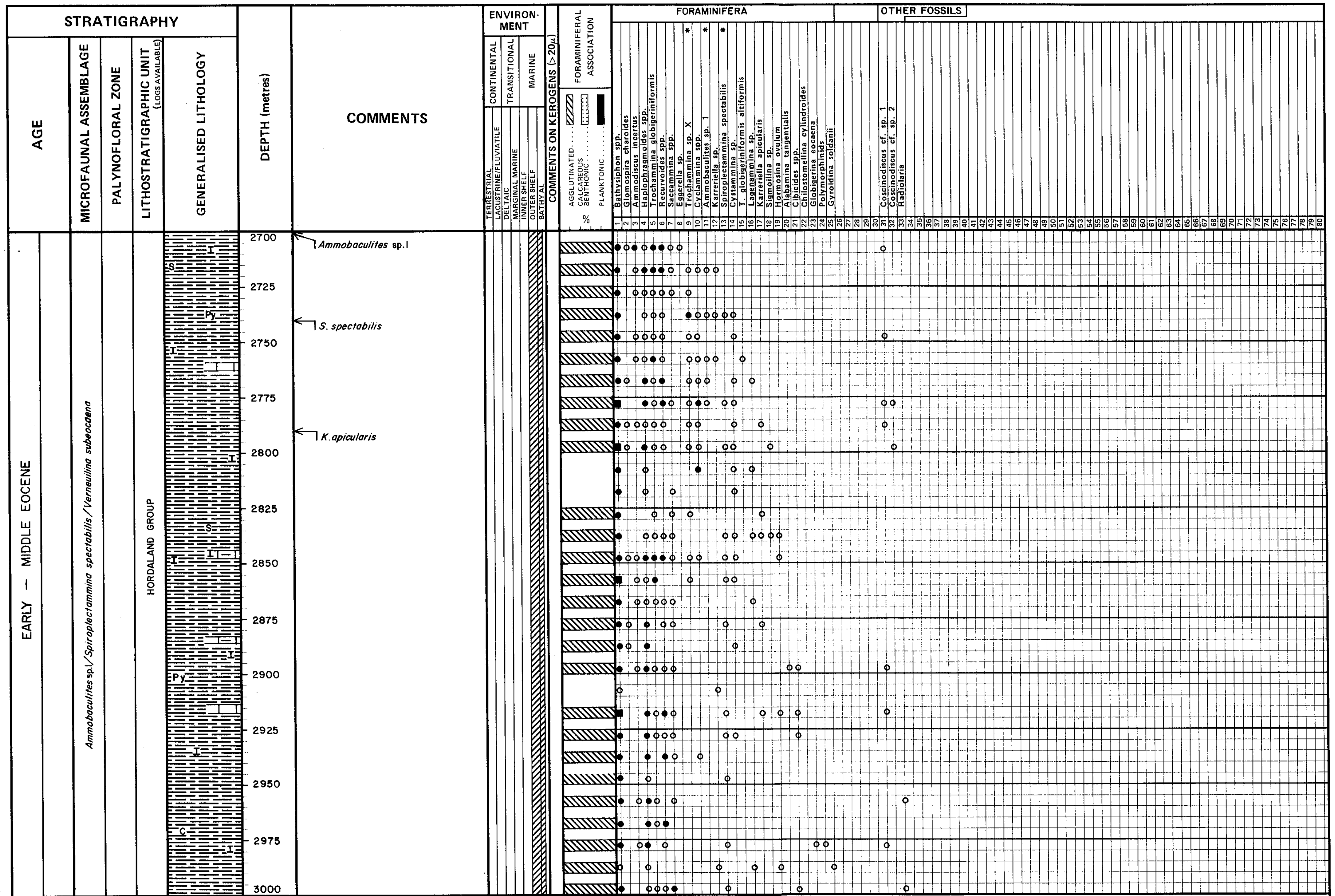
WELL:– 2/11-6
CHART:– 9 of 14
FIGURE:– 10

CLIENT:– AMOCO (NORWAY)
DEPTH:– 2400m – 2700m
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

ANALYST:– PGC, ND
DRAWING NO.:– 788P/10258/5204
DATE:– AUGUST 1982

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART



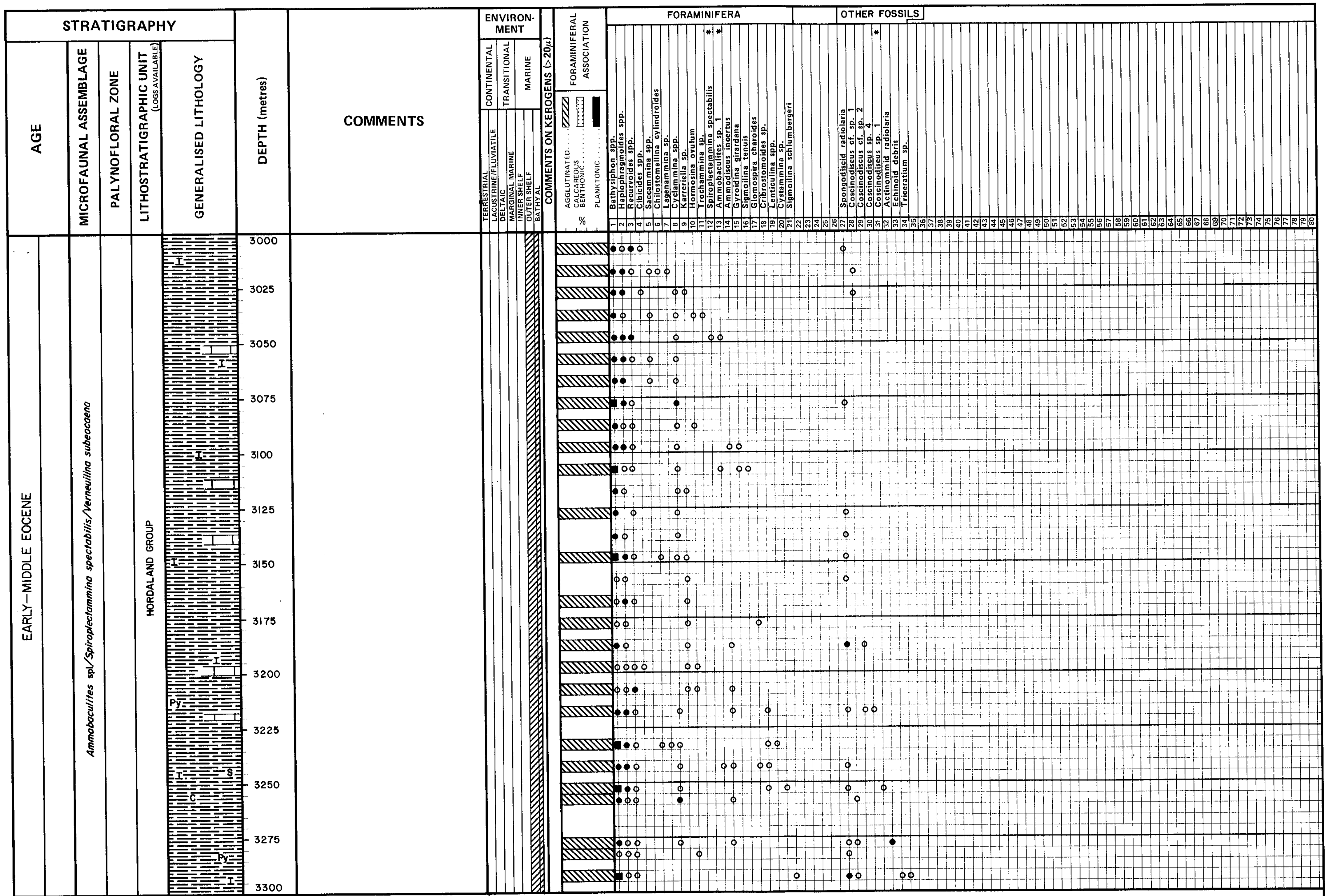
WELL:– 2/11-6
CHART:– 10 of 14
FIGURE:–11

CLIENT:– AMOCO (NORWAY)
DEPTH:– 2700m – 3000
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

ANALYST:– PGC, ND
DRAWING NO.:– 788P/10258/5204
DATE:– AUGUST 1982

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART



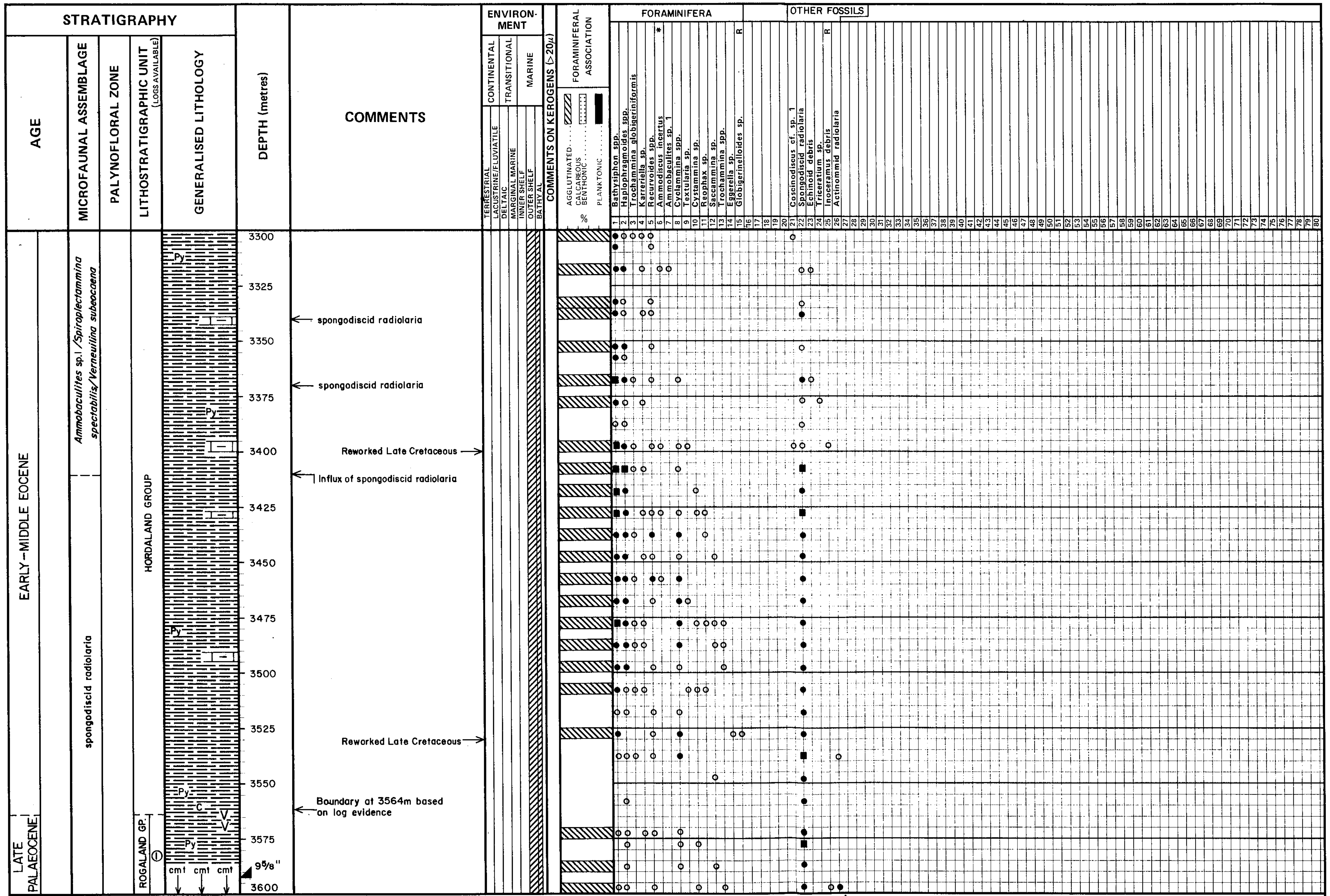
WELL:– 2/11-6
CHART:– 11 of 14
FIGURE:– 12

CLIENT:– AMOCO (NORWAY)
DEPTH:– 3000m – 3300m
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

ANALYST:– PGC, ND
DRAWING NO.:– 788P/10258/5204
DATE:– AUGUST 1982

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART



WELL:– 2/11–6
CHART:– 12 of 14
FIGURE:– 13

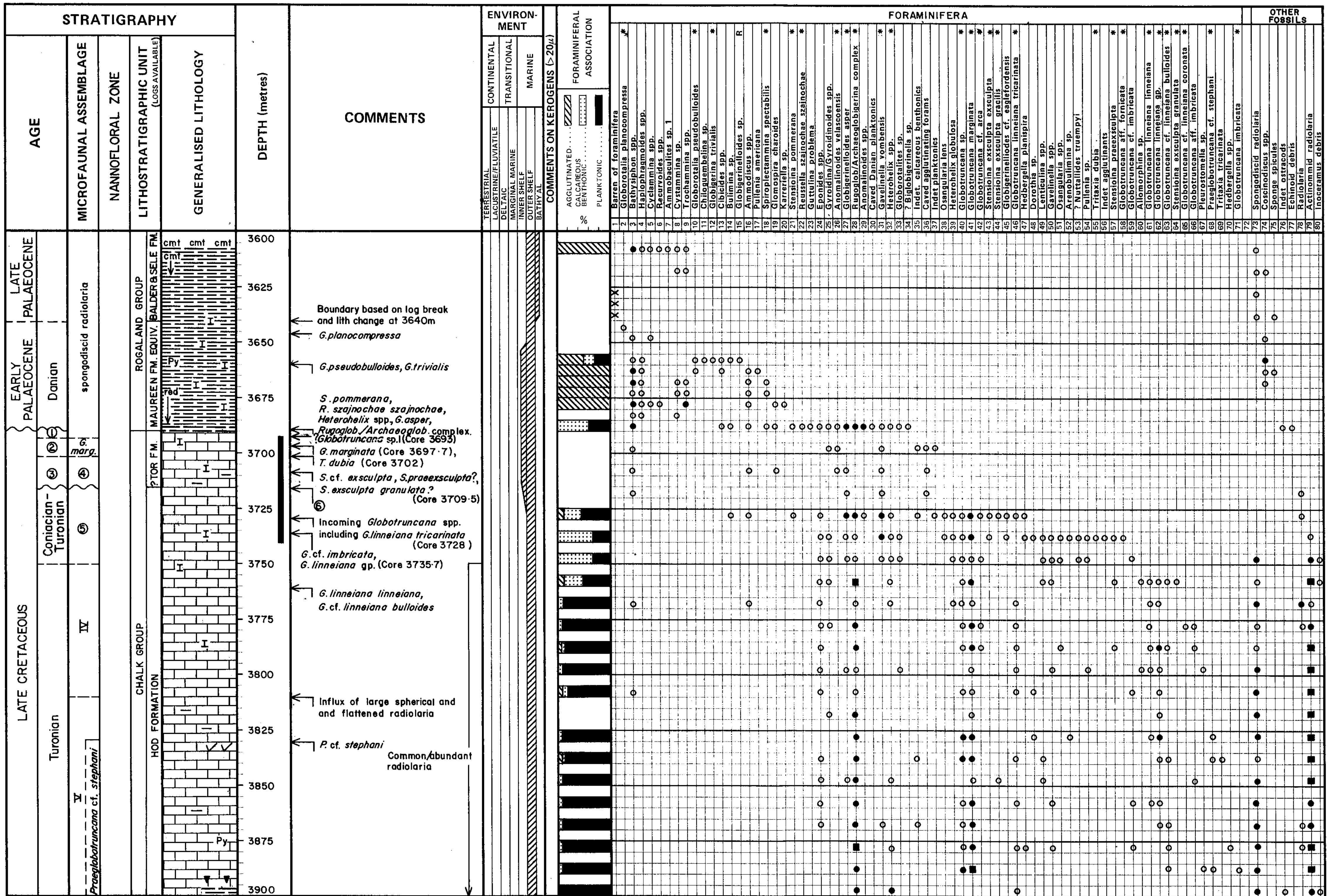
CLIENT:– AMOCO (NORWAY)
DEPTH:– 3300m – 3600m
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

ANALYST:– PGC, ND
DRAWING NO.:– 788P/10258/5204
DATE:– AUGUST 1982

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART

① BALDER AND SELE FORMATIONS



WELL:– 2/11-6 CHART:– 13a of 14 FIGURE:– 14	CLIENT:– AMOCO (NORWAY) DEPTH:– 3600m–3900m LOCATION:– NORWEGIAN NORTH SEA	SCALE 1 : 2000 LEGEND:– SEE FIGURE 1	ANALYST:– PGC, PF, ND DRAWING NO.:– 788P/10258/5204 DATE:–

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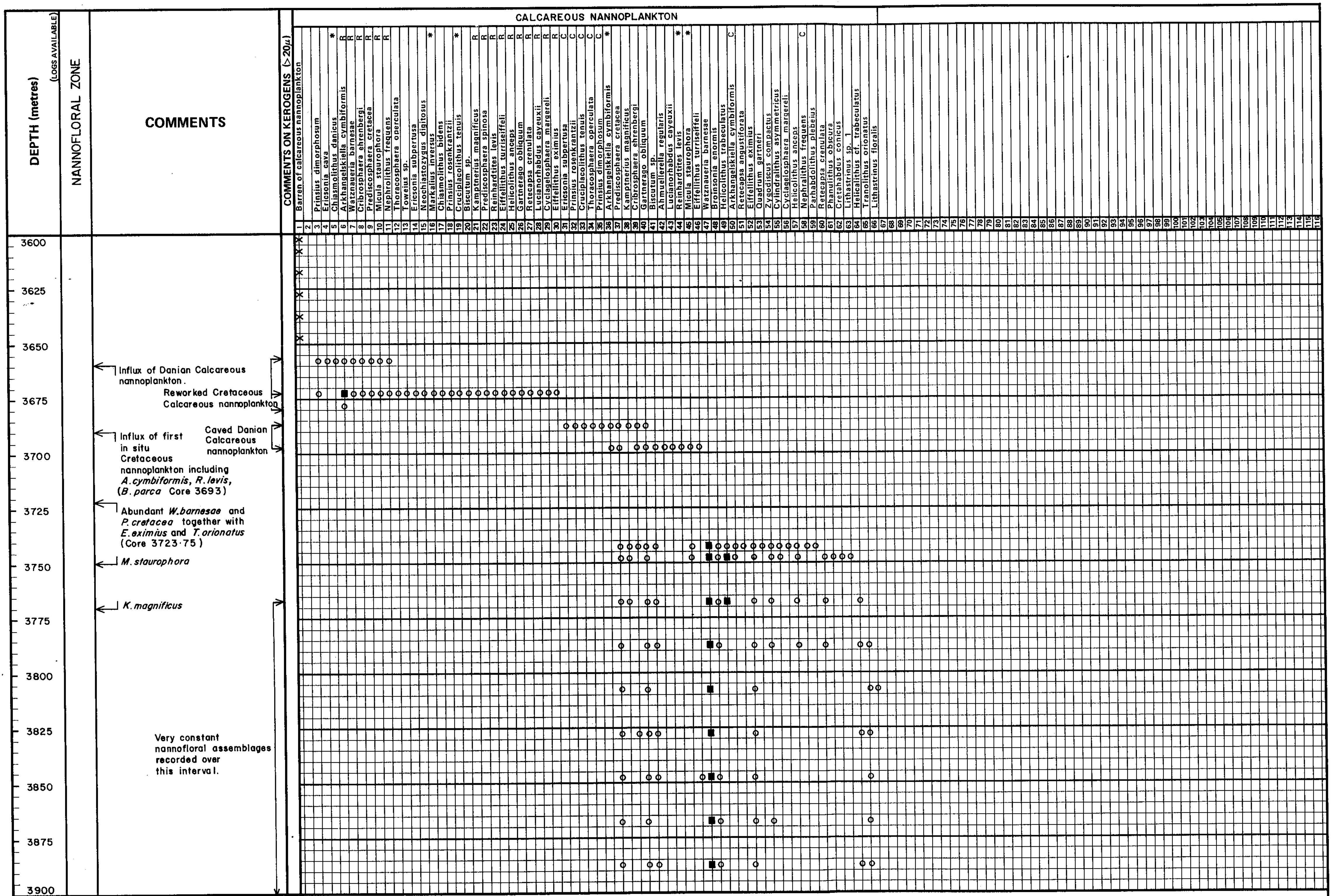
BIOSTRATIGRAPHIC ANALYSIS CHART

① early Maastrichtian
② late Campanian
③ early Campanian–?Santonian
④ *Tritaxia dubia–?Stensioina* Assemblage
⑤ *Globotruncana marginata*/Radiolaria–*Globotruncana* Assemblage
⑥ Boundary on log break at 3716m



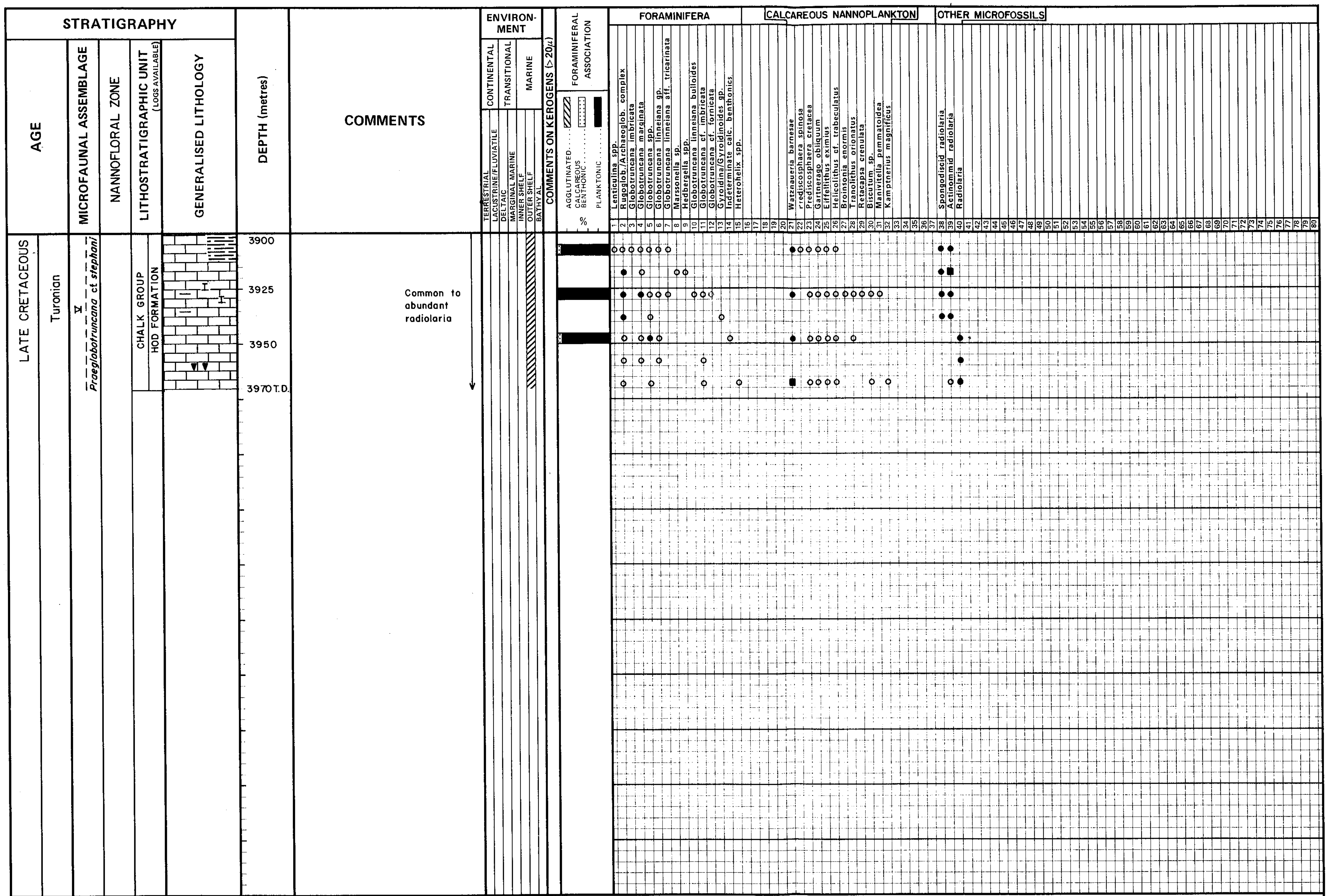
WELL:– 2/11–6
CHART:– 13b of 14
FIGURE:– 15

CLIENT:– AMOCO (NORWAY)
DEPTH:– 3600m–3900m
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

ANALYST:– CPM
DRAWING NO.:– 788P/10258/5204
DATE:– AUGUST 1982

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART



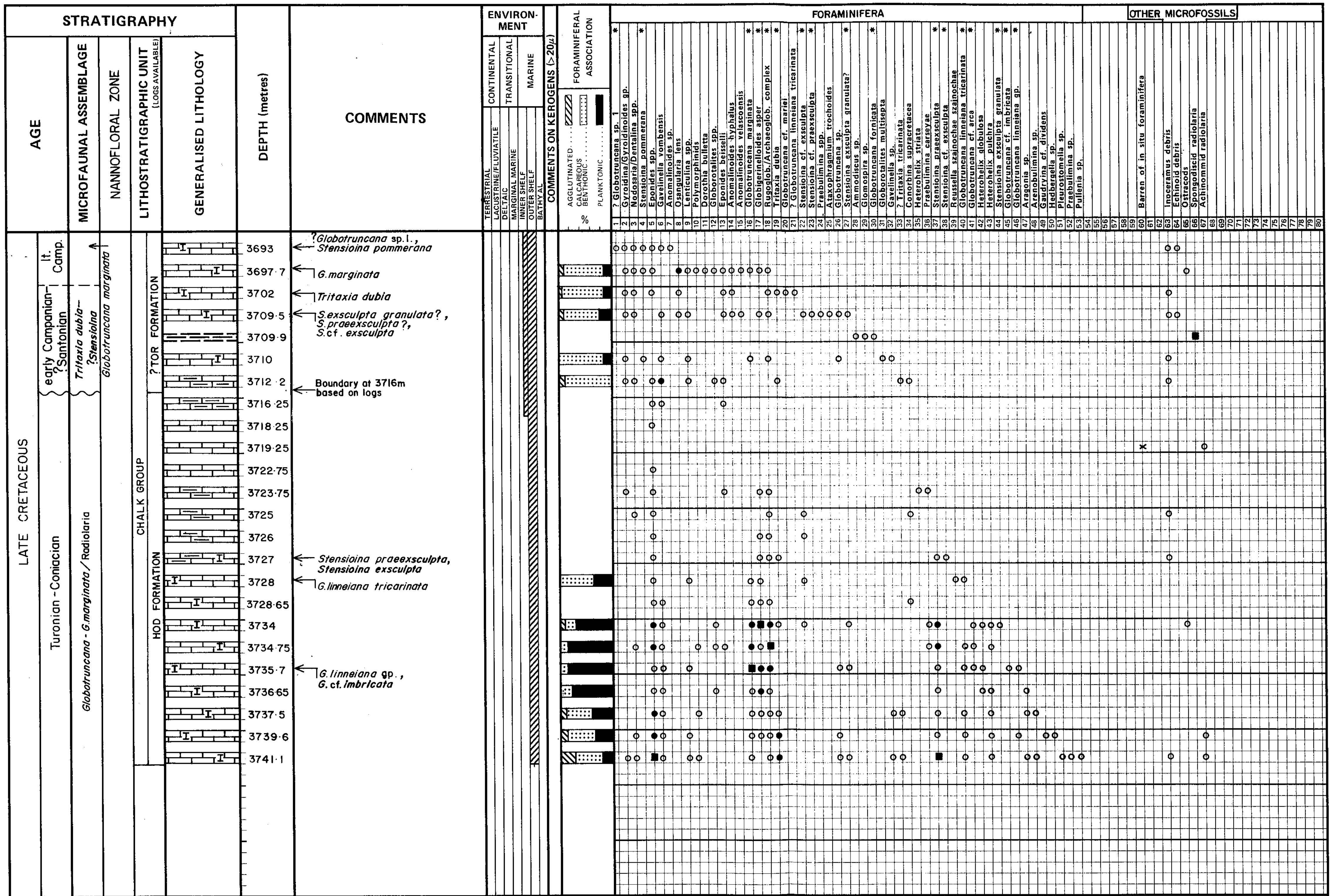
WELL:– 2/11-6
CHART:– 14 of 14
FIGURE:– 16

CLIENT:– AMOCO (NORWAY)
DEPTH:– 3900m – 3970m
LOCATION:– NORWEGIAN NORTH SEA

SCALE 1 : 2000
LEGEND:– SEE FIGURE 1

ANALYST:– PF, CPM, ND
DRAWING NO.:– 788P/10258/5204
DATE:– AUGUST 1982

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART



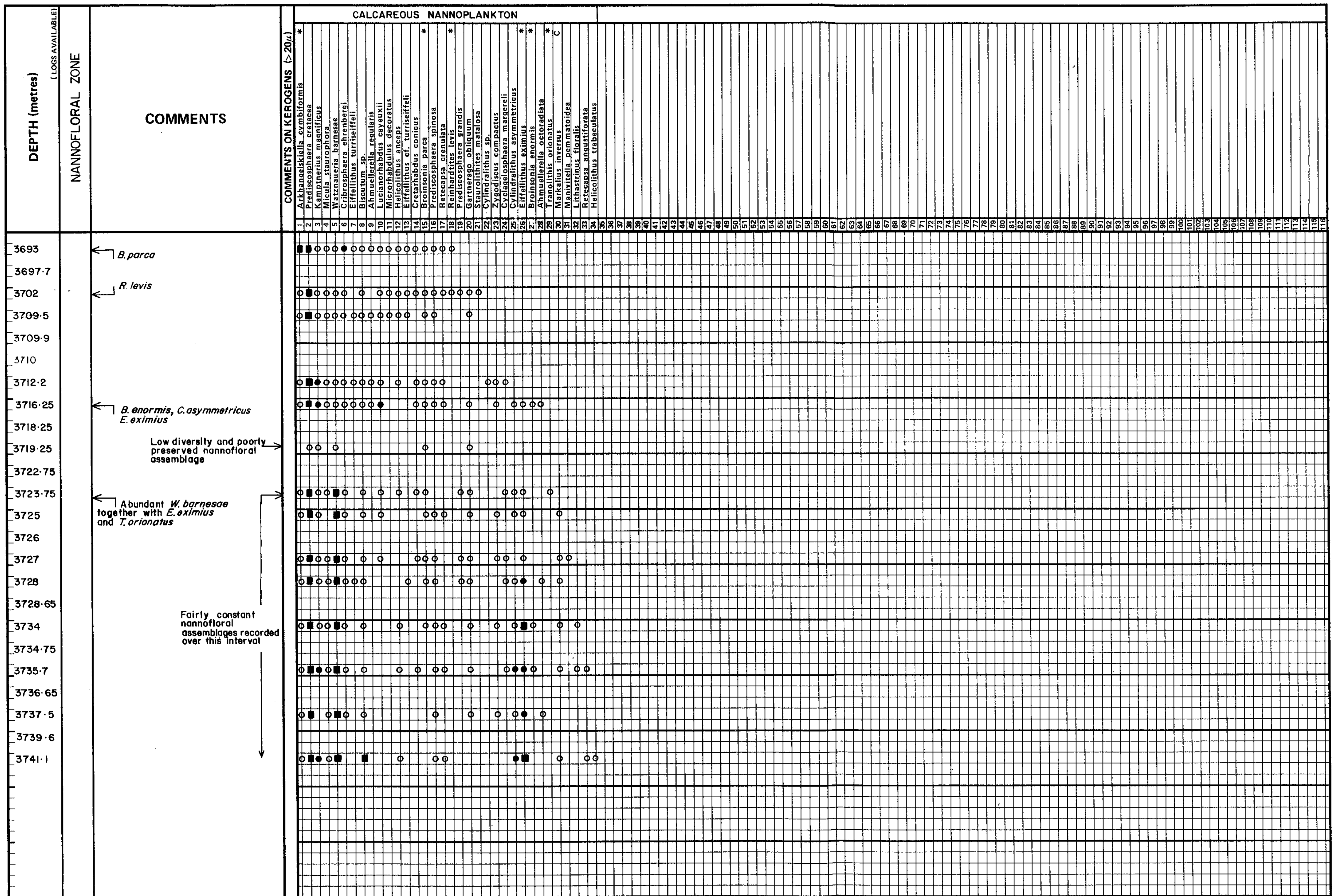
WELL:– 2/11-6
CHART:– Ia of I
FIGURE:– 17

CLIENT:– AMOCO (NORWAY)
CORE PIECES
LOCATION:– NORWEGIAN NORTH SEA

LEGEND:– SEE FIGURE 1

ANALYST:– PF, ND
DRAWING NO.:– 788P/10258/5204
DATE:– AUGUST 1982

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART



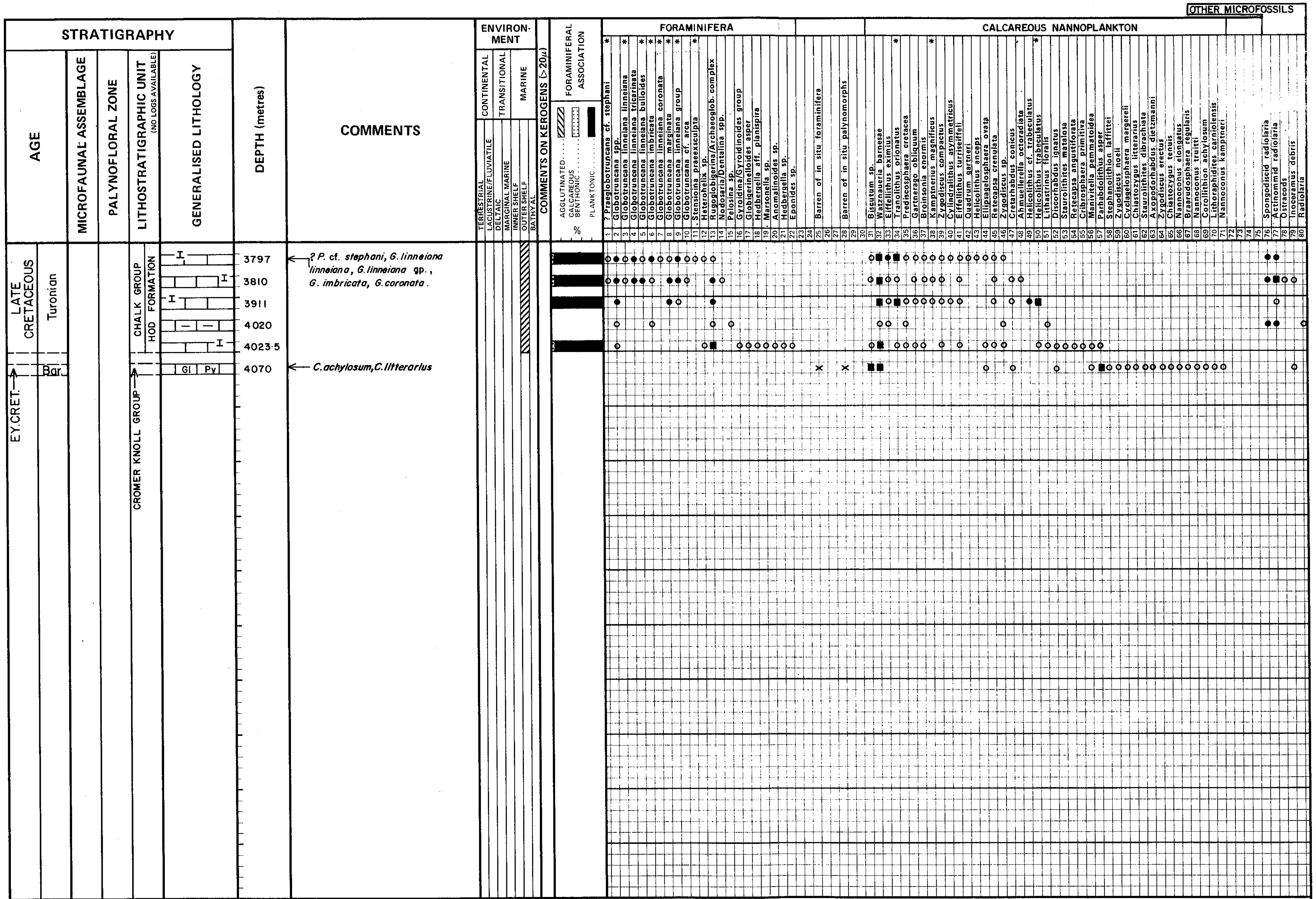
WELL:– 2/11-6
CHART:– 1b of 1
FIGURE:– 18

CLIENT:– AMOCO (NORWAY)
CORE PIECES
LOCATION:– NORWEGIAN NORTH SEA

LEGEND:– SEE FIGURE 1

ANALYST:– CPM
DRAWING NO.:– 788P/10258/5204
DATE:– AUGUST 1982

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART



WELL:– 2/11-6 S.T.-1 CHART:– 1 of 1 FIGURE:– 19	CLIENT:– AMOCO(NORWAY) SIDEWALL CORES LOCATION:– NORWEGIAN NORTH SEA	LEGEND:– SEE FIGURE 1	ANALYST:– PF, CPM, NHM DRAWING NO.:– 788P/10258/5204 DATE:– AUGUST 1982

ROBERTSON RESEARCH INTERNATIONAL
BIOSTRATIGRAPHIC ANALYSIS CHART

ENCLOSURE 1

SUMMARY LOG

ROBERTSON RESEARCH INTERNATIONAL

SCALE 1 : 500

AMOCO 2/11-6 (MAIN HOLE)

AREA: NORWEGIAN NORTH SEA

SPUD DATE: 2nd SEPTEMBER 1981

COMPANY: AMOCO NORWAY

COMPLETION DATE: 17th SEPTEMBER 1981

INTERVAL STUDIED: 180m – 3970m

T.D.: 3970m

Drawing No. 788P/10258/5204

ANALYST PF, PGC, ND, CPM

Date AUGUST 1982

Cored Interval

Casing Shoe

Sidewall Core

Sidewall Core (no recovery)

Sidewall Core analysed for biostratigraphy

ENCLOSURE 2

SUMMARY LOG

ROBERTSON RESEARCH INTERNATIONAL

SCALE 1 : 500

AMOCO 2/11-6 (SIDETRACK HOLE)

AREA: NORWEGIAN NORTH SEA

SPUD DATE: 19th DECEMBER 1981

COMPANY: AMOCO NORWAY

COMPLETION DATE: 25th FEBRUARY 1982

INTERVAL STUDIED: 3607.5m – 4075m

T.D.: 4075m

Drawing No 788P/10258/5204

ANALYST PF, ND, CPM, NHM.

Date AUGUST 1982