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LABORATORIUM
FOR APPLIED PALYNOLOGY

PALEONTOLOGICAL AND SEDIMENTOLOGICAL STUDIES
OF THE JURASSIC SEQUENCE, NORTHERN NORTH SEA

KEROGEN ANALYSIS AND PALYNOLOGY

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SUMMARY

Kerogen analysis and palynology have been carried out on conventional core samples from Wells 33/12-2, 33/9-9, 33/12-4 and 33/9-6 covering the Dunlin and Brent Formations. This report summarizes results and interpretations based on kerogen analysis and palynological examination. This study is part of a project lead by Jenő Nagy, University of Oslo, and includes also sedimentological and paleontological studies.

INTRODUCTION

This report summarizes the results of kerogen analysis and palynology carried out on conventional core samples from the Dunlin and Brent Formations in the northern North Sea. The study forms a part of the project "Paleontological and sedimentological studies of the Jurassic sequence, Northern North Sea" lead by Jenő Nagy, University of Oslo, and financially supported by The Norwegian Petroleum Directorate.

The studies reported here were carried out in 1981 and 1982.

Sedimentological and paleontological studies carried out by H.Dypvik and J.Nagy, University of Oslo, on the same material, were reported separately in recent reports to the NPD. Integration of the information obtained from all these studies will be presented in a future report.

WELLS 33/12-2 AND 33/9-9

Methods

Kerogen analysis was carried out on strew mounts of residue remaining after HF/HCl treatment, floatation ($ZnBr_2$, sp.gr.2.2) and screening (20 micron net). The amount of finely dispersed debris was estimated semi-quantatively from unscreened residues. The relative amounts of the remaining kerogen categories were obtained by counting 200 fragments from strew mounts of screened residues.

The kerogen was referred to the following five categories: Wood (incl. opaque fragments of wood origin), membraneous material (mainly cuticle fragments), non-marine palynomorphs (spores and pollen), marine palynomorphs (dinoflagellates and acritarchs) and finely dispersed debris.

In the samples studied from Well 33/12-2 the wood material was further subdivided into inertinite (I), unstructured fragments of wood origin characterized by continuously varying thickness (W1), fibrous wood fragments with elongate outline, thickened cell walls and/or tracheidal cells (W3), and degraded fragments of wood origin (DEG).

Qualitative palynology was carried out in order to establish the age of the studied intervals. No effort was made to give an exhaustive account of the spore and pollen assemblages present.

The results of the kerogen analysis are shown in Enclosures 1 and 3. Range charts showing the distribution of stratigraphically significant species are found in Enclosures 2 and 4.

WELL 33/12-2 8655'(2638.7m) - 8693'(2650.3m)

Kerogen analysis

(Enclosure 1)

Eleven samples have been studied from core 1 (8655'-8693').

There are only minor variations in kerogen composition through the studied interval. Finely dispersed debris is common to abundant in all samples except in sample 405 at 8657' where it is reduced.

Wood fragments dominate the particulate kerogen assemblage throughout and constitutes 40 to 60%. Membraneous material shows a steady increase from 10-20% in the lower part to about 30% in the upper part, but dropping below 20% in the uppermost sample. Non-marine palynomorphs constitutes between 20 and 30% of the assemblage in most samples.

Marine palynomorphs are rare throughout, in most samples 1 to 3%. Variations are not statistically significant.

Interpretation: Dominance of terrestrially derived debris and the presence of minor amounts of marine palynomorphs show that a marginal marine environment with considerable input of land-derived plant material, prevailed during the deposition of the sediments studied. Common to abundant finely dispersed debris indicate low energy conditions.

The maximum of membraneous material between 8658' and 8666' probably causes the masking of marine palynomorphs. This indicates an episode of higher input of terrestrial material. The minimum of finely dispersed debris at 8658' also suggests slight variations in energy within this interval. At 8655' there is a return to the same conditions as seen below 8666'.

Age: (Enclosure 2) The presence of Nannoceratopsis senex from 8682' upwards in association with a characteristic large variety of Quadraeculina anellaeformis show a Pliensbachian age for this interval. The absence of N. senex below 8662' may indicate that we are at the lower end of its range, and that the studied interval is in the middle part of the Pliensbachian.

The spore and pollen assemblages comprising Stereisporites perforatus, Duplexisporites probelmaticus, Chasmatosporites hians, Uvaesporites reissingerii, Cerebropollenites mesozoicus, Lycopodiacidites rugulatus, Cerebropollenites cf. thiergartii and Kraeuselisporites reissingerii are consistent with a Pliensbachian age.

WELL 33/9-9 (2486m-2516.6m)

Kerogen analysis

(Enclosure 3)

Ten samples have been studied from core 7 (2486.0m-2516.6m)

Finely dispersed debris varies between common and only traces through the interval. A maximum is reached at 2501.9m where it is abundant.

Wood fragments dominate the particulate kerogen assemblage showing significant increase upwards from 60 to 70% in the lower part to 90-100% in the sandstones at 2497.3m and 2489.0m. Membraneous material forms between 10 and 20% of the assemblage in the lower part and is reduced to less than 10% in the upper. A significant maximum is seen at 2501.9m and 2500.7m.

Non-marine palynomorphs constitute nearly 20% of the assemblage in the lower part but is rapidly reduced from 2503.3m upwards due to stronger dominance of wood material. Marine palynomorphs make up 10-15% of the assemblage at 2516.6m and 2512.2m but is then rapidly reduced, and was not recorded during the quantitative analyses above 2503.3m. From the qualitative study marine palynomorphs are recorded as high as 2500.7m, and a relative maximum of Nannoceratopsis gracilis is noted at 2503.3m

Interpretation: A distinct change in kerogen composition is noted through the studied sequence. This change may be explained by a response to both changes in environment from marine to non-marine conditions and increasing energy upwards. At 2516.6m and 2512.2m marine palynomorphs are making up 10-15% of the assemblage. The decrease in marine palynomorphs at 2507.0m is due to relative increase in terrestrial input and/or reduced production, and not directly related to energy increase. This is seen by the high spore and pollen content over this interval.

Above 2500.7m increasing energy results in reduction in membranaceous material and non-marine palynomorphs and a relative increase in wood material which makes up 90% or more of the kerogen assemblages at 2497.3m and above.

The kerogen analysis shows a continuous development from a marginal marine situation with high terrestrial input in a medium energy regime to high energy non-marine conditions.

Age. (Enclosure 4)

The presence of N.gracilis in association with Callialasporites dampieri and C.turbatus at 2503.3m to 2500.7m and in addition Comparodinium punctatum, Phalloecysta eumekes, Parvocysta contracta and P.bullula between 2503.8m and 2516.4m gives a late Toarcian to possibly Aalenian age for the studied interval. Accompanying spore and pollen assemblages are consistent with this dating.

WELL 33/12-4 (8827 - 8927 feet)
April 1982

Methods

Kerogen analysis was carried out on strew mounts of residue remaining after HF/HCl treatment, floatation (ZnBr, sp.gr.2.2) and screening (20 micron net). The amount of finely dispersed debris was estimated semiquantitatively from unscreened residues. The relative amounts of remaining kerogen categories were estimated semiquantitatively from strew mounts of screened residues.

The kerogen was referred to the following categories: Finely dispersed debris (FDD), Wood fragments (W), inertinite (I), Membraneous fragments (M), Non-marine palynomorphs (S+P), Marine palynomorphs (Dinos).

Qualitative palynology was carried out in order to establish the age of the studied interval. No effort was made to give an exhaustive account of the spore and pollen assemblages present.

Range chart showing the distribution of stratigraphically significant species are found in Enclosure 5.

The results of the kerogen analysis are shown in Enclosure 6.

Age.

8824 - 8835 feet Toarcian - Aalenian

Above 8835 feet the palynomorph productivity is very low. The presence of Nannoceratopsis gracilis at 8835 feet in association with Callialasporites dampieri, Classopollis classoides, Quadraeculina anellaeformis and Klukisporites

scaberis suggest a late Toarcian to Aalenian age for this horizon.

8837 - 8849 feet Late Toarcian

The appearance of Comparodinium punctatum at 8839 feet and continued presence of N.gracilis downwards in association with species like C.dampieri, C.turbatus, C.microvelatus and Parvocysta bullula give a late Toarcian age for this interval.

8849 - 8882 feet ?Toarcian

This interval did not produce diagnostic assemblages. It is sandwiched between the late Toarcian and the Pliensbachian and is tentatively referred to the Toarcian.

8883 - 8905 feet Late Pliensbachian

Although characteristic Late Pliensbachian markers like N.gracilis var. senex, C.cf.thiergartii and K.Reissingerii do not appear higher than 8896 feet and 8898 feet, the shale interval up to 8883 feet is regarded as a single unit, probably of a Late Pliensbachian age also in the upper part.

8906 - 8927 feet Pliensbachian ?"middle"

C.perpunctatum at 8910 feet, has previously been recorded from the early Pliensbachian. However, characteristic N.gracilis var. senex at 8920-27 feet, has not been recorded from beds older than the late Pliensbachian. A late lower or early upper Pliensbachian age is suggested for this interval.

Kerogen analysis

8824 - 8835 feet

Finely dispersed debris dominates the interval completely. The particulate kerogen is dominated by inertinite and wood. These categories probably contribute to the finely dispersed debris. Other kerogen categories are rare or absent except for abundant spores and pollen present in one assemblage at 8835 feet. Rare marine palynomorphs are also present at this horizon, but absent higher up.

The lower part of the sequence was deposited in a marginal marine bay? environment within the close proximity of a terrestrial source. A regressive development is seen upwards probably representing the lower part of a distributary mouth bar.

8837 - 8849 feet

Finely dispersed debris is dominating at the base of the interval at 8848 and 8849 feet. At 8846 feet FDD is rare but increases upwards to be dominating at 8837 feet. Inertinite is rare to common in the lower part increasing to common and abundant upwards, becoming dominating in the uppermost sample at 8837 feet. Wood fragments show a similar development becoming dominating at 8839 feet. Non-marine palynomorphs are abundant except at 8848 feet where they are relatively reduced due to a maximum of dinoflagellates, and at 8837 feet where they are absent. Marine palynomorphs show a significant maximum at 8848 and 8849 feet due to a bloom of N. gracilis. They are reduced to rare at 8846, 8845 and 8842 feet and are absent in the upper part of the interval.

At the base of this interval an environment characterized by a low sedimentation rate was established with low terrestrial input. This was probably caused by a high energy shelf environment. The dominance of N.gracilis indicate a restricted shallow marine environment. Upwards a regressive development is seen by increased terrestrial input. This terminates by the deposition of the sandstone at 8837 feet with a highly sorted assemblage dominated by inertinite.

8849 - 8882 feet

Only two samples were studied from this interval, both from sandstone horizons. The lower one show rare finely dispersed debris, common inertinite and abundant wood debris. Spores and pollen are abundant, while marine palynomorphs are present in small amounts. The kerogen composition indicates a relatively high energy environment with dominance of terrestrially derived material. The presence of rare marine palynomorphs indicates a marginal facies.

The upper sample at 8856 feet has an extremely low kerogen content with abundant finely dispersed debris, other kerogen components being rare. The evidende is not sufficient for any facies interpretation. It is, however, a poorly sorted assemblage with a dominance of terrestrial plant material.

8883 - 8905 feet

This interval is characterized by highly variable amounts of finely dispersed debris varying between rare and dominating with a minimum in the middle part of the interval and a maximum in the upper part. Inertinite varies between rare.

and abundant also with a minimum in the middle part of the interval. Wood fragments are abundant throughout. Membraneous material is abundant in the lower part, common in the middle part and reduced to rare or absent from the uppermost three samples. Non-marine palynomorphs are common in the two lowermost samples, dominating in the middle part and common to abundant in the uppermost three samples. Rare marine palynomorphs are present in most samples.

This interval differs from those above in considerable higher amounts of membraneous material and non-marine palynomorphs. A low energy, marginal marine environment was established with a transgressive development in the lower part and a regressive development in the upper.

8906 - 8927 feet

The amount of finely dispersed debris varies considerably through the interval with a minimum in the middle and upper part of the interval. Inertinite reaches a maximum at 8917 feet where it is dominating, in the other samples it is common to abundant. Wood fragments are common to abundant throughout the interval. Membraneous material is common in most samples, but reduced to rare at 8917 feet and abundant at 8915 feet. Non-marine palynomorphs are abundant to dominating in all samples except at 8917 feet where they are reduced to common. Marine palynomorphs are present in small amounts in most samples. A relative maximum of N. gracilis var. senex is observed at 8920 and 8927 feet.

This interval was formed in a shallow, marginal marine environment with a considerable terrestrial input. Frequent changes in kerogen composition reflect changes in energy and possibly bottom conditions during deposition.

WELL 33/9-6 (3021 - 3031m)

Nov. 1982

INTRODUCTION

As part of the multidisciplinary study of the Dunlin and Brent Formation in the Northern North Sea, kerogen analysis has been carried out in detail on conventional core samples from Well 33/9-6 (3021-3031m). The studied interval covers silt and shale intercalations in sandstone-dominated intervals referred to the Ness Member, Brent Formation.

RESULTS (Enclosure 7)

19 samples were analysed. The results show a high stability over the interval 3021.0m to 3028.25m. The kerogen assemblages are characterized by abundant spores and pollen and abundant wood fragments. Inertinite and membraneous material are common in most assemblages, degraded material is rare. Finely dispersed debris consisting of fragmented wood and cuticle fragments show a distinct maximum between 3024.45m and 3025.40m. Rare marine palynomorphs are present at 3021.00m, 3021.35m, 3024.45m and 3026.00m.

The sample at 3031.06m differs from the other samples by reduced content of finely dispersed debris, membraneous material and spores and pollen, and an increase in inertinite and wood fragments.

INTERPRETATION

The kerogen assemblages show that the fine grained deposits within the studied interval were deposited in relatively low energy environment dominated by input of terrestrially derived material. Relatively large amounts of spores/pollen and membraneous material show that local vegetation contributed considerably to the organic content. The marine elements present probably show a slight marine influence. A possible reworking of these elements from older sediments seems less likely due to excellent preservation of most specimens. It must be stressed however, that they are extremely rare.

From the kerogen analysis a back barrier lagoonal environment with slight marine influence is suggested for these beds. The presence of rare Nannoceratopsis gracilis if in place, shows that the age is not younger than the Bajocian.

- Enclosure 1 Results of kerogen analysis from Well 33/12-2 (8655' - 8693'), core 1.
- Enclosure 2 Distribution of selected palynomorphs recorded from Well 33/12-2 (8655' - 8690'), core 1.
- Enclosure 3 Results of kerogen analysis from Well 33/9-9 (2486.0m - 2516.6m), core 7
- Enclosure 4 Distribution of selected palynomorphs recorded from Well 33/9-9 (2486.0m - 2516.6m), core 7.
- Enclosure 5 Distribution of selected palynomorphs recorded from Well 33/12-4 (8827' - 8927')
- Enclosure 6 Results of kerogen analysis from Well 33/12-4 (8827' - 8927')
- Enclosure 7 Results of kerogen analysis from Well 33/9-6 (3021 - 3031m)