Report EP-56203

Palynofacies investigation in the Jurassic interval of the Norske Shell well 31/2-4

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EXPLORATION AND PRODUCTION

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SUMMARY

A palynofacies analysis of the post Pliensbachian-Jurassic strata of the Norske Shell well 31/2-4 was undertaken to aid in the interpretation of the depositional environments of the Norwegian 31/2 block.

Nine palynofacies sequences are discussed, of which 3-6 represent a series of superimposed prograding offlap units each reflecting a gradual change of the depositional environment from lower offshore to shoreface. Only the very lowermost parts of some sequences indicate a distal offshore marine environment, the remaining lower and upper parts of the sequence being characterized by the increasing effects of a prograding distributary mouth. The uppermost part of some sequences is suggested to represent a period of non-deposition and gentle reworking of previously deposited sediments. During Aalenian/ Bajocian time, palynofacies indicate the upper part of this sequence included coastal plain sediments deposited in a large lacustrine and lagoonal environment.

Sequences 7-9 indicate a major change in the general palaeogeographic setting. They represent most likely deposits laid down in a shallow water marine environment with increased energy conditions at the sea bottom, associated with a continuing period of transgression.

A comparison of palynofacies from adjacent wells indicates that the sequences in 31/2-4 often bear an intermediate character to the more offshore indications frequently displayed by 31/2-5 and the more coastal aspects of the wells 31/2-2 and -3.

KEY WORDS

31/2-4, 31/2-1, 31/2-2, 31/2-3, 31/2-5, palynofacies, Norway, North Sea, offshore, environments, Jurassic, deltaic, dinoflagellates, microplakton, palynodebris.

1. INTRODUCTION

A palynofacies analysis of the Norske Shell well 31/2-4 was undertaken in order to further the understanding of the environmental setting in which the Jurassic sediments of this area were deposited. (For general location and stuctural setting of the well, see figure 1). The study follows closely the analysis procedures established for wells 31/2-1 and 31/2-2, in report EP-53031. The latter report also includes a description and discussion of the palynological constituents and palynofacies types used in the present report, together with their environmental significance. The present report also adopts the slightly modified terminology for some palynodebris types as indicated in report EP-54927 (31/2-5). As a reference and guide, illustrations from EP-53031 (31/2-1 and -2), summarizing the distribution of the various palynofacies types in coastal plain and offshore sediments, are included here (figures 6-8).

2. RESULTS

The palynofacies study in the post Pliensbachian interval from the Norske Shell well 31/2-4 included the analysis of 97 cores and 33 sidewall samples. From the character of the palynological constituents a number of palynofacies types could be identified, which could be further grouped into 9 palynofacies sequences. By applying basic sedimentological and palaeontological principles to the distribution of their constituents, an environmental interpretation is suggested for each of these sequences.

SEQUENCE 1

Interval : 1982.5-1902.0 m

Age : Toarcian

Description

Palynofacies types IV/I in the lowest part of the sequence are characterized by a moderate proportion of bisaccates and other buoyant sporomorphs together with blade shaped small and medium sized material comparable to palynomaceral 2 and structureless (sapropelic) organic matter. Dinocysts (2 types) are infrequent.

Palynofacies types V/VI, also in the lower sequence, are characterized by a moderate proportion of large and medium sized debris comparable to palynomacerals 1 and 2, together with a relatively high proportion of bisaccates and other buoyant sporomorphs. Dinocysts (2 types) are frequent.

Palynofacies type IV from the upper part of the sequence are characterized by a high proportion of bisaccate and other buoyant sporomorphs, together with a low proportion of material comparable to palynomacerals 2 and 4. Dinocysts (usually 3 types) are common.

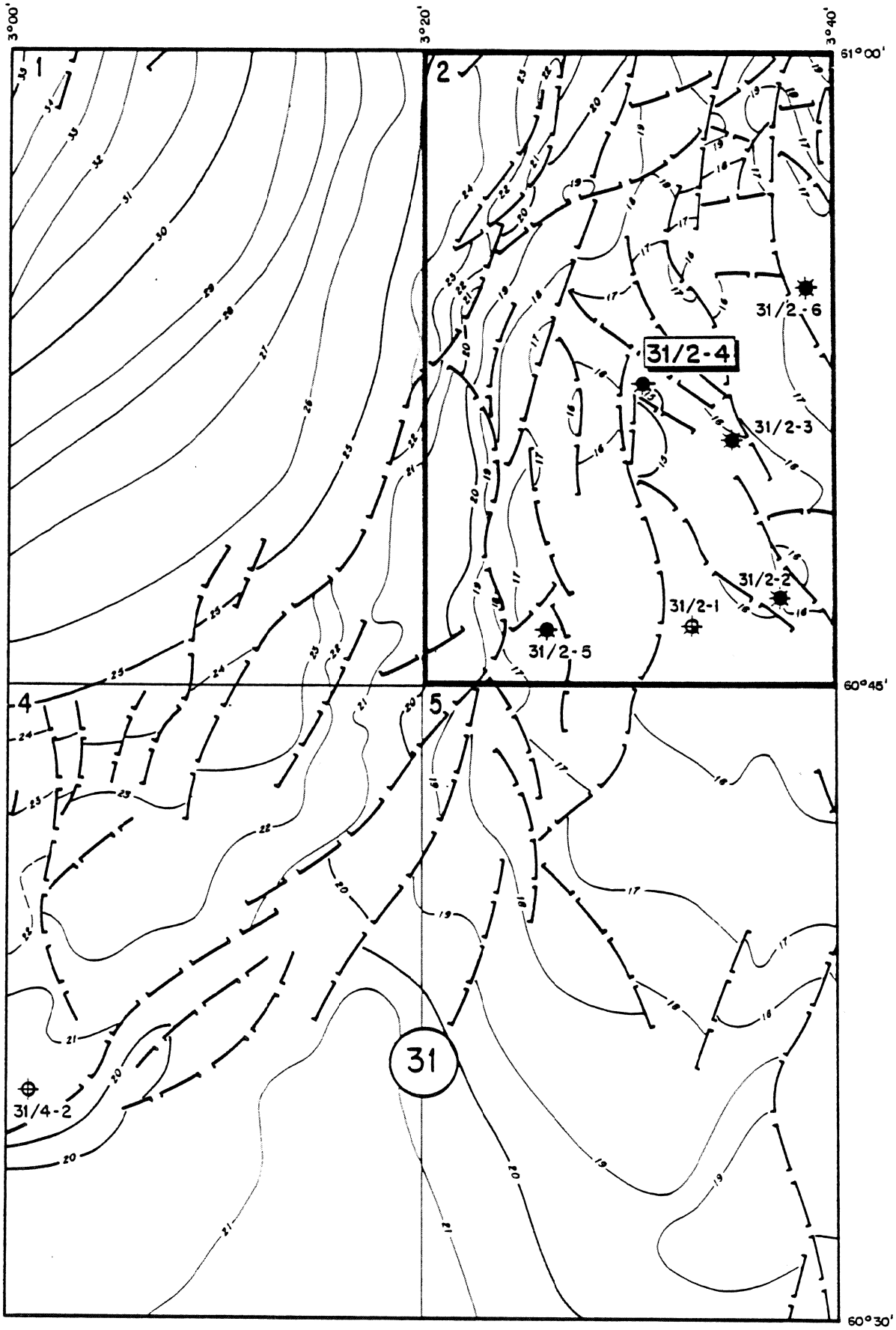


FIGURE 1

GENERAL LOCATION MAP

(Base Cretaceous play map 1: 250 000)

REPORT No.: EP-56203 DRAWING No.: G. 66257/1

Discussion

Palynofacies types IV/I from the lower part of this sequence are comparable to those observed from a similar interval in well 31/2-5 (see report EP-54927, sequence 1, p. 2). They indicate an offshore marine setting with relatively anoxic (stagnant) bottom water conditions. Sediments from this interval, although tending towards qualifying as source rocks (when maturity has been reached) are not as rich in structureless (sapropelic) organic matter relative to 31/2-5.

Palynofacies types V/VI towards the middle part of this sequence indicate a predominantly low energy offshore marine environment into which the larger terrestrial debris has been introduced possibly by occasional high energy storm action.

Palynofacies type IV from the upper part of the sequence indicates a similar offshore lower marine environment, in which storm processes were not effective.

Environmental interpretation

Upper part of the sequence	:	marine lower offshore
Lower part of the sequence	:	marine upper/lower offshore (storm activity)
Lowest part of the sequence	:	marine lower offshore, with some restriction of bottom water circulation.

SEQUENCE 2

Interval : 1861.1-1789.4 m

Age : ?Uncertain

Description

Palynofacies types XIII/XII from the lower and middle part of this sequence are characterized by the very high proportion of small, thin walled fern spores and bisaccate sporomorphs. In several samples the presentation is excellent.

Palynofacies type XI, at 1829.4 m, is characterized by small and medium sized equidimensional shaped material comparable to palynomaceral 4, together with large material comparable to palynomaceral 2. The low proportion of sporomorphs present are dominated by fern spores (thick walled) and species of *Calliasporites*.

Palynofacies type VIII in the upper part of the sequence is characterized by small sized material comparable to palynomacerals 4 and (occasionally rounded) 1. In the lower sample, at 1801.0 m a single species of *Escharisphaeridia* is very common.

All samples from this sequence (except at 1801.0 m) are barren of dinocysts.

Discussion (see figure 11)

Palynofacies types XIII/XII from the lower and middle part of this sequence indicate an enclosed lake/lagoon separated from the sea. The virtual absence of palynomacerals 1 and 2 suggest little direct fluvial input. A similar sequence is recognized in well 31/2-5 (report EP-54927, sequence 2, p. 3). In the latter sequence species of *Classopollis*, believed to have originated from a mangrove like plant (thus a coastal dweller) are also common together with rare dinocysts and marine algae. This may imply a more lacustrine setting for 31/2-4, relative to the lagoonal nature of 31/2-5.

Palynofacies type XI, at 1829.4 m, suggests a more dynamic environment such as associated with point bars and levees.

Palynofacies type VIII in the upper part of the sequence suggest a high energy, possibly a reworked deposit in a very shallow marine setting.

Environmental interpretation

Upper part of the sequence : shallow marine (?shoreface/embayment)

Lower part of the sequence : large lacustrine

SEQUENCE 3

Interval : 1773.0-1659.9 m

Age : Middle Bathonian-Middle Callovian

Description

Palynofacies types III and IV from the lower part of this sequence are characterized by high proportions of bisaccate and other buoyant sporomorphs, low proportions of small sized material of palynomacerals 1-3, and a moderate diversity (7-16 types) and frequency of dinocysts.

Palynofacies types V and VI from the upper and middle parts of the sequence show a gradual increase in the proportion and size of debris comparable to palynomacerals 1-3. Dinocysts are generally present and decrease in diversity towards the upper part of the sequence. (i.e. lower part 16-20 types; upper part 8-9 types). Some of the dinocyst assemblages in the upper part are dominated by one species of *Lunatodinium*.

Palynofacies type VII from the uppermost part of the sequence are characterized by a further reduction of dinocyst diversity (4-7 types), and proportion of bisaccate and other sporomorphs. Large material mainly comparable to palynomacerals 1 and 2 predominates.

Discussion

Sequence 3 of 31/2-5 (EP-54927) compares in general with the sequence described above. In detail, palynodebris from the middle part (P. V) is generally less well preserved and in the upper part smaller and more rounded. These two sequences almost certainly represent the same gradual progradation of a nearby terrestrial source. The nature of the debris preservation, however, would suggest the area of 31/2-4 to be more proximal to this source.

Environmental interpretation

Uppermost part of the sequence : shoreface (proximal to source)

Middle part of the sequence : marine upper offshore (proximal to source)

Lower part of the sequence : marine lower offshore

SEQUENCE 4

Interval : 1646.40-1575.70 m

Age : Middle Callovian

Description

Palynofacies from this interval are unusual in that they contain in the upper part a proportion of material comparable to a form of structureless organic matter. The remaining content resembles a palynofacies intermediate between palynofacies type IV and V. In the lower part of this sequence the debris is characterized by low to moderate proportions of material comparable to palynomacerals 2, 3, and to a lesser extent 1, together with a moderate proportion of bisaccate and other buoyant palynomorphs. A palynofacies type V/XI in the upper part of this sequence is characterized by a greater proportion of material comparable to palynomaceral 1. Dinocysts are diverse (13-25 types) and frequent in the lower part of the sequence, but apparently absent from the upper part.

Discussion

It is likely that two subsequences are represented. The lower subsequence suggests a progradation from offshore lower to offshore upper. The unusual nature of the organic material occurring in the upper subsequence may have resulted from the presence of oil in the sediments. The remaining palynodebris indicates a strong fluvial influence.

Environmental interpretation

Upper subsequence : ?offshore upper (fluvial dominated)

Lower subsequence : offshore lower

SEQUENCE 5

Interval : 1564.55-1521.06 m

Age : Middle-Late Callovian

N.B.

This interval has been studied in greater detail in order to provide further information and control as to the nature of microplankton and palynodebris association in a nearshore and offshore setting.

Description

Four subsequences can be recognized :

Subsequence 5d	:	1523.04-1521.06 m
Subsequence 5c	:	1529.95-1523.90 m
Subsequence 5b	:	1549.7 -1530.29 m
Subsequence 5a	:	1564.55-1552.03 m

Subsequence 5a

Palynofacies VI and VII characterize the lower part. Dinocysts are very infrequent but include, particularly towards the base of the subsequence *Hystrichogonyaolax cladophora, Pareodinia ceratophora, Sentusidinium rioultii, Chlamydophorella nov. sp. 1* (MORGENROTH) and *Sirmiodinium grossi*. Acritarchs and microforam test linings dominate the assemblage.

The upper part of the subsequence is characterized by palynofacies type IX. The only microplankton present is an unusual microplankton type ? dinocyst type B.

Subsequence 5b

The lower part from 1547.53-1545.2 is characterized by palynofacies IV. Bisaccate sporomorphs occur in high proportions throughout, together with a significant proportion of small palynomaceral 1. Dinocysts are frequent and characterized by *Nov. gen. G. sp. 1* (MORGENROTH), *Chlamydophorella rectilinea, ?Hystrichodinium sp., Nov. gen. B. sp.1&2* (DE HAAN), *Kalyptea diceras, Wanaea digitata, W. accollaris, Ctenidodinium ornatum, Sentusidinium rioulti, Lithodinia suturocomplexa, Tubotuberella apatela, Stephanelytron redcliffense, Hestertonia teichophora, Atopodinium prostratum, Escharisphaeridia fondugranulado, Scriniodinium luridum, Gonyaulacysta eisenackii, Sentusidinium pilosum, Sirmiodinium grossi* and *Veryhachium spp.*

The middle part is characterized by palynofacies type V^B and the uppermost part V. Palynomacerals 2 and 3 in palynofacies V^B are particularly affected by bacterial activity consequent with bioturbation, resulting in a very typical 'frayed' appearance. Dinocysts are very frequent and characterized by abundant *H. cladophora, P. ceratophora, Valensiella cf. vermiculata, Lithodinia nov. sp. 1* (MORGENROTH), *C. rectilinea, Mendicodinium woodhamensis, Lithodinia sp. 4/6* (DE HAAN), together with *V. vermiculata* and *Occisucysta filipicata.* The dinocyst diversity is reduced in the uppermost part associated with palynofacies V.

The upper part is characterized by palynofacies type IX^R in which the palynodebris is commonly small sized and rounded material comparable to palynomaceral 1. Bisaccate sporomorphs become conspicuous towards the top of the subsequence. Dinocysts are virtually absent towards the base. The uppermost samples, however, contain *H. cladophora, V. cf. vermiculata, H. cf. cladophora, C. rectilinea*, together with *S. pilosum, M. woodhamensis, Ellipsoidictyum cinctum* and *T. apatela.*

Subsequence 5c

The lowermost part is characterized by palynofacies type IV. Bisaccate and other buoyant sporomorphs occur in high proportions together with a moderate proportion of small sized material comparable to palynomacerals 1, 2 and 3. Dinocysts are frequent and include the common occurrence of *H. cladophora, M. woodhamensis* and *E. sp. 10* (DE HAAN), together with *P. ceratophora, Nannoceratopsis pellucida, E. fondugranulado, E. accollaris, T. apatela, H. regale, A. prostatum* and *Cleistospheridium lumectum.*

The remaining lower and middle part of this sequence is characterized by palynofacies type V^B. The larger material comparable to palynomacerals 2 and 3 present in this sequence is characterized by its 'frayed' appearance which is most likely associated with bacterial activity caused by bioturbating infauna. Dinocysts are frequent and include *H. cladophora, Occisucysta filipicata, Escarisphaeridia spp. (psilate), Escarisphaeridia sp. 10* (DE HAAN), *Valensiella vermiculata* and *Sentusidinium rioulti.*

The upper part of the sequence is characterized by palynofacies types VI and VII. Sporomorphs occur rarely and large sized material comparable to palynomaceral 1 and 2 dominates. Dinocysts are present and include the common occurrence of *H. cladophora* and *O. filipicata*, together with *Cassiculosphaeridia spp.* and *Parvocavatus sp. 1* (DE HAAN).

Subsequence 5a

The lower part is characterized by palynofacies IV. Moderate and high proportions of bisaccate and other buoyant sporomorphs, a moderate proportion of small sized material comparable to palynomacerals 1, 2 and 3 together with often rich dinocyst assemblages occur. These assemblages include the common occurrence of *S. divavica, T. apatela* and *Nov. gen G nov. sp. 1* (MORGENROTH), together with *Lanterna spp., Cleistosphaeridium lumectum, Prolixosphaeridium analissum, P. capitatum, L. suturocomplexa, P. ceratophora, Heslertonia teichophera, Stephanelytron redcliffense, Pareodinia verrucosa, S. luridum, S. rioulti, Veryhachium spp.* and *H. cf. cladophora.*

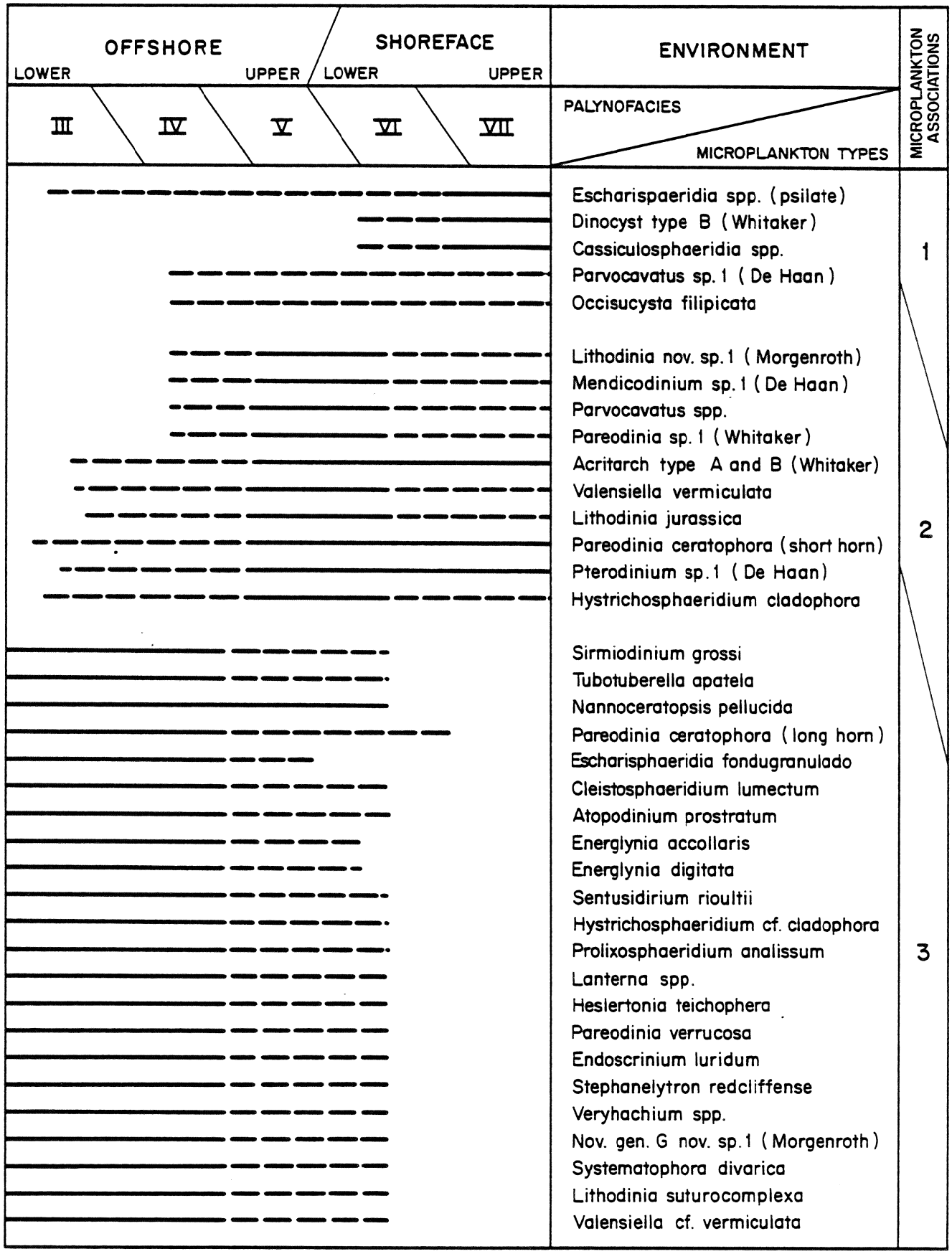
The upper part is characterized by palynofacies type V. Dinocysts include the common occurrence of *H. cladophora* and *Lithodinia nov. sp. 1* (MORGENROTH), together with *Mendicodinium sp. 1* (DE HAAN), *Parvocavatus spp., Pareodinia sp. 1* (WHITAKER), *Pterodinium sp. 1* (DE HAAN), *V. vermiculata, Lithodinia jurassica* and acritarchs.

The uppermost part is characterized by palynofacies IX^R, containing rounded small sized material of palynomacerals 1 and 2, together with bisaccate and other buoyant sporomorphs. Dinocysts include *M. woodhamensis, E. cinctum, S. rioulti, Chamydophorella sp. 1* (WHITAKER) and microforam test linings.

Discussion

The nature of the palynodebris and the general character of the microplankton suggests subsequence 5a to represent a brackish water, fluvial dominated setting. Subsequences 5b, c & d indicate a more fully marine environment with a gradual progradation from an offshore lower to offshore upper setting. Near the top of each subsequence rounded debris comparable to palynomaceral 1 in association with occasional bisaccate sporomorphs and dinocysts suggest a period of deepening with a reduced input of terrestrial material resulting in gentle reworking of previously deposited organic debris.

In subsequences 5b, c and d a pattern can be recognized in the development of the microplankton. The lower parts, particularly in subsequences 4b and 4 d associated with palynofacies type IV are characterized by a similar composition of microplankton which will be provisionally referred to as the "Norway Microplankton Association 1 (NMA1)". The middle parts of subsequences 5b and 5d, together with the lower part of subsequence 5c, associated with palynofacies type V^B and V, are characterized by *H. cladophora* and will be referred to as "Norway Microplankton Association 2 (NMA2)". The upper parts are characterized by an association dominated by *Cassiculosphaeridia* or dinocyst B, to be referred to as "Norway Microplankton Association 3 (NMA3)"



MICROPLANKTON ASSOCIATIONS RECOGNISED WITHIN THE CALLOVIAN INTERVAL OF 31/2-4 AND THEIR ENVISAGED ENVIRONMENTAL DISTRIBUTION.

Fig. 2

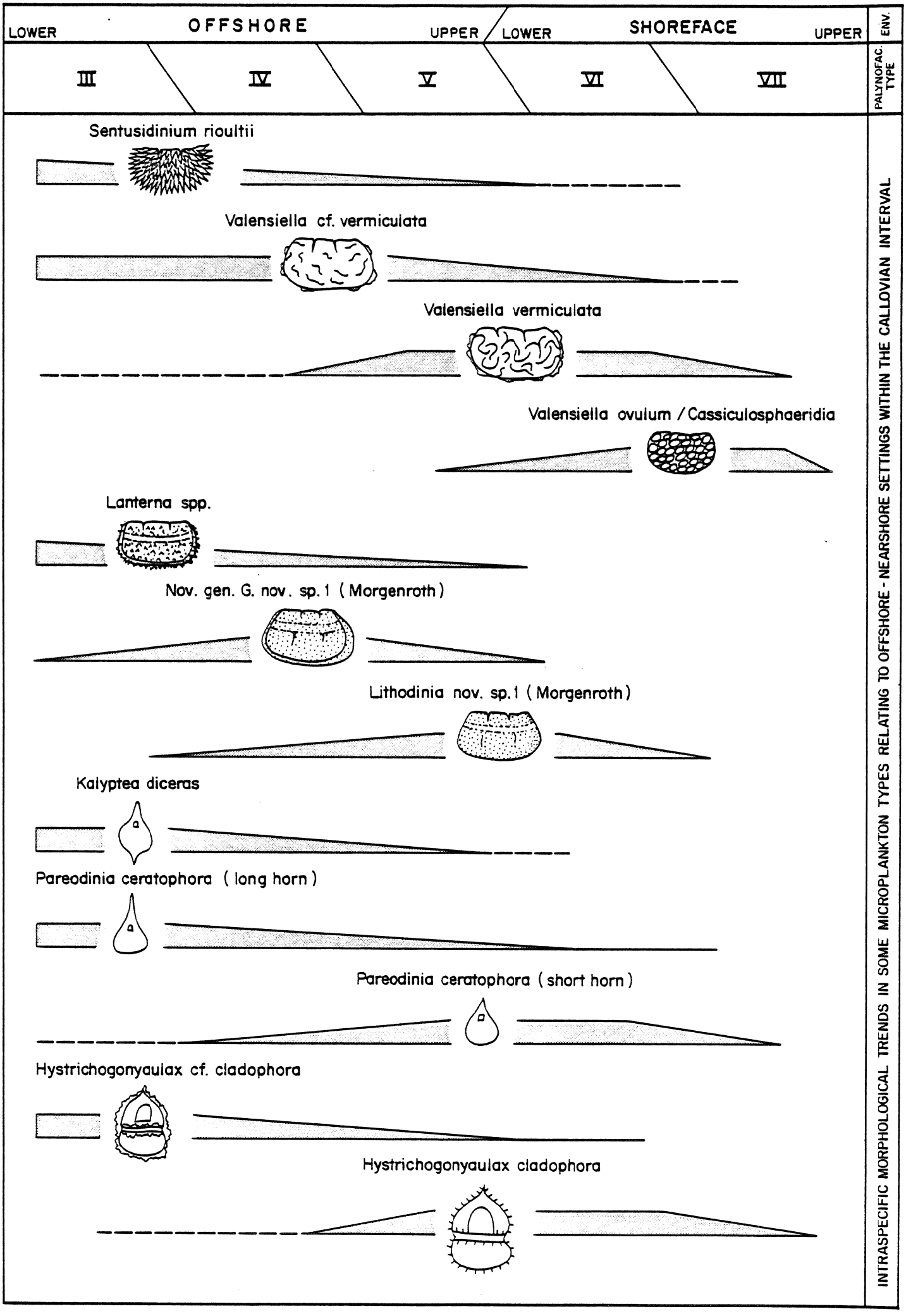


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Fig. 3

These associations suggest that they are related to the changing environmental conditions during the progradation of a shoreline. They have also been recognized from a study, collating data from all wells drilled in the 31/2-block, together with a consideration of the microplankton distributions known from other areas in the Northern North Sea during Callovian times (see fig. 2).

These associations also indicate several gradual morphological changes in closely allied types which appear to relate to an offshore-inshore trend (see fig. 3).

The dinocyst content also compares very well with sequence 5 as described in 31/2-5. Subsequence 5b of 31/2-4 has a very similar dinocyst assemblage to that of the interval 1721.0 -1700.0 m in 31/2-5. In contrast similar stratigraphic intervals in 31/2-2 and -3 show a significant increase in the proportion of large equidimensional, darkened almost black material comparable to palynomacerals 1 and 4, together with a reduction of the more buoyant constituents and dinocyst diversity. This clearly indicates a more coastal setting in these areas.

Environmental interpretation

Three of these subsequences 5b, c and d, each suggest the following prograding sequence :

Upper part	:	marine incursion (little terrestrial input)
Middle part	:	offshore upper (lower shoreface)
Lower part	:	offshore lower
Subsequence 5a	:	brackish water, fluvial dominated.

SEQUENCE 6

Interval : 1518.2-1493.90 m

Age : Late Callovian

Description

Palynofacies from the lower shalier part of the sequence are intermediate between palynofacies type V^B and IV^B. They are characterized by high or moderate proportions of bisaccate and other buoyant sporomorphs, together with increasing amounts of small sized material comparable to palynomacerals 2, 3 and then 1.

Preservation suggests bacterial activity. A minor proportion of small and medium sized blade shaped material comparable to palynomaceral 4 is also present.

Palynofacies types V and VI from the upper part of the shalier interval are characterized by high proportions of large and small sized material comparable to palynomacerals 1, 2, 3 and 4. Bisaccates and other sporomorphs occur only in very low proportions. Preservation is medium to good. Dinocysts are diverse (8-28 types) and frequent.

Discussion

The above sequence of palynofacies suggests a gradual progradation from offshore lower/upper to an offshore upper environment which is fluvial dominated. This sequence represents a slightly more proximal equivalent of the lower part of sequence 6 from 31/2-5 but a more offshore position relative to equivalent strata in 31/2-3.

Environmental interpretation

Upper part of the sequence : offshore upper, fluvial dominated

Lower part of the sequence : offshore lower/upper

SEQUENCE 7

Interval : 1487.1-1415.90 m

Age : Early Oxfordian

Description

Palynofacies V and VIII from the lower more fine grained sediments of this sequence are characterized "bleached" medium and small sized material comparable to palynomacerals 1 and 2. Bisaccates and other sporomorphs occur only in small proportions. Preservation is generally poor.

The upper part of the sequence containing fine grained sediments include palynofacies types V and IV. These are characterized by a high proportion of poorly preserved bisaccate and other buoyant sporomorphs, including abundant small featureless palynomorphs comparable to dissociated microforam chambers or leiosphaeroids. These latter constituents also characterize basal Early Oxfordian sediments in adjacent wells. Dinocysts are of low/moderate diversity (10-15 types) and of low/moderate frequency.

Palynofacies from the upper sandy part of this sequence are of three types VII/VI, IX and IV/III, and are all characterized by a high proportion of material comparable to palynomaceral 4.

Discussion

The sequence in general appears to represent a series of deposits related to the onset of transgressive conditions at the start of the Early Oxfordian, a feature recognized regionally in the 31/2-block and other areas of the North Sea.

The lower part of the sequence is represented by an upper offshore fluvial dominated setting, continuous with the progradation established in the upper part of the previous sequence. The higher energy conditions now established due to perhaps the transgressive setting, is the most likely explanation for the bleached material occurring in this part of the sequence. In the middle part of the sequence progressively more offshore conditions are established (see fig. 4).

The occurrence of palynofacies type VII^T in the basal unit from the upper sandy part of the sequence (i.e. lower part of the "Good Reservoir Sands") suggests a (lower) shoreface environment some distance away from any direct fluvial influence.

Palynofacies IX^T, in the uppermost part of this sequence, indicates extremely high oxidizing conditions, most likely due to high energy. This is suggested by the angular, sharp character to the opaque material (palynomaceral 4), indicating fragmentation of the prior blade opaque material in the palynofacies VII^T, below. Within the base of this unit occurs a finer grained clast deposit characterized by palynofacies III.

A similar sequence of palynofacies types can be recognized in the "Good Reservoir Sands" of the well 31/2-5. These palynological characteristics when considered in relation to palynofacies from other adjacent wells suggest the following environmental setting : a progradation established during Late Callovian times in the upper part of sequence 6 continues into the basal part of the present sequence 7. In earliest Oxfordian times, at the base of sequence 7, however, high energy conditions are established at the sea bottom, perhaps associated with a transgression. These sediments are then onlapped by sediments characterized by more offshore palynofacies. A further progradation follows, represented in the basal part of the "Good Reservoir Sands" by a lower shoreface facies wedging out towards the east in the area of 31/2-5. Overlying this progradation and probably cutting down into the unit are sediments characterized by palynofacies IX^T. These represent a series of highly reworked deposits laid down during a marked transgressive pulse during the middle part of Late Oxfordian times. The sands may have been derived in part from the underlying sediments and in part from a lateral transport of sands deflected from coastal erosion.

DETAIL OF THE PALYNOFACIES SEQUENCES 6 AND 7

Fig. 4

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Environmental interpretation

Uppermost part of the sequence ("Good Reservoir Sands") : very strong oxidizing conditions, possibly associated with a transgressive period.

Upper part of the sequence ("Good Reservoir Sands") : shoreface lower ? some distance from any fluvial influence

Middle part of the sequence (finer grained sediments) : offshore lower, increasing energy at sea bottom

Lower part of the sequence (finer grained sediments) : offshore upper, fluvial dominated, high energy sea bottom conditions

SEQUENCE 8

Interval : 1413.13-1381.9 m

Age : Late Oxfordian

Description

Much of this sequence is characterized by palynofacies intermediate between palynofacies types IV and V^T. They include high proportions of blade shaped material comparable to palynomaceral 4, together with a moderate proportion of bisaccate and other buoyant sporomorphs. Poorly preserved material comparable to palynomacerals 1 and 2 occurs only in low proportions.

Towards the upper part of the sequence there is an increase in the proportion of palynomaceral 4.

Dinocysts are diverse (17-33 types) and frequent. The assemblages are often dominated by thick-walled species of *Lithodinia* and other closely related types.

Discussion

The lower part of the sequence represents a continuation of the Late Oxfordian transgression. The above palynofacies suggest an environment some distance away from any direct terrestrial input of organic matter and with normal offshore marine physico-chemical water properties. The common occurrence of thick-walled *Lithodinia* like dinocysts suggest shallow water conditions.

Environmental interpretation

Shallow marine water conditions in an offshore setting, some distance from any direct terrestrial input.

SEQUENCE 9

Interval : 1379.2-1369.3 m

Age : Late Oxfordian-Kimmeridgian

Description

Two subsequences involving palynofacies types IV, V^T, VI^T and VII^T may be recognized in this sequence. Each of these palynofacies types is characterized by a high proportion of blade material comparable to palynomaceral 4 (hence designation ^{T}). Poorly preserved and often rounded material comparable to palynomacerals 1, 2 and 3 occur only in low proportion.

In palynofacies V^T bisaccate and other buoyant sporomorphs are present in moderate or low proportions. Dinocysts are generally present, and are moderately diverse.

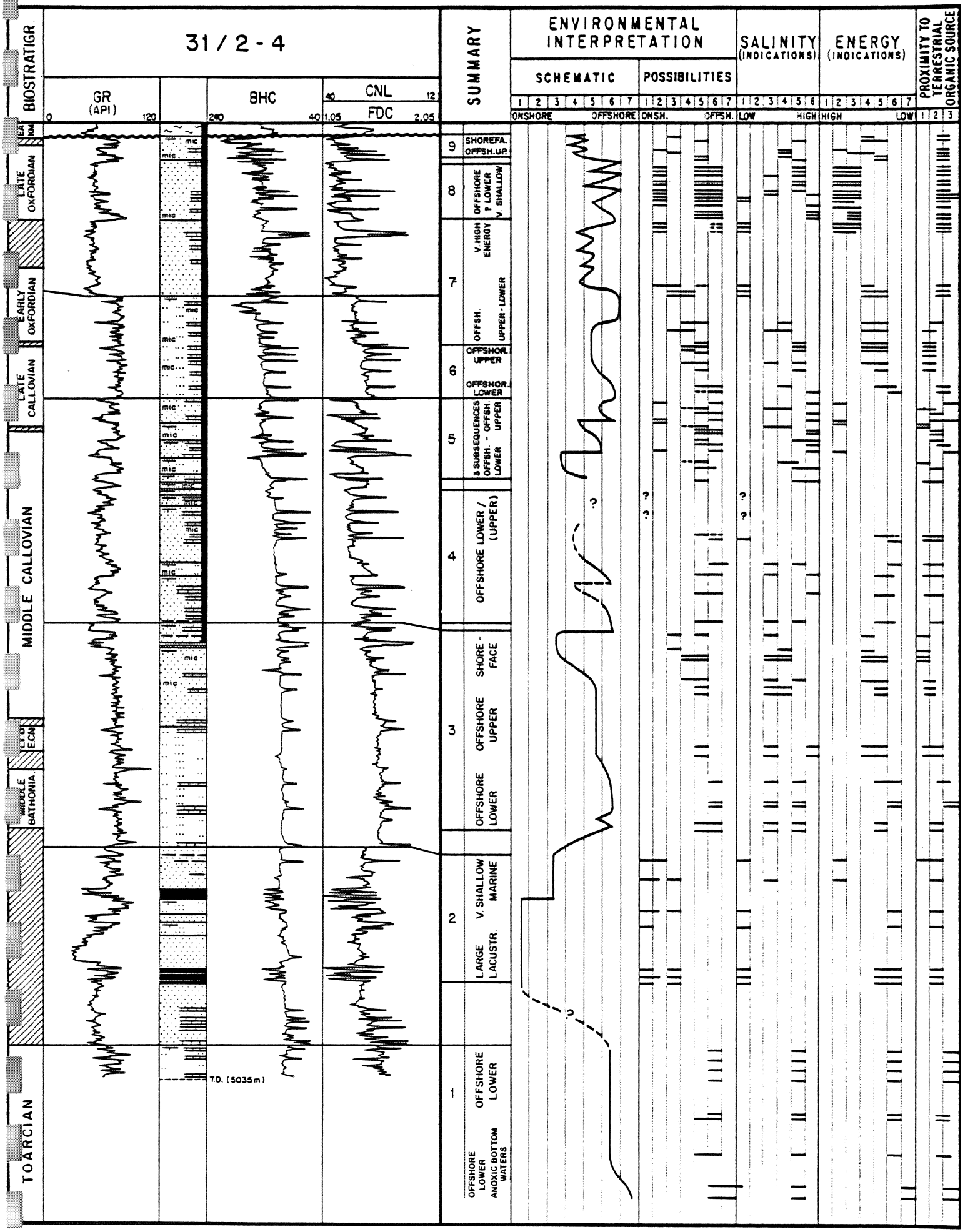
Discussion

The above palynofacies suggests in general a similar environmental setting to sequence 7. There is, however, a minor increase in the proportion of palynomacerals 1 and 2, particularly in the palynofacies types V^T, VI^T and VII^t, which suggests the distant effects of a terrestrial source of organic material. This closer proximity to a river mouth area is further suggested by the lower diversity of dinocysts.

Environmental interpretation

Upper subsequence : offshore upper - shoreface (more proximal to river mouth)

Lower subsequence : offshore lower - shoreface (lateral to a river mouth)



PALYNOFACIES SEQUENCES AND THEIR
SUMMARIZED ENVIRONMENTAL INTERPRETATION IN 31/2-4

Fig. 5

3. CONCLUSIONS

By applying principles described in report EP-53031, the following general environmental interpretation of the Jurassic (post-Pliensbachian) interval of the Norske Shell well 31/2-4 is suggested (see fig. 5).

Eight palynofacies sequences can be recognized, which are shown to represent a series of prograding units.

- Sequence 1 approximately corresponds with the Toarcian interval. The basal part of this sequence was probably deposited in a marine lower offshore environment, with restricted circulation at the sea bottom. Towards the upper part of the sequence circulation at the sea bottom improved, possibly due to shallowing, followed in the uppermost part by the distant approach of a terrestrial source of organic material.

- Sequence 2 probably represents in part the Aalenian/Bajocian interval. Palynofacies from the finer grained sediments in the lower part of this sequence indicate a large lacustrine environment. In the uppermost part a marginal marine, perhaps embayment or lagoonal environment is suggested.

- Sequence 3 of Bathonian age represents a gradual progradation from lower offshore to a shoreface close to the mouth of a distributary. This sequence almost certainly represents an intermediate situation between the more offshore equivalent sequence 3 of 31/2-5 and the corresponding more proximal and coastal equivalents from the Bathonian intervals in 31/2-3 (sequences 3 and 4) and 31/2-2.

- Sequence 4 of Middle Callovian age indicates in the lower part a lower offshore environment, and represents a more distal setting relative to equivalent sequences in 31/2-3 (sequence 5) and 31/2-2 (1772.0-1780.0 m). The upper part, however, suggests more influence from a river mouth.

- Sequence 5 of Middle and Late Callovian age can be subdivided into four subsequences, three of which represent a progradation from a setting intermediate to lower and upper offshore in the lower part, to offshore upper, possibly lower shoreface in the upper part. The uppermost part of each subsequence represents a period of reworking and probably relates to a period when active deposition switched from the site of 31/2-4 to another area. The fourth and basal subsequence indicates a brackish water, fluvial dominated environment.

- Sequence 6 of Late Callovian age represents a progradation, in its lowermost part, from lower offshore to upper offshore which then continues for much of the remaining lower sequence.

- Sequence 7 of Early Oxfordian age represents a gradual return to more offshore conditions, and probably relates to the regional transgression recorded in the adjacent wells of the 31/2-block and other North Sea areas during the Late Callovian/Early Oxfordian.

  The upper part of this sequence includes the sediments known as the "Good Reservoir Sands". The lower part of this unit contain palynofacies which indicate a lower shoreface depositional setting some distance away from any major source of terrestrial organic material. The upper part of this unit is a highly reworked sand, probably forming part of the basal deposits of the Late Oxfordian transgression.

- Sequence 8 of Late Oxfordian age represents in its lower part a relative deepening in a high energy offshore setting. The upper part probably represents a lower shoreface setting, but some distance away from any fluvial influence.

- Sequence 9 of Late Oxfordian and Early Kimmeridgian age indicates deposition in an environment similar to sequence 8 but with a minor influence of organic material from a terrestrial source.

In general, the palynofacies for many of the prograding sequences, i.e. 1, 3, 4, 5, 6 and 8, suggest an intermediate position relative to those of their equivalent more coastal sequences observed in 31/2-2, -3 and -6, and the generally offshore sequences in 31/2-5. There is perhaps a greater comparison with palynofacies from 31/2-5. This is particularly true for the reservoir sand intervals from the upper part of sequence 7 and those of sequences 8 and 9.

4. REFERENCES

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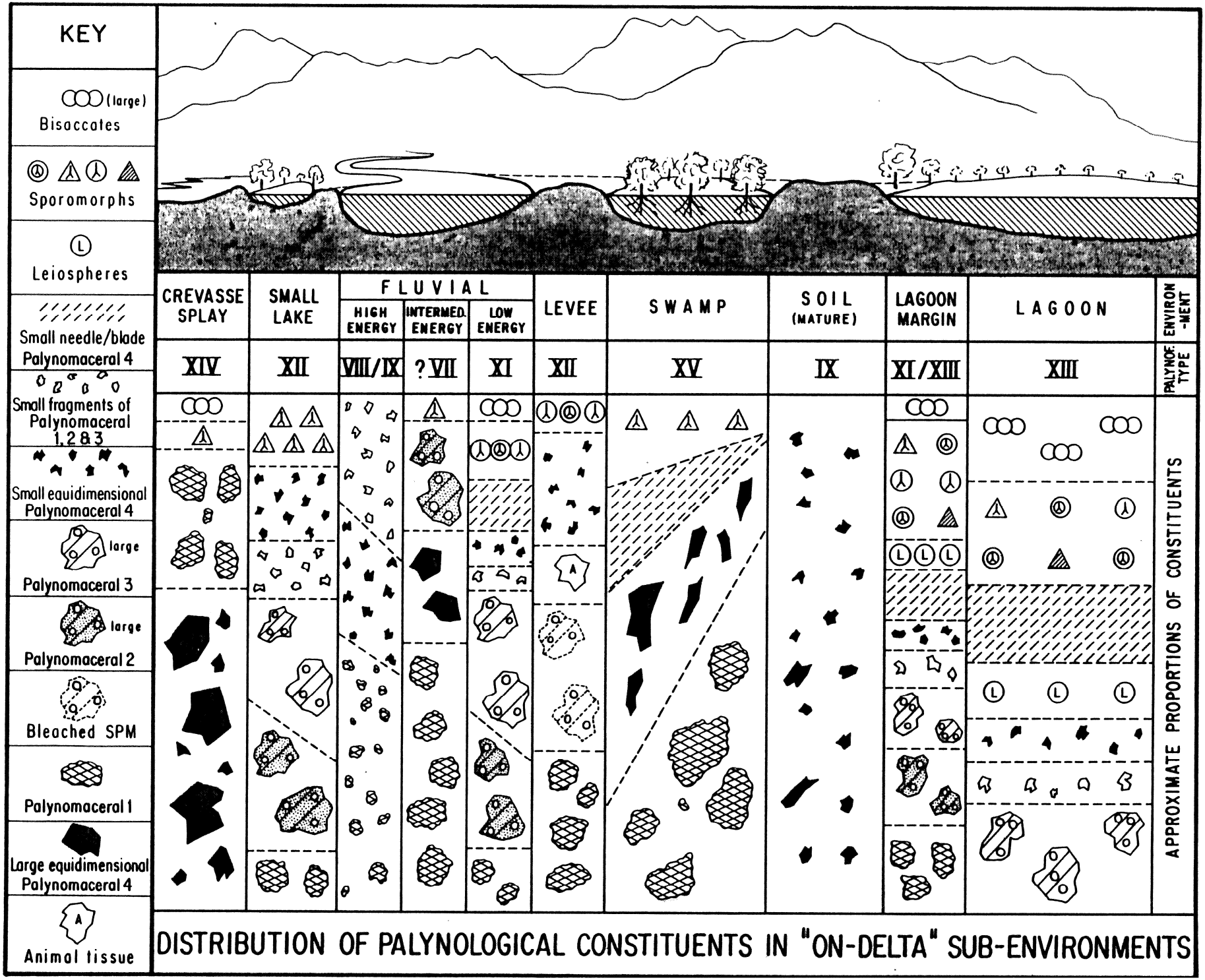
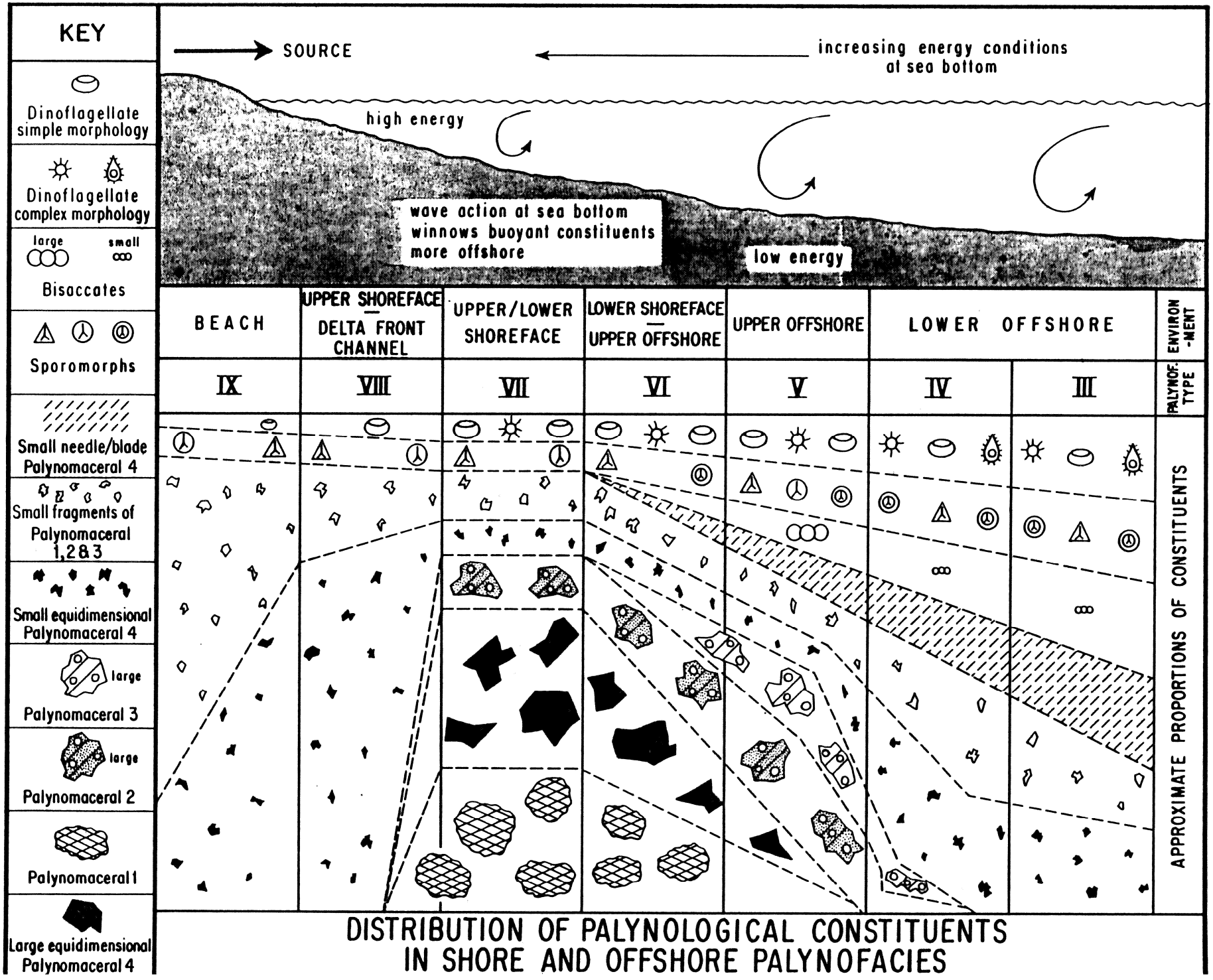


FIGURE 6

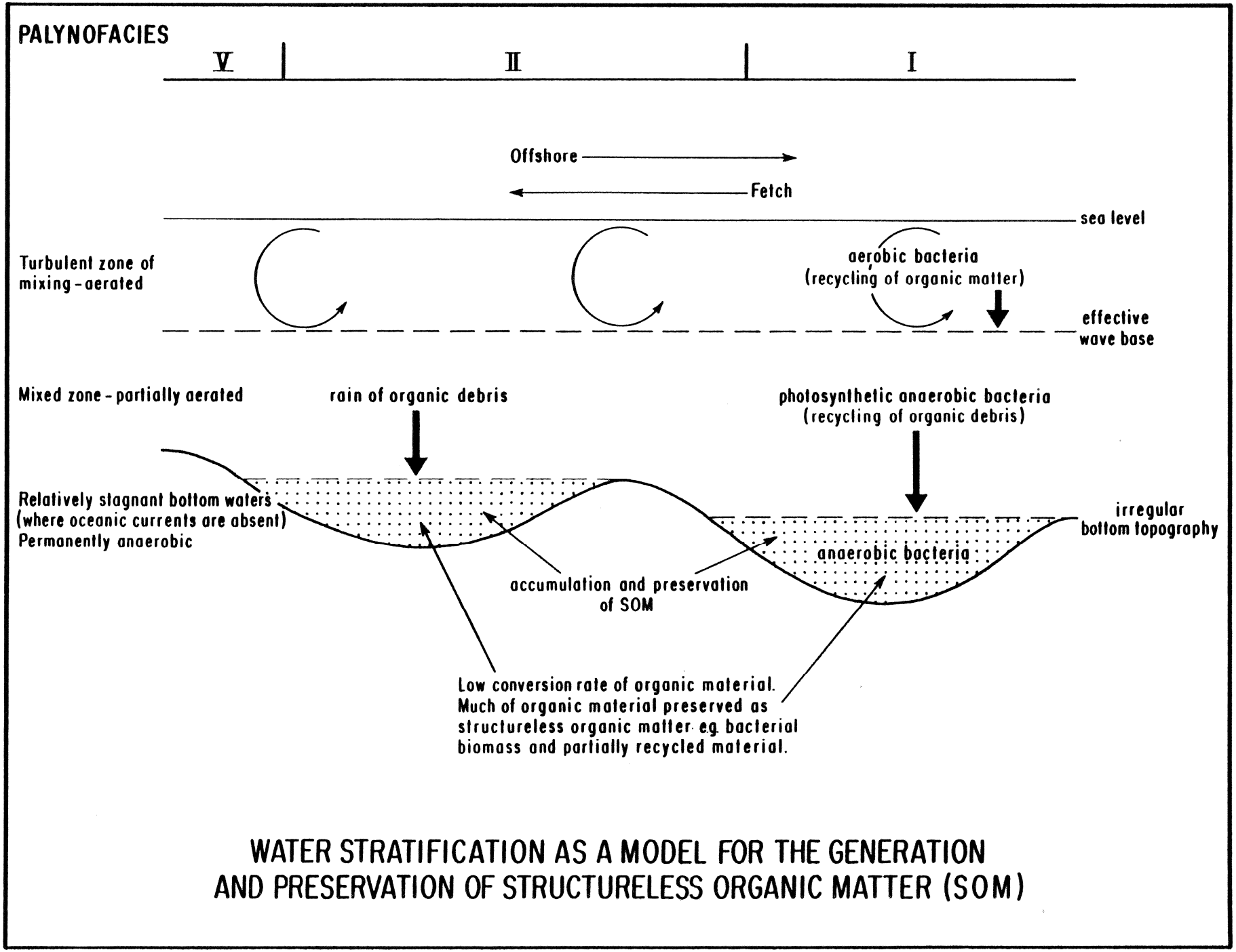
REPORT Nº EP56203 DRAWING Nº G.66257/6



DISTRIBUTION OF PALYNOLOGICAL CONSTITUENTS IN SHORE AND OFFSHORE PALYNOFACIES

FIGURE 7

REPORT Nº EP 56203 DRAWING Nº G.66 257/7



WATER STRATIFICATION AS A MODEL FOR THE GENERATION AND PRESERVATION OF STRUCTURELESS ORGANIC MATTER (SOM)

FIGURE 8

REPORT Nº EP56203 DRAWING Nº G.66 257/8

ORT 56 2C DRA No.: G. /9

Stratigraphy	Sample depth	Type	Miscellaneous Total	SOM Semi-SOM Total	SOM Small/Darkened Total	SOM Large clusters Total	SOM Undifferent. Total	Marine palynomorphs Degradation	Marine palynomorphs Broken	Microf. testlinings Total	Marine algae Total	Acritarchs Spinose Total	Acritarchs Leiosph. Large	Acritarchs Leiosph. Small	Dinocysts No. dom. types	Dinocysts Diversity	Dinocysts Total	Terrestrial palynomorphs Degradation	Terrestrial palynomorphs Broken	Bisaccates Large	Bisaccates Medium	Bisaccates Small	Bisaccates Undifferentiated*	Fresh water algae Total	Fungal spores Total	Sporomorphs (non-specified) Non-buoyant	Sporomorphs Buoyant	Sporomorphs No. of dominants	Sporomorphs Diversity	Sporomorphs Undifferentiated*	Palynomaceral 4 Blade needle Large	Palynomaceral 4 Blade needle Medium	Palynomaceral 4 Blade needle Small	Palynomaceral 4 Blade needle Undifferent.*	Palynomaceral 4 Equi-dimen. Large	Palynomaceral 4 Equi-dimen. Medium	Palynomaceral 4 Equi-dimen. Small	Palynomaceral 4 Equi-dimen. Undifferent.*	Palynomaceral 1,2&3 Degradation	Palynomaceral 1,2&3 Rounding	Palynomaceral 3 Large	Palynomaceral 3 Medium	Palynomaceral 3 Small	Palynomaceral 3 Undifferentiated*	Palynomaceral 2 Large	Palynomaceral 2 Medium	Palynomaceral 2 Small	Palynomaceral 2 Undifferentiated*	Palynomaceral 1 Large 100+	Palynomaceral 1 Medium 50-100	Palynomaceral 1 Small 0-50	Palynomaceral 1 Undifferentiated*	Palynofacies type	Environmental interpretation
EARLY KIMME.	1369.30	C								1						L	>1	P	C				2								25	25	10		1	10	10		P	C										8	8		VII^T	Shoreface
LATE OXFORD.	1371.10	C														L	1	P	C				8			1	1		L		20	20	5			9	10		M	M										5	20		VI/V^T	Shoreface lower
" "	1373.80	C														L		P	C																		90		P	C											10		IX	Strong oxidizing condit.
" "	1375.60	C														L		P	C				2							1		40	20			10	15		P	M										2	10		VII^T	Shoreface ?
" "	1375.60	C																																																				
" "	1378.00	C																																																				
" "	1379.20	C														L	1	P	C			10								1	5	25	20			3	15		P	R										5	15		V/VI	Offshore upper / Shoreface lower
" "	1381.90	C														L	1	P	C			10								1	5	25	20			3	15		P	R										5	15		V/VI	"
" "	1384.60	C														H	5					15				1	5					25	5				5		P	R											5		IV/V	Offshore lower/upper
" "	1386.60	C								1						M	1														1	30	30			2	30		P	C											5		IV/VI	" " "
" "	1395.40	C														M	3					10				1	3				5	20	20			10	20		P	C										2	8		IV	Offshore lower
" "	1399.50	C								1						H	1	M	M		5	10				2	8					20	20		1	20	20		M	M							2			2	8		IV	" "
" "	1404.90	C														L	<1																35				55		P	C											10		IX (IV)	High energy, probably
" "	1409.40	C														H	1	M	C		5	10				2	8					10	20			10	15		P	M							2			3	15		V/IV	Shallow water, some
" "	1410.00	C								1						H	2	M	M	5	5	20				2	8					2	15				15		P	M							2			10	15		V/IV	distance from a
" "	1413.13	C								1						M	1					10				2	3					17	20		2	10	20		P	C									2	2	8		IV (VII?)	terrestrial source
" "	1415.90	C																																		?	50		P	C										?	50		IX	" "
" "	1417.30	C																																		10	40		P	C											50		IX	" "
" "	1419.10	C																																		?	50		P	C										?	50		IX	" "
" "	1420.90	C																																		?	50		P	C										?	50		IX	" "
" "	1422.70	C																																			30		P	C									10	10	50		IX (VII)	" "
" "	1440.40	C														H	2					25					10					15	17			10	10		P	C											5		III/IV	? Offshore lower
" "	1442.20	C														H	2					25					10					15	17			10	10		P	C											5		III/IV	" "
EARLY OXFOR.	1444.00	C								1							1					10					5						40				40		P	C											5		VII/VI	" "
" "	1446.70	C							?	1						?	1				?	10				?	5					?	40			?	40		P	C										?	5		VII	" "

NORWAY · WELL 31/2-4 - DISTRIBUTION OF PALYNOLOGICAL CONSTITUENTS - TABLE 1

ORT N 5520 DRA o.: G / 10

STRATIGRAPHY	SAMPLE DEPTH	TYPE	MISCELLANEOUS	SOM				MARINE PALYNOMORPHS (ORGANIC WALLED)								TERRESTRIAL PALYNOMORPHS										DEBRIS OF MAINLY PLANT ORIGIN																				PALYNOFACIES TYPE	ENVIRONMENTAL INTERPRETATION
				SEMI - SOM	SMALL / DARKENED	LARGE CLUSTERS	UNDIFFERENT.	MARINE PALYNOMORPHS		MICROF. TESTLININGS	MARINE ALGAE	ACRITARCHS		DINOCYSTS			TERRESTRIAL PALYNOMORPHS	BISACCATES				FRESH WATER ALGAE	FUNGAL SPORES	SPOROMORPHS (NON-SPECIFIED)				PALYNOMACERAL 4								PALYNOMACERAL 1,2&3		PALYNOMACERAL 3				PALYNOMACERAL 2				PALYNOMACERAL 1					
												SPINOSE	LEDIOSPH.														BLADE NEEDLE				EQUI-DIMEN.																	
			TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	DEGRADATION	BROKEN	TOTAL	TOTAL	TOTAL	LARGE	SMALL	No. DOM. TYPES	DIVERSITY	TOTAL	DEGRADATION	BROKEN	LARGE	MEDIUM	SMALL	UNDIFFERENTIATED*	TOTAL	TOTAL	NON - BUOYANT	BUOYANT	No. OF DOMINANTS	DIVERSITY	UNDIFFERENTIATED*	LARGE	MEDIUM	SMALL	UNDIFFERENT.*	LARGE	MEDIUM	SMALL	UNDIFFERENT.*	DEGRADATION	ROUNDING	LARGE	MEDIUM	SMALL	UNDIFFERENTIATED*	LARGE	MEDIUM	SMALL	UNDIFFERENTIATED*	LARGE 100+	MEDIUM 50-100	SMALL 0-50	UNDIFFERENTIATED*		
EARLY OXFOR.	1455.10	C															P	C			?	5								20	20			15	30		P	C										5		IX	
"	1457.80	C								1					M	2						5								8	10		10	20	20		P	C									5	10	10		VII/VI	Shoreface lower
"	1459.25															1						22			40					5	5				5		G		1	1	10		1	2	1				5		IV	Offshore lower
"	1459.40															1						22			40					5	5				5		G		1	1	10		1	2	1				5		IV	"
"	1465.90	C						P	C	1					M	<1	P	C				1							1	8	10		6	6	10		P	M	2	2	2		5	10	10		10	10	10		V	Offshore upper
"	1479.10	C						P	C						M	1	P	C				1							5	1	5		1	2	5		P	M	1	1	1		5	10	20		5	20	20		V	"
"	1481.15	C						P	C						M	1	P	C				1							5	1	4			2	3				1	1	1		5	13	20		5	20	20		V	"
"	1483.50	C													M	1	P	C	3	3	4			2	8				1	4		6	5	5		M	R		1	1		5	5	10		5	20	20		V	"
"	1485.30	C													M	1	M	M	5	3	2								5		10				10		G	R		1	1		1	5	15		2	5	15		V	"
"	1487.10	C													L	1						5							?2	1							P	C	1	1	1		8	10	25		8	20	25		V	"
CALLOVIAN	1493.90	C		BARREN ?											L																																		IX	Strong oxidizing condition
"	1498.40	C													M	1	M	M	2	2	2			3	3				1	2				2				2	4	5		8	10	15		8	15	20		V	Offshore upper
"	1502.90	C													M	1				2	10								6	1	2				2		P	M	2	4	5		8	10	15		8	15	15		V	"
"	1509.20	C													M	1				2	5								15										1	4	6		2	10	17		2	15	21		V	"

LEGEND :

DIVERSITY
- V. LOW : L
- MEDIUM : M
- V. HIGH : H

No. OF DOMINANTS
- 1, 2, 3 etc.

DEGRADATION
- POOR : P
- MEDIUM : M
- GOOD : G
- CARBONIZED : B

BROKEN
- V.COMMON : C
- MEDIUM : M
- RARE : R

ROUNDING
- V. COMMON : C
- MEDIUM : M
- RARE : R

NORWAY · WELL 31/2-4 - DISTRIBUTION OF PALYNOLOGICAL CONSTITUENTS - TABLE 2

Stratigraphy	Log depths	Type	Miscellaneous: Total	SOM: Semi-SOM Total	SOM: Small/Darkened Total	SOM: Large Clusters Total	SOM: Undifferent. Total	Marine Palynomorphs: Degradation	Marine Palynomorphs: Broken	Microf. Testlinings: Total	Marine Algae: Total	Acritarchs Spinose: Total	Acritarchs Leiosph.: Large	Acritarchs Leiosph.: Small	Dinocysts: No. Dom. Types	Dinocysts: Diversity	Dinocysts: Total	Terrestrial Palynomorphs: Degradation	Terrestrial Palynomorphs: Broken	Bisaccates: Large	Bisaccates: Medium	Bisaccates: Small	Bisaccates: Undifferentiated*	Fresh Water Algae: Total	Fungal Spores: Total	Sporomorphs (non-specified): Non-Buoyant	Sporomorphs: Buoyant	Sporomorphs: No. of Dominants	Sporomorphs: Diversity	Sporomorphs: Undifferentiated*	Palynomaceral 4 Blade Needle: Large	Palynomaceral 4 Blade Needle: Medium	Palynomaceral 4 Blade Needle: Small	Palynomaceral 4 Blade Needle: Undifferent.*	Palynomaceral 4 Equi-dimen.: Large	Palynomaceral 4 Equi-dimen.: Medium	Palynomaceral 4 Equi-dimen.: Small	Palynomaceral 4 Equi-dimen.: Undifferent.*	Palynomaceral 1,2 & 3: Degradation	Palynomaceral 1,2 & 3: Rounding	Palynomaceral 3: Large	Palynomaceral 3: Medium	Palynomaceral 3: Small	Palynomaceral 3: Undifferentiated*	Palynomaceral 2: Large	Palynomaceral 2: Medium	Palynomaceral 2: Small	Palynomaceral 2: Undifferentiated*	Palynomaceral 1: Large 100+	Palynomaceral 1: Medium 50-100	Palynomaceral 1: Small 0-50	Palynomaceral 1: Undifferentiated*	Palynofacies Type	Environmental Interpretation
LATE CALLON.	1518.20	CORE													1	M	1				15	10				5	20					2	9							R			18				15				5		IV	Offshore lower
MIDDLE CALL.	1521.06 - 09	"						M		<1							<1				10	14				3	20										1		P	C			10				10				30		$IX^R(IV)$	Low deposition rate ? Offshore
" "	1521.19 - 23	"						M		<1	<1						<1				10	14				10	13										1		P	C			10				10				30		$IX^R(IV)$	" "
" "	1521.52 - 55	"						G		<1		<1			1	H	5			5	5	5				10	10						2				3		G	R		2	5			5	10			3	30		V(IV)	Offshore upper/lower
" "	1521.60 - 64	"						G				<1			1	H	5			4	2	2				4	4					1	5				5		G	R		2	5		1	10	15			5	30		V(IV)	" " "
" "	1521.64 - 68	"						G		<1		<1			1	H	5			4	2	2				4	4					1	2				5		G	R		2	5		1	10	15			5	30		V(IV)	" " "
" "	1521.80 - 84	"						G		<1		<1			1		5			3	2					3	2										5		G	R	1	2	5		3	10	20			10	30		V	Offshore upper
" "	1522.01 - 05	"						G		1		<1			1		5				15	10				5	20					1	1				1		P	M			15			5	10			3	10		IV	Offshore lower
" "	1521.08 - 11	"						M	C	<1	<1	<1					2			10	5					2	2						1				2		M	R	1	2	15			5	18			5	30		V/IV	Offshore upper/lower
" "	1522.7	"						M							1		10			10	5	3				2	2						1				2		P	C							15			10	40		IV/V^B	" " "
" "	1523.04 - 08	"						G		<1		<1			1		5				15	10				5	20						1				2		P	M			15			5	10			3	10		IV	Offshore lower
" "	1523.88 - 90	"						P		<1							<1			1	1	1				1	1						1				2		G	R		5	5			10	30			10	30		VII/VIII	Shoreface
" "	1523.91 - 93	"															<1			1	1	1				1	1						1				1		G	R		1	5		5	10	30		1	10	30		VII	"
" "	1525.28 - 31	"															<1			1	1	1				1	1						1				1		B	R		1	1		5	10	25		5	15	30		VII	"
" "	1527.2	"															<1			3	2	1				2	2						1				1		G	R	1	5	5		2	10	20		5	10	20		VI	Shoreface lower
" "	1529.70 - 73	"															1			5	10	5				10	10						2				2		M	R		5	5			2	15			2	15		IV(V)	Offshore lower/upper
" "	1529.75 - 78	"															1			5	10	5				10	10						2				2		P	R	5	5	10		5	5	10			2	10		V^B	Offshore upper
" "	1529.9	"															1			5	10	5				10	10						2				2		P	R	5	5	10		5	5	10			2	10		V^B	" "
" "	1529.90 - 95	"								<1		<1			<1		2			10	15	5				10	10						2				2		M	M		5	15			5	10				10		IV	Offshore lower
" "	1530.29 - 32	"								<1							<1										5	1					1				1		P	C			15				15				60		IX^R	Low deposition rate ? in an offshore setting
" "	1530.80 - 84	"								<1		<1					<1																1				1		P	C			15				15				60		IX^R	"
" "	1531.09 - 13	"								<1		<1					1			2	1	1				2	2						1				1		P	C			15				15				52		IX^R (IV)	" "
" "	1531.72 - 75	"								<1		<1					1			2	2	2				3	3												G	R		3	8		10	10	20			5	30		V	Offshore upper
" "	1531.77 - 80	"								<1		<1					<1																						P	C			15				15				60		IX^R	Low deposition rate ? offshore
" "	1532.21 - 25	"								<1		<1					<1			1	1	1				1	1												P	C			15				15				55		$IX^{(R)}$	" "

NORWAY · WELL 31/2-4 - DISTRIBUTION OF PALYNOLOGICAL CONSTITUENTS - TABLE 3

REPORT No.: EP. 56203 DRAWING No.: G. 66257/12

STRATIGRAPHY	SAMPLE DEPTH	TYPE	MISCELLANEOUS	SOM				MARINE PALYNOMORPHS (ORGANIC WALLED)										TERRESTRIAL PALYNOMORPHS													DEBRIS OF MAINLY PLANT ORIGIN																						PALYNOFACIES TYPE	ENVIRONMENTAL INTERPRETATION
				SEMI - SOM	SMALL / DARKENED	LARGE CLUSTERS	UNDIFFERENT.	MARINE PALYNOMORPHS		MICROF. TESTLININGS	MARINE ALGAE	ACRITARCHS SPINOSE	ACRITARCHS LEIOSPH.		DINOCYSTS			TERRESTRIAL PALYNOMORPHS		BISACCATES				FRESH WATER ALGAE	FUNGAL SPORES	SPOROMORPHS (NON-SPECIFIED)					PALYNOMACERAL 4 BLADE NEEDLE				PALYNOMACERAL 4 EQUI-DIMEN.				PALYNOMACERAL 1, 2 & 3		PALYNOMACERAL 3				PALYNOMACERAL 2				PALYNOMACERAL 1					
			TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	DEGRADATION	BROKEN	TOTAL	TOTAL	TOTAL	LARGE	SMALL	No. DOM. TYPES	DIVERSITY	TOTAL	DEGRADATION	BROKEN	LARGE	MEDIUM	SMALL	UNDIFFERENTIATED*	TOTAL	TOTAL	NON - BUOYANT	BUOYANT	No. OF DOMINANTS	DIVERSITY	UNDIFFERENTIATED*	LARGE	MEDIUM	SMALL	UNDIFFERENT.*	LARGE	MEDIUM	SMALL	UNDIFFERENT.*	DEGRADATION	ROUNDING	LARGE	MEDIUM	SMALL	UNDIFFERENTIATED*	LARGE	MEDIUM	SMALL	UNDIFFERENTIATED*	LARGE 100+	MEDIUM 50-100	SMALL 0-50	UNDIFFERENTIATED*		
MIDDLE CALL.	1532.60	CORE															1			1	1	1				1	1												P	C			15				15				55		IX^R	Low deposition rate ? offshore
" "	1536.20	"															1			3	2	1				2	2						1				1		G	R	1	5	5		2	10	20		5	10	20		VI	Shoreface lower
" "	1536.90 - 94	"								<1							1			2	2	2				3	3												G	R		3	8		10	10	20			5	30		V	Offshore upper
" "	1538.90	"															1			5	10	5				10	10						1				1		P	R	5	5	10		5	5	10			2	10		V^B	" "
" "	1541.60	"															1			5	10	5				10	10						1				1		P	R	5	5	10		5	5	10			2	10		V^B	" "
" "	1541.62 - 67	"								<1		<1					1			5	10	5				10	10						1				1		G	R	5	5	10		5	5	10			2	10		V	" "
EARLY CALL.	1542.50 - 55	"										<1					1			5	10	5				10	10						1				1		G	R	5	5	10		5	5	10			2	10		V	" "
" "	1543.40	"															1			5	10	5				10	10						1				1		P	R	5	5	10		5	5	10			2	10		V^B	" "
" "	1544.40 - 44	"										<1					1			5	5	5				10	5						1				1		P	R		5	10		5	5	10			2	20		V^B/IV	Offshore upper / lower
" "	1544.90 - 94	"										<1					1				15	10				5	20												M	R			15				15				20		IV	Offshore lower
" "	1545.20	"										<1					1				15	10				5	20												M	R			15				15				20		IV	" "
" "	1545.28 - 31	"								<1	<1	<1					5			10	15	10				10	25												M	R			10				10				5		IV	" "
" "	1545.38 - 41	"									<1	<1					1				15	10				5	20												M	R			15				15				10		IV	" "
" "	1545.70 - 72	"								<1		<1					3				15	10				5	20												M	R			15				15				10		IV	" "
" "	1546.73 - 76	"								<1		<1					1				15	10				5	20												M	R			15				15				10		IV	" "
" "	1547.50 - 53	"								<1		<1					1				15	10				5	20										10			B	M							10				30		IV(IX)	Offshore lower Low deposition rate ?
" "	1549.70	"															1																																				IX^R/IV	" " "
? EARLY CALL.	1552.00 - 03	"								?5											1					1	1												P	M			15				15				55		IX	Foreshore ?
" "	1554.20	"															<1			3	2	1				2	2												M	R	1	5	5		2	10	20		5	10	20		VI	Shoreface lower
" "	1556.13 - 23	"															<1			2	2	2				3	3												P	R		1	8			10	10			10	10		V^B	Offshore upper
" "	1559.60	"															<1			3	2	1				2	2												M	R	1	5	5		2	10	20		5	10	20		VI	Shoreface lower / embayment
" "	1560.48 - 12	"															<1			3	2	1				2	2												M	R	1	5	5		2	10	20		5	10	20		VI	" "
" "	1561.36 - 40	"															<1			3	2	1				2	2												M	R	1	5	5		2	10	20		5	10	20		VI	" "
" "	1564.55	"															<1			3	2	1				2	2												M	R	1	5	5		2	10	20		5	10	20		VI	" "

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REPORT No.: [redacted] 5620[redacted] DRAWING No.: G. [redacted]/13

STRATIGRAPHY	SAMPLE DEPTH	TYPE	MISCELLANEOUS	SOM				MARINE PALYNOMORPHS (ORGANIC WALLED)										TERRESTRIAL PALYNOMORPHS													DEBRIS OF MAINLY PLANT ORIGIN																						PALYNOFACIES TYPE	ENVIRONMENTAL INTERPRETATION
			MISCELLANEOUS	SEMI-SOM	SMALL/DARKENED	LARGE CLUSTERS	UNDIFFERENT.	MARINE PALYNOMORPHS		MICROF. TESTLININGS	MARINE ALGAE	ACRITARCHS SPINOSE	ACRITARCHS LEIOSPH.		DINOCYSTS			TERRESTRIAL PALYNOMORPHS		BISACCATES				FRESH WATER ALGAE	FUNGAL SPORES	SPOROMORPHS (NON-SPECIFIED)					PALYNOMACERAL 4 BLADE NEEDLE				PALYNOMACERAL 4 EQUI-DIMEN.				PALYNOMACERAL 1,2 & 3		PALYNOMACERAL 3				PALYNOMACERAL 2				PALYNOMACERAL 1					
			TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	DEGRADATION	BROKEN	TOTAL	TOTAL	TOTAL	LARGE	SMALL	No. DOM. TYPES	DIVERSITY	TOTAL	DEGRADATION	BROKEN	LARGE	MEDIUM	SMALL	UNDIFFERENTIATED*	TOTAL	TOTAL	NON-BUOYANT	BUOYANT	No. OF DOMINANTS	DIVERSITY	UNDIFFERENTIATED*	LARGE	MEDIUM	SMALL	UNDIFFERENT.*	LARGE	MEDIUM	SMALL	UNDIFFERENT.*	DEGRADATION	ROUNDING	LARGE	MEDIUM	SMALL	UNDIFFERENTIATED*	LARGE	MEDIUM	SMALL	UNDIFFERENTIATED*	LARGE 100+	MEDIUM 50-100	SMALL 0-50	UNDIFFERENTIATED*		
EARLY CALLO.	1575.70	C															O						2							3																							?	Strong bacterial
"	1583.70	C															O	P	C				5							5									G	R	2	4	5		8	10	15		8	15	20		V/XI	degradation ?
"	1596.10	C		80%													O						2							3																					15		?	"
"	1608.80	C		20%												H	1			5	5	10								15								5									20				20		IV ?	? Offshore lower
"	1620.40	C														H	1						15							15											1	5	15		1	10	15		1	5	15		IV/V	"
"	1634.80	C	?	20%												H							20							15											1	5	10	?	1	5	10	?	1	5	10	?	IV/VB	"
"	1646.40	C														H	1						15							10											5	5	15		5	10	15		1	5	15		V/IV	"
"	1658.40	C														L	1						5							3											5	5	15		5	10	15		5	10	25		VII/VI	Shoreface lower
"	1667.80	SWS														L																										5					25		10	25	35		VII	"
"	1672.00	SWS														M	<1						2							1									M	M		5	3		2	10	25		10	15	25		V/VI	Shoreface lower/ Offshore upper
"	1676.20	SWS														M	3						10							10											1	2	5		5	10	25			5	25		V/VI	"
"	1685.70	SWS														M	2	G	R				2					2		5									G	R	3	3	5		10	10	25			3	30		V/VI	"
"	1690.00	SWS														M	1	G	R				6					2		5									G	R	3	8	5		5	10	25			3	30		V/XI	"
"	1694.00	SWS														M	1	M	M				10					2		10									M	M	3	8	5		5	10	20			3	26		V/XI	"
"	1702.50	SWS														M	1	P	C				10							10									P	C	3	8	5		5	10	20			3	26		V	Offshore upper
"	1709.00	SWS														H	8						20							15							5					5	7			5	5			5	15		V	"
LATE BATH. / EARLY CALLOV.	1713.20	SWS														H	1						10							10					?5							1	5	5		1	10	20	1	10	15		V	"
"	1723.30	SWS														H	1						15							15								5				1	5	15		1	10	15	1	5	15		V	"
"	1728.60	SWS														H	1						5							10					15							5	5	15		5	10	15	5	5	15		V	"
MIDDLE BATH.	1739.60	SWS														H	1						15							15								5				1	5	15		1	10	15	1	5	15		V	"
"	1745.60	SWS														H	1			20	5	5								20														15			5	15			15		IV	Offshore lower
"	1755.20	SWS														H	1			30	5	5								25							15							15				5					III	"
"	1758.20	SWS														M	1			40	5	5								30			5				5							5				5					III	"
"	1767.80	SWS																					15							15			5				5					1	5	10		1	10	15	1	5	5		IV/V	"

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STRATIGRAPHY	SAMPLE DEPTH	TYPE	SOM: MISCELLANEOUS	SOM: SEMI-SOM TOTAL	SOM: SMALL/DARKENED TOTAL	SOM: LARGE CLUSTERS TOTAL	SOM: UNDIFFERENT. TOTAL	MARINE PALYNOMORPHS (ORGANIC WALLED): MARINE PALYNOMORPHS DEGRADATION	MARINE PALYNOMORPHS: MARINE PALYNOMORPHS BROKEN	MARINE PALYNOMORPHS: MICROF. TESTLININGS TOTAL	MARINE PALYNOMORPHS: MARINE ALGAE TOTAL	MARINE PALYNOMORPHS: ACRITARCHS SPINOSE TOTAL	MARINE PALYNOMORPHS: ACRITARCHS LEIOSPH. LARGE	MARINE PALYNOMORPHS: ACRITARCHS LEIOSPH. SMALL	MARINE PALYNOMORPHS: DINOCYSTS No. DOM. TYPES	MARINE PALYNOMORPHS: DINOCYSTS DIVERSITY	MARINE PALYNOMORPHS: DINOCYSTS TOTAL	TERRESTRIAL PALYNOMORPHS: TERRESTRIAL PALYNOMORPHS DEGRADATION	TERRESTRIAL PALYNOMORPHS: TERRESTRIAL PALYNOMORPHS BROKEN	TERRESTRIAL PALYNOMORPHS: BISACCATES LARGE	TERRESTRIAL PALYNOMORPHS: BISACCATES MEDIUM	TERRESTRIAL PALYNOMORPHS: BISACCATES SMALL	TERRESTRIAL PALYNOMORPHS: BISACCATES UNDIFFERENTIATED*	TERRESTRIAL PALYNOMORPHS: FRESH WATER ALGAE TOTAL	TERRESTRIAL PALYNOMORPHS: FUNGAL SPORES TOTAL	TERRESTRIAL PALYNOMORPHS: SPOROMORPHS (NON-SPECIFIED) NON-BUOYANT	TERRESTRIAL PALYNOMORPHS: SPOROMORPHS (NON-SPECIFIED) BUOYANT	TERRESTRIAL PALYNOMORPHS: SPOROMORPHS (NON-SPECIFIED) No. OF DOMINANTS	TERRESTRIAL PALYNOMORPHS: SPOROMORPHS (NON-SPECIFIED) DIVERSITY	TERRESTRIAL PALYNOMORPHS: SPOROMORPHS (NON-SPECIFIED) UNDIFFERENTIATED*	DEBRIS OF MAINLY PLANT ORIGIN: PALYNOMACERAL 4 BLADE NEEDLE LARGE	PALYNOMACERAL 4 BLADE NEEDLE MEDIUM	PALYNOMACERAL 4 BLADE NEEDLE SMALL	PALYNOMACERAL 4 BLADE NEEDLE UNDIFFERENT.*	PALYNOMACERAL 4 EQUI-DIMEN. LARGE	PALYNOMACERAL 4 EQUI-DIMEN. MEDIUM	PALYNOMACERAL 4 EQUI-DIMEN. SMALL	PALYNOMACERAL 4 EQUI-DIMEN. UNDIFFERENT.*	PALYNOMACERAL 1,2&3 DEGRADATION	PALYNOMACERAL 1,2&3 ROUNDING	PALYNOMACERAL 3 LARGE	PALYNOMACERAL 3 MEDIUM	PALYNOMACERAL 3 SMALL	PALYNOMACERAL 3 UNDIFFERENTIATED*	PALYNOMACERAL 2 LARGE	PALYNOMACERAL 2 MEDIUM	PALYNOMACERAL 2 SMALL	PALYNOMACERAL 2 UNDIFFERENTIATED*	PALYNOMACERAL 1 LARGE 100+	PALYNOMACERAL 1 MEDIUM 50-100	PALYNOMACERAL 1 SMALL 0-50	PALYNOMACERAL 1 UNDIFFERENTIATED*	PALYNOFACIES TYPE	ENVIRONMENTAL INTERPRETATION
MIDDLE BATH.	1773.00	SWS															1					5												3															IV/V	Offshore lower/upper
"	1789.40	SWS																																15															VIII	Shoreface/embayment
"	1801.00	SWS													1	L	10																	40															VIII	" "
"	1819.00	SWS																		5	10			50										10															XIII/XII	Large lacustrine
"	1829.40	SWS																								10																							XI	" "
"	1855.40	SWS																			25			30										5															XIII/XII	" "
"	1858.20	SWS																			25			30								5	10			2	10											XIII/XII	" "
"	1861.10	SWS																			25			30								5	10			2	10											XIII/XII	" "
TOARCIAN	1902.00	SWS											1				1			5	15			20								5	10			2	10			1	10	10				5			IV	Offshore lower
"	1907.00	SWS															5	G	R			22		40								5	5				5		G		1	1	10		1	2	1				1		IV	" "
"	1912.00	SWS															5	G	R			22		40								5	5				5		G		1	1	10		1	2	1				1		IV	" "
"	1924.00	SWS															1	G	R			20		37								5	5				5		G		1	1	10			5	5			5	5		IV	" "
"	1929.40	SWS															1					19		19										2	10	10					5		1	2	2		5	10	10		V/VI	Offshore upper
"	1942.50	SWS															1					10		10								10	5			2	5	5				3	5		5	10	10		5	10	15		V/VI	" "
"	1968.00	SWS				10											1					15		15								10	5				5	5				3	5		5	10	10		1	5	15		IV/I	Offshore lower
"	1982.50	SWS				20											5					15		20								1	5				1	5					5			10	10				5		IV/I	" "

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