British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

A palynological study of the lowermost Nordland Shale Formation in Norwegian Well 15/9-A11 at 906.00 m

Responsive Programme

Internal Report CR/03/001

BRITISH GEOLOGICAL SURVEY

INTERNAL REPORT CR/03/001

A palynological study of the lowermost Nordland Shale Formation in Norwegian Well 15/9-A11 at 906.00 m

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Key words

palynomorphs, biostratigraphy, palaeoecology, Pliocene.

Bibliographical reference

RIDING, JAMES B.. 2003. A palynological study of the lowermost Nordland Shale Formation in Norwegian Well 15/9-A11 at 906.00 m. *British Geological Survey Internal Report*, CR/03/001. 1pp.

Keyworth, Nottingham British Geological Survey 2003

Foreword

This report is based on a palynological investigation of a single sample of conventional core from 906.00 m in Norwegian offshore well 15/9-A11. This horizon lies within the lowermost Nordland Shale Formation. This unit is the cap rock for the Utsira Formation. The sample is of suspected Miocene-Pliocene age and this investigation aims to determine the age and environment of deposition.

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Summary

The sample studied is interpreted as being of Late/latest Pliocene age based on its low diversity dinoflagellate cyst flora which is dominated by *Brigantedinium* spp. and includes low proportions of *Selenopemphix quanta*. *Selenopemphix quanta* is known to extend into the Pliocene and the overall dinoflagellate cyst flora does not resemble any known Early Pleistocene assemblages in the North Sea region. The abundance of *Brigantedinium* spp., the low diversity nature of this association and the common plant spores points to an inner neritic palaeoenvironment, close to an area of high fluvial output.

1 Introduction

A single sample of conventional core from 906.00 m in Norwegian offshore well 15/9-A11 was submitted for palynological analysis. This horizon is within the lowermost Nordland Shale Formation, and this is the cap rock for the Utsira Formation. The sample is of suspected Miocene-Pliocene age and this investigation aims to determine the age and environment of deposition. Previous studies (e.g. Eidvin *et al*., 1999; Piasecki *et al*., 2002) indicate that a Late Pliocene age is most likely. The lithology is dark green clay, with a crude fabric of laminations and no visible macrofossils. This small (*c*. 15 g.) sample was registered in the BGS collection as number MPA 51092, it was prepared using the conventional mineral acid digestion method.

2 Palynology

The sample produced a moderately abundant organic residue and palynoflora. Palynomorphs are relatively abundant and are well preserved. Some reworking was noted. The kerogen assemblage comprises common wood fragments with lesser proportions of other plant tissues and amorphous organic material. Resistant mineral grains are present; most of these are a distinctive light blue colour. Appendix 1 gives a listing of the palynomorph taxa recognised.

The palynoflora comprises both indigenous marine and terrestrially-derived forms. Dinoflagellate cysts are the most common component, however are not diverse (Appendix 1). The most common forms are *Brigantedinium* spp., indeterminate forms, *Lejeunecysta* spp., *Selenopemphix nephroides* and *Spiniferites* spp. A Miocene age is precluded by the absence of key Miocene marker dinoflagellate cyst such as *Unipontidinium aquaeductum* (see Powell, 1992) and the low diversity. The presence of *Selenopemphix quanta* suggests that the sample is no older than Late/latest Pliocene. Harland (1992, fig. 5.2) indicated that the range base of *Selenopemphix quanta* (as *Protoperidinium conicum*) is pre-Pleistocene, although there are few records of this species from the Pliocene. *Selenopemphix quanta* is present throughout the Quaternary and may be common (Harland, 1992; Head, 1998, table 1, Riding *et al*., 1997; 2000). The overall dinoflagellate cyst association does not appear to be of Early Pleistocene (or Quaternary generally) in character (Cameron *et al*., 1984; Harland, 1988; 1992; Harland *et al*., 1991), therefore it is interpreted as being Late/latest Pliocene in age. For example *Operculodinium* spp. are absent. The low dinoflagellate cyst diversity is also consistent with the Late/latest Pliocene; this interval is typified by low dinoflagellate cyst abundances and diversities due to global cooling at this time (De Vernal and Mudie, 1992; Stover *et al*., 1996, p. 720). The horizon is probably very close to the Pliocene-Pleistocene transition.

Peridinialean dinoflagellate cysts dominate the assemblage. This, particularly the abundance of *Brigantedinium* spp., and the low diversity, indicate a nearshore, inner neritic palaeoenvironment (Stover *et al*., 1996, p. 718). Abundant *Brigantedinium* spp. can indicate areas of upwelling areas, rich in nutrients (Bujak, 1984). This scenario is not envisaged for the northern North Sea and Head *et al*. (1989) reported that common/abundant *Brigantedinium* spp. are consistent with areas of high fluvial discharge such as an estuary. The abundance of congruentidiacean ('protoperidiniacean') forms such as *Brigantedinium* spp. is also typical of high latitude Miocene-Holocene associations. Eidvin *et al*. (1999) reported that the underlying Utsira Sand Formation is of latest Mid Miocene to earliest Late Pliocene on foraminiferal evidence. Furthermore, Piasecki *et al*. (2002) concluded that the Utsira Sand Formation of well 15/9-A23 is Early Pliocene in age. Thus both the studies of Eidvin *et al*. (1999) and Piasecki *et al*. (2002) are therefore consistent with the lowermost Nordland Shale Formation cap rock being of Late/latest Pliocene age.

The pollen/spore association is also of low diversity. Age diagnostic taxa are absent and the flora is dominated by undifferentiated bisaccate pollen, some of which may be reworked. Carboniferous and possibly Jurassic/Cretaceous reworking is also present (Appendix 1). The low diversity and the occurrence of reworking precludes a detailed palaeoecological assessment based on miospores. However, the common occurrence of spores such as *Laevigatosporites* spp., *Lycopodiumsporites* spp., *Polypodium* sp. and *Stereisporites* spp. suggests a wet, low lying, nearshore setting.

3 Conclusions/Summary

Sample MPA 51092 is interpreted as being of Late/latest Pliocene age based on its low diversity dinoflagellate cyst flora which is dominated by *Brigantedinium* spp. and includes low proportions of *Selenopemphix quanta*. *Selenopemphix quanta* is known to extend into the Pliocene and the overall dinoflagellate cyst flora does not resemble any known Early Pleistocene assemblages in the North Sea region. The abundance of *Brigantedinium* spp., the low diversity nature of this association and the common plant spores points to an inner neritic palaeoenvironment, close to an area of high fluvial output, such as an estuary.

Appendix 1 Listing of palynomorph taxa recognised

This Appendix lists all palynomorphs recognised in this study, alphabetically in their constituent groups. The number of specimens per microscope slide is indicated in the right hand column. (R) = reworked.

Dinoflagellate cysts:

Achomosphaera spp.	2
Barssidinium sp.	1
Batiacasphaera spp.	7
Brigantedinium spp.	543
chorate dinoflagellate cysts – indeterminate	32
dinoflagellate cysts – indeterminate	29
Habibacysta sp.	1 + ?1
Lejeunecysta spp.	14
Lejeunecysta sp. (dark and denticulate)	31
?cysts of *Polykrikos schwartzii*	4
Selenopemphix nephroides	23
Selenopemphix quanta	2
Selenopemphix sp.	1
Spiniferites spp.	51

Miscellaneous microplankton:

Acanthomorph acritarchs – indeterminate	33
Botryococcus braunii	1
foraminiferal test linings	52
Micrhystridium spp.	39

Pollen:

bisaccate pollen – undifferentiated	391
Compositae pollen	1
Inaperturopollenites hiatus	2
?*Perinopollenites elatoides* (?R)	1
pollen grains – indeterminate	30

Spores:

Carboniferous spore – indeterminate (R)	1
Cicatricosisporites sp. (R)	1
Cyathidites spp.	29
Densosporites spp. (R)	4
Laevigatosporites spp.	7
Lycopodiumsporites spp.	11
Lycospora pusilla (R)	2
Polypodium sp.	1
Stereisporites spp.	22

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