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A palynological investigation of the Brent Group from UK North Sea wells 211/28-H15 and 211/28-H1 (Hutton Field)

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A palynological investigation of the Brent Group from UK North Sea wells 211/28-H15 and 211/28-H1 (Hutton Field)

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Foreword

This report comprises a palynological study of 13 core samples from the Brent Group (Broom and Ness formations) of wells 211/28-H15 and 211/28-H1 (Hutton Field).

Contents

Summary

The 13 samples all produced abundant palynofloras that are dominated by characteristically Middle Jurassic spores and pollen such as *Callialasporites* spp., *Ischyosporites variegatus, Leptolepidites* spp. and *Neoraistrickia gristhorpensis*. Marine palynomorphs proved extremely rare, normally well below 1% of the overall association, and four samples entirely lack marine palynomorphs. Extremely low proportions of marine palynomorphs are consistent, for example, with a lagoonal setting where marine waters occasionally entered. The dinoflagellate cysts are dominated by the euryhaline genus *Nannoceratopsis*, so this may represent brackish water conditions. Clearly, the degree of marine influence was extremely small. The dominance of *Nanoceratopsis* is consistent with the Aalenian/earliest Bajocian interval. This is confirmed by the absence of the *Parvocysta* group, and the lack of *Durotrigia filapicata* and *Phallocysta thomasii*. This means that the succession studied ranges from the Murchisonae to Laeviuscula chronozones. In summary, the presence of the dinoflagellate cysts *Nannoceratopsis deflandrei* subsp. *senex* and *Pareodinia halosa,* and the pollen genus *Callialasporites* is indicative of the Aalenian-earliest Bajocian.

Sample 3 at 16579 feet from well 211/28-H15 is within the Mid Ness Shale; it produced 13 marine palynomorphs per slide and is indicative of marginal marine conditions. A single sample of the non-marine/brackish acritarch *Truncatisphaeridium clevelandense* was also recovered.

The occurrence of *Truncatisphaeridium clevelandense* in this horizon is indicative of a mid Aalenian (Murchisonae Chronozone) age, and a probable brackish water palaeoenvironent.

Sample 6 at 11200 feet from well 211/28-H1 produced a relatively abundant marine palynomorph association, therefore represents open marine conditions.

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1 Introduction

Thirteen conventional core samples collected from the Brent Group (Broom and Ness formations) of UK North Sea wells 211/28-H15 and 211/28-H1 (Hutton Field) were studied for their palynomorph content. This study aimed to determine the age and palaeoecology of this material. The work has been undertaken in order to contribute to a project on the reservoir architecture, sedimentology and sequence stratigraphy of the Brent Group from the Hutton Field.

2 Sample Details

The 13 samples studied are listed below. The columns represent the (informal) sample number, the BGS micropalaeontological registration number (prefixed MPA), the depth in feet, lithostratigraphical details and lithology respectively. The samples were prepared using standard acid-digestion techniques.

I	**Well 211/28-H15**			
1	MPA 55478	16492 ft.	uppermost Ness Fm.	black, carbonaceous shale
2	MPA 55479	16521 ft.	upper Ness Fm.	black, carbonaceous shale
3	MPA 55480	16579 ft.	Mid Ness Fm. Shale	sheared shale w. plants
4	MPA 55481	16874 ft.	uppermost Broom Fm.	sandstone/shale
5	MPA 55482	16886 ft.	Broom Fm.	bioturbated shale/sst.
II	**Well 211/28-H1**			
6	MPA 55483	11200 ft.	upper Ness Fm.	carbonaceous siltstn.
7	MPA 55484	11228 ft.	upper Mid Ness Fm. Shale	laminated mudstone
8	MPA 55485	11250 ft.	Mid Ness Fm. Shale	laminated black mudstone
9	MPA 55486	11234 ft.	Mid Ness Fm. Shale	burrowed black siltstone
10	MPA 55487	11272.3 ft.	Ness Fm., below MNS	sheared mudstone
11	MPA 55488	11308 ft.	Lower Ness Fm.	rippled carbonaceous sst.
12	MPA 55489	11317.5 ft.	Lower Ness Fm.	sheared black mudstone
13	MPA 55490	11479.25 ft.	Broom Fm.	carbonaceous sandstone

3 Palynology

In this section, the palynofloras are described. Full listings of palynomorphs, including semiquantitative data, are held on the respective BGS micropalaeontology/palynology data sheets, which have been archived.

All the samples studied yielded abundant, well-preserved palynofloras that are overwhelmingly dominated by spores/pollen. The kerogen associations are also abundant and include common wood fragments and plant tissue.

The abundant spore/pollen associations include bisaccate pollen (undifferentiated), *Callialasporites* spp. (largely *Callialasporites dampieri* and *Callialasporites turbatus), Cerebropollenites macroverrucosus, Chasmatosporites* spp., *Cibotiumspora juriensis, Classopollis* spp. (including *Classopollis classoides* and *Classopollis meyariana*), *Concavissimisporites verrucosus, Contignisporites* spp., *Coronatispora valdensis, Cyathidites* spp., *Dictyophyllidites* spp., *Ischyosporites variegatus, Leptolepidites* spp., *Neoraistrickia gristhorpensis, Osmundacidites wellmanii, Perinopolllenites elatoides, Retitriletes* spp., *Sestrosporites pseudoalveolatus* and *Vitreisporites pallidus*. These taxa are characteristic of the Middle Jurassic. For example, the range base of common *Callialasporites* is close to the Early/Mid Jurassic transition (e.g. Riding et al., 1991). Furthermore, *Ischyosporites variegatus, Leptolepidites* spp., *Neoraistrickia gristhorpensis* and *Osmundacidites wellmanii* are also indicative of the Aalenian-Bathonian interval.

Marine palynomorphs are extremely rare, normally representing well below 1% of the overall association where they are present. Four samples lack marine palynomorphs. These extremely low levels of marine forms are somewhat difficult to interpret. In large estuaries, marine palynomorphs are present in significant proportions up to the tidal limit (Farr, 1989). These low proportions of marine palynomorphs would be consistent, for example, with a lagoon where marine waters occasionally entered. The dinoflagellate cysts are dominated by the genus *Nannoceratopsis*. The Toarcian-early Bajocian representatives of this genus are considered to have been euryhaline (e.g. Riding, 1983), so it is possible that they were tolerant of brackish conditions. This means that the samples in this study containing this genus may represent brackish water settings. Assuming these marine grains are *in-situ*, the degree of marine influence is clearly extremely small. Alternatively, the marine forms may be reworked. However, the relatively consistent proportions of marine palynomorphs mitigates against these forms being allochthonous.

In terms of dinoflagellate cyst biostratigraphy, the fact that these associations are dominated by *Nanoceratopsis* is entirely consistent with the Aalenian/earliest Bajocian interval (Richards et al., 1993; Butler et al., 2005). The absence of the *Parvocysta* group/diverse Phallocystaceae precludes an early Aalenian (Opalinum Chronozone) or older age (Riding, 1984; Butler et al., 2005). Furthermore, the lack of forms such as *Durotrigia filapicata* and *Phallocysta thomasii* is indicative that the interval is no younger than pre-'mid' early Bajocian (Butler et al., 2005, fig. 6). This means that the succession studied ranges from the Murchisonae to Laeviuscula chronozones. The dinoflagellate cysts are dominated by *Nannoceratopsis deflandrei* subsp. *senex*. This form is known to be abundant in the early Toarcian (Riding et al., 1999, fig. 11), but is known to range into the Bajocian (Butler et al., 2005, fig. 3). The presence of the dinoflagellate cysts *Nannoceratopsis deflandrei* subsp. *senex* and *Pareodinia halosa*, and the pollen genus *Callialasporites* is indicative of the Aalenian-earliest Bajocian.

Specific comments regarding the marine content of individual samples are given in the following 12 subsections.

3.1 WELL 211/28-H15

3.1.1 Samples 1 and 2 16492 and 16521 feet respectively.

Both these samples are black, carbonaceous shales from the upper part of the Ness Formation. The highly carbonaceous nature of them makes them appear to approach coal. Unsurprisingly, both samples yielded residues dominated by dark wood fragments. Plant tissues and miospores are also present; *Botryococcus* and marine microplankton are entirely absent. They therefore

represent a freshwater/terrestrial depositional setting. The miospores are of low diversity and are dominated by representatives of *Cyathidites* and *Classopollis*.

3.1.2 Sample 3 16579 feet.

This sample is within the Mid Ness Shale (Ness Formation). Marine palynomorphs are rare; 13 specimens per slide were counted. These comprise acanthomorph acritarchs (*Micrhystridium* spp.), the dinoflagellate cysts *Nannoceratopsis deflandrei* subsp. *deflandrei*, *Nannoceratopsis deflandrei* subsp. *senex* and prasinophytes (*Crassosphaera* spp.). This association may represent marginal marine conditions and is consistent with an Aalenian/early Bajocian age. A single sample of the non-marine acritarch *Truncatisphaeridium clevelandense* was also recovered from this sample. This occurrence is highly significant. The species was described as being associated with a transition from marine to non-marine, largely fluvial-deltaic depositional situations (Riding and Duxbury, 1993). The species was recorded from the mid Aalenian Saltwick Formation (Murchisonae Chronozone) of North Yorkshire and the Etive/Ness formational transition in the Ninian Field (Riding and Duxbury, 1993). These occurrences are coeval according to Butler et al. (2005, fig. 6). Riding and Duxbury (1993) reported that *Truncatisphaeridium clevelandense* does not occur with marine elements, although these authors stated (p. 57) that it may occur in brackish settings. The occurrence of *Truncatisphaeridium clevelandense* in sample 3 is indicative of a mid Aalenian age and a probable brackish water depositional setting.

3.1.3 Sample 4 16874 feet.

This sample is within the uppermost Broom Formation. The freshwater/brackish alga *Botryococcus* is present in relatively low proportions. Marine palynomorphs proved rare; 15 specimens per slide were counted. These comprise the dinoflagellate cysts ?*Nannoceratopsis deflandrei* subsp. *deflandrei*, *Nannoceratopsis deflandrei* subsp. *senex*, *Nannoceratopsis gracilis* and *Pareodinia halosa*, and prasinophytes (*Tasmanites* spp.). This association is dominated by *Nannoceratopsis deflandrei* subsp. *senex* and may represent marginal marine conditions. For example it may represent a lagoonal setting with the spores/pollen and *Botryococcus* swept in by fluvial input. It is consistent with an Aalenian/early Bajocian age.

3.1.4 Sample 5 16886 feet.

Sample 5 is from the Broom Formation. The freshwater/brackish alga *Botryococcus* was recorded in low proportions. Marine palynomorphs proved extremely rare; the only marine index is a single, poorly-preserved specimen of the dinoflagellate cyst genus *Luehndea*. The occurrence of this form is consistent with an Aalenian (Murchisonae Chronozone) age (Butler et al., 2005, fig 4). This assemblage is indicative of marginal marine conditions.

3.2 WELL 211/28-H1

3.2.1 Sample 6 11200 feet.

This sample is from the upper part of the Ness Formation. Marine palynomorphs are relatively common; 54 specimens per slide were counted. These comprise the dinoflagellate cysts *Nannoceratopsis deflandrei* subsp. *senex*, *Nannoceratopsis* sp. and *Pareodinia halosa*, foraminiferal test linings and prasinophytes (*Tasmanites* spp.). *Nannoceratopsis deflandrei* subsp. *senex* is the dominant form, with 49 specimens counted per slide. This association appears to represent relatively open marine conditions because of the moderately abundant and diverse marine microplankton assemblage. The species richness of marine microplankton is higher than other samples in this study, but is still relatively low. The palynoflora is consistent

with an Aalenian/early Bajocian age. The freshwater/brackish alga *Botryococcus* was recorded in significant proportions, these specimens are assumed to have been delivered by fluvial input.

3.2.2 Sample 7 11228 feet.

This sample is from the uppermost part of the Mid Ness Shale, within the Ness Formation. Marine palynomorphs are extremely rare; 5 specimens per slide were counted. These comprise the dinoflagellate cysts *Nannoceratopsis deflandrei* subsp. *senex* and *Nannoceratopsis* sp., and prasinophytes (*Tasmanites* sp.). *Botryococcus* is absent. This association may represent marginal marine or brackish conditions, and is consistent with an Aalenian/early Bajocian age. This sample may represent a lagoonal environment with the miospores swept in via fluvial input.

3.2.3 Sample 8 11250 feet.

This sample is from the Mid Ness Shale (Ness Formation). Marine palynomorphs are absent; however the freshwater/brackish alga *Botryococcus* was recorded in significant proportions. This association therefore is interpreted as being freshwater/brackish.

3.2.4 Sample 9 11234 feet.

Sample 9 is also from the Mid Ness Shale. Unequivocal marine palynomorphs were not recorded, however a single, poorly-preserved questionable specimen of *Nannoceratopsis deflandrei* subsp. *senex* was observed. The freshwater/brackish alga *Botryococcus* was recorded in significant proportions. This association hence probably represents a freshwater/brackish depositional setting. A single specimen of the reworked Carboniferous spore *Densoisporites* sp. was encountered.

3.2.5 Sample 10 11272.3 feet.

This sample is from below the Mid Ness Shale, within the Ness Formation. Marine palynomorphs are extremely rare; 5 specimens per slide were counted. These comprise the dinoflagellate cysts *Nannoceratopsis deflandrei* subsp. *deflandrei*, *Nannoceratopsis deflandrei* subsp. *senex* and *Nannoceratopsis* sp., and prasinophytes (*Tasmanites* spp.). This association may represent marginal marine, or brackish conditions, and is consistent with an Aalenian/early Bajocian age. The freshwater/brackish alga *Botryococcus* was recorded in significant proportions. For example, this horizon may represent a lagoonal environment with the miospores and *Botryococcus* delivered by fluvial input.

3.2.6 Sample 11 11308 feet.

This sample is from the lower part of the Ness Formation. Marine palynomorphs proved absent; however the freshwater/brackish alga *Botryococcus* was recorded in significant proportions. The palaeoenvironment therefore is interpreted as being freshwater/brackish.

3.2.7 Sample 12 11317.6 feet.

This sample is also from the lower part of the Ness Formation. Marine palynomorphs are rare; 15 specimens per slide were recovered. These comprise acanthomorph acritarchs (*Micrhystridium* spp.), the dinoflagellate cysts *Nannoceratopsis deflandrei* subsp. *senex* and *Nannoceratopsis* sp. (smooth), and prasinophytes (Tasmanites spp.). This association is dominated by *Nannoceratopsis deflandrei* subsp. *senex*. It may represent marginal marine, or brackish water conditions, and is consistent with an Aalenian/early Bajocian age. The freshwater/brackish alga *Botryococcus* was also recorded. The sample may represent a lagoonal environment with the miospores and *Botryococcus* derived fluvially.

3.2.8 Sample 13 11479.25 feet.

Sample 13 is from the Broom Formation. Marine palynomorphs are extremely rare; 7 specimens per microscope slide were recovered. These comprise the dinoflagellate cysts *Nannoceratopsis deflandrei* subsp. *senex* and *Pareodinia halosa*, and prasinophytes (Tasmanites spp.). This sparse assemblage is dominated by *Nannoceratopsis deflandrei* subsp. *senex*. It may represent marginal marine, or brackish water conditions, and is consistent with an Aalenian/early Bajocian age. The freshwater/brackish alga *Botryococcus* was also recorded and the sample may represent a lagoonal environment with the miospores and *Botryococcus* derived fluvially. A single, questionable specimen of the reworked Carboniferous spore *Densoisporites* sp. was also encountered.

4 Summary

The 13 samples all produced abundant palynofloras that are dominated by characteristically Middle Jurassic spores and pollen such as *Callialasporites* spp., *Ischyosporites variegatus, Leptolepidites* spp. and *Neoraistrickia gristhorpensis*. Marine palynomorphs proved extremely rare, normally well below 1% of the overall association, and four samples entirely lack marine palynomorphs. Extremely low proportions of marine palynomorphs are consistent, for example, with a lagoonal setting where marine waters occasionally entered. The dinoflagellate cysts are dominated by the euryhaline genus *Nannoceratopsis*, so this may represent brackish water conditions. Clearly, the degree of marine influence was extremely small. The dominance of *Nanoceratopsis* is consistent with the Aalenian/earliest Bajocian interval. This is confirmed by the absence of the *Parvocysta* group, and the lack of *Durotrigia filapicata* and *Phallocysta thomasii*. This means that the succession studied ranges from the Murchisonae to Laeviuscula chronozones. In summary, the presence of the dinoflagellate cysts *Nannoceratopsis deflandrei* subsp. *senex* and *Pareodinia halosa,* and the pollen genus *Callialasporites* is indicative of the Aalenian-earliest Bajocian.

Sample 3 at 16579 feet from well 211/28-H15 is within the Mid Ness Shale; it produced 13 marine palynomorphs per slide and is indicative of marginal marine conditions. A single sample of the non-marine/brackish acritarch *Truncatisphaeridium clevelandense* was also recovered. The occurrence of *Truncatisphaeridium clevelandense* in this horizon is indicative of a mid Aalenian (Murchisonae Chronozone) age, and a probable brackish water palaeoenvironent.

Sample 6 at 11200 feet from well 211/28-H1 produced a moderately abundant marine palynomorph association, and therefore represents relatively open marine conditions.

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