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Palynology of the interval 1856.4 to 1896.9 m of well 202/04-1, Faroe-Shetland Basin

Energy Systems and Basin Analysis Programme
Commissioned Report CR/16/174

BRITISH GEOLOGICAL SURVEY

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Summary

As part of Phase 3 of the BGS Faroe-Shetland Consortium project on the Jurassic of the UK sector of the Faroe-Shetland Basin, detailed logging of core from well 202/04-1 was undertaken and samples were taken for palynology in order to provide additional facies information and age determinations.

The palynological assemblages were generally dominated by terrestrially derived pollen and spores. Marine palynomorph assemblages, where present, were poorly preserved and of low diversity. Some samples showed no marine palynomorphs. A marginal marine setting with periodic more marine incursions is indicated.

Four samples yielded sufficient dinoflagellate cyst data to suggest an Early to Mid Volgian age. This is supported by the presence of the spore genus *Cicatricosisporites* in most samples.

1 Introduction

During detailed logging of core from well 202/04-1, samples were taken for palynology in order to provide additional facies information and age determinations for the lithofacies analysis.

The samples were prepared for palynology using standard acid maceration techniques. The residues were mounted onto glass slides for microscopic examination. The samples, aqueous residues and microscope slides are held in the BGS collections at Keyworth, Nottingham.

Sample details are given in Appendix 1.

2 Palynology

Summary descriptions of all 18 samples follow. Detailed data is set out in Appendix 2. Zones referred to are standard ammonite zones.

2.1 SAMPLES 1 TO 3 (1856.4 TO 1863.88 M) – EARLY TO MID VOLGIAN

This interval is characterised by high proportions of the four main kerogen groups with amorphous organic material and plant cuticle being particularly common. The percentage of marine palynomorphs is low in sample 1, made up of specimens of the acritarch genus *Micrhystridium* spp. and foraminiferal test linings, but higher in samples 2 and 3,

In sample 1, questionable specimens of the dinoflagellate cysts *Pareodinia halosa* and *Cyclonephelium* sp. are present but not particularly age diagnostic, being only generally characteristic of the Late Jurassic. In sample 2, isolated specimens occur of the dinoflagellate cysts *Gochteodinia mutabilis*, indicating a latest Kimmeridgian to Mid Volgian (range top Okusensis Zone) age, and *Kleithriasphaeridium porosispinum* indicating a late Early Volgian to Valanginian age, plus poorly preserved specimens of the Late Jurassic genera *Systematophora* and *Cribroperidinium*. The overlapping ranges of *G. mutabilis* and *K porosispinum* indicate a late Early to Mid Volgian age (Riding and Thomas, 1992) no younger than the Okusensis Zone. The dinoflagellate cysts present in sample 3 include *Cribroperidinium* spp. and *Gochteodinia mutabilis*, the latter indicating a latest Kimmeridgian to Mid Volgian. Also present are a specimen questionably allocated to *Systematophora* cf. *daveyi* and several indeterminate chorate dinocysts.

The pollen assemblages are dominated by bisaccate and inaperturate gymnospermous forms. The spore assemblage includes *Baculatisporites commaumensis, Cyathidites* spp., *Dictyophyllidites* sp. *Gleicheniidites cirniidites*, *G. minor, Retitriletes* sp., *Tuberositriletes grossetuberculatus* and *Cicatricosisporites* sp. The latter indicates strata no older than Volgian (Dörhöfer, 1979).

2.2 SAMPLES 4 TO 7 (1864.93 TO 1867.97 M) – EARLY TO MID VOLGIAN

This interval is characterised by low diversity palynological assemblages**.** Marine palynomorphs are absent from samples 4 and 5. In sample 6**,** the very sparse marine assemblage includes only *Micrhystridium* spp. and an indeterminate chorate dinoflagellate cyst. The sparse marine palynomorphs in sample 7 include a fragment of the chorate dinoflagellate cyst genus *Systematophora*. The kerogen assemblage is dominated by amorphous organic material and contains relatively little opaque woody material, except for sample 7.

The pollen assemblages are dominated by bisaccate pollen with *Perinopollenites elatoides, Cerebropollenites* spp. and *Classopollis* spp. The sparse spore assemblages yield *Baculatisporites commaumensis, Cyathidites* spp., *Densosporites* spp., *Dictyophyllidites* spp., *Ischyosporites* sp., *Maculatisporites* spp., *Neoraistrickia* sp., *Obtusisporis* sp., *Retitriletes* sp. *Rubinella* spp. and *Cicatricosisporites* spp., the latter suggesting a Volgian or younger age. The position of this interval between samples containing good age markers allows the assignment of an Early to Mid Volgian age.

2.3 SAMPLES 8 TO 10 (1871.26 TO 1882.17 M) – EARLY TO MID VOLGIAN

The kerogen recovered from this interval is variable in composition. Sample 8 is unusual in that it is dominated by woody material and has very little plant cuticle and amorphous organic material; sample 9 has kerogen of all types but with a slight dominance of brown woody material; and in sample 10, kerogen is abundant and spread across all kerogen types.

The pollen assemblages are dominated by bisaccate pollen, inaperturate pollen and *Perinopollenites elatoides* with less common occurrences of *Araucariacites australis, Callialasporites* spp., *Cerebropollenites* spp., *Classopollis* spp., and *Exesipollenites scabratus*. The spore assemblage is diverse with representatives of the genera *Baculatisporites commaumensis, Cicatricosisporites* spp., *Cyathidites* spp., *Densosporites, Gleicheniidites* spp., *Ischyosporites* spp., *Maculatisporites* spp., *Obtusisporis canadensis, Retitriletes* spp., *Rubinella major* and *Trilobosporites* sp.

Sample 8 has the highest percentage of marine palynomorphs of all the samples analysed for this well with a dinoflagellate cyst assemblage dominated by the *Cribroperidinium globatum* group which ranges in age from the Mid Oxfordian to the Cretaceous (Riding and Thomas, 1992). Also present are *Cyclonephelium hystrix, Systematophora* spp., *Hystrichosphaerina orbifera* and *Leptodinium subtile* (range top Albani Zone). The latter indicates a Late Jurassic age no younger than the Mid Volgian (Riding and Thomas, 1992). Sample 9 is dominated by *Cyclonephelium hystrix* which has an age range from the Kimmeridgian to the Cretaceous (Riding and Thomas, 1992). Also present are *Pareodinia halosa,* the *Cribroperidinium globatum* group, *Systematophora* spp. and *Ctenidodinium* sp. The percentage of marine palynomorphs in sample 10 is very low. The assemblage includes *Cribroperidinium* sp., *Endoscrinium* sp. and an indeterminate chorate dinoflagellate cyst.

2.4 SAMPLES 11 TO 15 (1883.93 TO 1890.78 M) – EARLY TO MID VOLGIAN

Kerogen is abundant and spread across all types except for sample 11 which has brown wood, plant cuticle and amorphous organic material but opaque woody material is absent. Bisaccates, inaperturates and *Exesipollenites scabratus* dominate the pollen assemblage. *Araucariacites australis, Callialasporites* spp., *Cerebropollenites* spp., *Classopollis* spp. and *Perinopollenites elatoides* are also present. *Baculatisporites commaumensis* and *Densosporites* spp. dominate the spore assemblage with *Cicatricosisporites* spp., *Contignisporites contignii, Cyathidites* spp., *Gleicheniidites* spp,. *Granulatisporites* spp., *Ischyosporites* spp., *Neoraistrickia* spp., *Obtusisporis canadensis, Punctatisporites* spp., *Retitriletes austroclavatidites, Rubinella* spp., *Trilobosporites* spp. and *Tuberositriletes grossetuberculatus* also present.

The percentage of marine palynomorphs for this interval is very low. The most common marine palynomorphs present are acritarchs such as *Veryhachium* spp. and *Micrhystridium* spp. and indeterminate dinoflagellate cysts. In sample 13, a specimen tentatively attributed to the Early Jurassic species *Liasidium variabile* occurs which would indicate reworking of Late Sinemurian strata. Rare specimens of the dinoflagellate cyst *Systematophora* sp. occur in sample 14 and of *Pareodinia halosa* in sample 15. The position of this interval between samples containing good age markers allows the assignment of an Early to Mid Volgian age.

2.5 SAMPLES 16 TO 18 (1892.46 TO 1896.9 M) – EARLY TO MID VOLGIAN

The percentage of marine palynomorphs for this sample is very low in this interval. Kerogen is abundant and spread across all types.

Bisaccates and *Exesipollenites scabratus* dominate the pollen assemblage. Inaperturate pollen, *Araucariacites australis, Callialasporites, Cerebropollenites, Classopollis* and *Perinopollenites elatoides* are also present. The spore assemblage is sparse but the following genera are represented*: Baculatisporites, Cicatricosisporites, Cyathidites, Densosporites, Foraminisporis, Gleicheniidites, Impardecispora, Ischyosporites, Neoraistrickia, Obtusisporis, Punctatisporites, Retitriletes* and *Tuberositriletes.* The presence of *Cicatricosisporites* in sample 18 indicates that the whole run of samples from this well is no older than Volgian.

Marine palynomorphs in sample 16 include *Micrhystridium* spp. foraminiferal test linings, and the dinoflagellate cysts *Cyclonephelium hystrix* and *Cribroperidinium* sp. In sample 17, marine palynomorphs are rare and include the dinoflagellate cysts *Cribrperidinium globatum* group,

Systematophora cf. *daveyi* and *Dingodinium tuberosum*, which are characteristic of the Kimmeridgian and Volgian. In sample 18, marine palynomorphs include *Micrhystridium* spp., foraminiferal test linings, and the dinoflagellate cysts *Cyclonephelium hystrix*, *Cribroperidinium* sp. and *Systematophora* sp.

3 Conclusions

The 18 samples processed for palynology from the interval 1856.4 to 1896.9 m of well 202/04-1, yielded assemblages of palynomorphs generally showing some marine influence. Four yield a higher proportion of dinoflagellate cysts; these are samples 2 (1860.01 m), 3 (1863.88 m), 8 (1871.26 m) and 9 (1879.43 m). A marginal marine environment of deposition with occasional more fully marine incursions is suggested.

Age determinations are possible using dinoflagellate cysts evidence and, to a lesser degree, spore evidence. The dinoflagellate cysts assemblages are generally sparse and poorly preserved. However, the presence of *Gocheodinia mutabilis* in samples 2(1860.01 m) and 3 (1863.88 m) gives an age of no younger than the Mid Volgian (Okusensis Zone) and the presence of *Kleithriasphaeridiun porosispinum* at 1860.0 m suggests an age no older than Early Volgian Hudlestoni Zone (Riding and Thomas, 1992). The other dinoflagellate cysts present at this level such as the *Cribroperidinium globatum* Group and *Systematophora* spp. have longer Late Jurassic ranges but are not incompatible with a Mid Volgian age. The dinoflagellate cysts assemblages in samples 8 (1871.26 m) and 9 (1879.43 m) contain a limited number of taxa with larger numbers of *Cyclonephelium hystrix* and the *Cribroperidinium globatum* group. These taxa do not allow precise age determination but support a Kimmeridgian to Volgian age (Riding and Thomas, 1992). The presence of *Leptodinium subtile* at 1871.26 brackets the sample between the Oxfordian and Mid Volgian (Albani Zone). Negative evidence can also be used: the absence of the usually common dinoflagellate cyst *Gonyaulacysta jurassica jurassica* implies strata younger than Kimmeridgian.

At this stratigraphical level spores and pollen are generally long ranging and thus of little help in age determination. However, the presence in almost every sample of the very distinctive spore genus, *Cicatricosisporites*, indicates strata of Volgian or younger age. Similarly the occurrence of heavily ornamented spores such as *Tuberositriletes* suggests the early change to floras of a younger aspect (Dörhöfer, 1979).

4 References

DÖRHÖFER, G. 1979. Distribution and stratigraphic utility of Oxfordian to Valanginian miospores in Europe and North America. *American Association of Stratigraphic Palynologists Contributions Series,* No. 5B, 101–132.

RIDING, J B, and THOMAS, J E. 1992. Dinoflagellate cysts of the Jurassic System. 7–97 in *A stratigraphic index of dinoflagellate cysts.* POWELL, A J (editor). (London: Chapman and Hall, British Micropalaeontological Society Publications Series.)

Appendix 1- Sample details (measured depths).

INFORMAL No.	BGS MPA No.	DEPTH (m)	SSK No.
1	67499	1856.4	63450
2	67498	1860.01	63449
3	67497	1863.88	63448
4	67496	1864.93	63447
5	67495	1865	63827
6	67494	1865.25	63446
7	67493	1867.97	63445
8	67492	1871.26	63444
9	67491	1879.43	63443
10	67490	1882.17	63442
11	67489	1883.93	63441
12	67488	1886.47	63440
13	67487	1888.65	63439
14	67486	1890.1	63438
15	67485	1890.78	63437
16	67484	1892.46	63436
17	67483	1894.14	63435
18	67482	1896.9	63434

Appendix 2- Palynology data

Well 202/04-1																		
Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
MPA Number	67499	67498	67497	67496	67495	67494	67493	67492	67491	67490	67489	67488	67487	67486	67485	67484	67483	67482
Depth	1856.4	1860.01	1863.88	1864.93	1865	1865.25	1867.97	1871.26	1879.43	1882.17	1883.93	1886.47	1888.65	1890.1	1890.78	1892.46	1894.14	1896.9
Age interpretation	**Late Jur.**	**Early to Mid Volgian (no younger than the Okusensis Zone)**																
Palaeoenvironment	**Marine**			**Terrestrial taxa only**		**Marine**												
PTERIDOPHYTE SPORES																		
Aequitriradites sp.			?															
Baculatisportites commaumensis	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X
Cardioangulina major			X															
Cicatricosisporites perforatus								?	X		X			X			X	
Cicatricosisporites reticicatricosus									X		X	X	X		X			
Cicatricosisporites sprumontii			X															
Cicatricosisporites sp.	X	X	X	X			X		X		X	X	X	X	X	X	X	X
Contignisporites contignii											X							
Coptospora sp.									?	X			X					
Cyathidites mesozoica											X	X			X		X	X
Cyathidites minor									X		X	X	X	X	X	X	X	X
Cyathidites rotunda	X																	
Cyathidites sp.	X	X	X		X	X		X									X	
Densosporites sp.	X		X			X	X	X	X	X	X	X	X	X	X	X	X	X
Dictyophyllidites sp.	X						X							X				
Foraminisporis sp.											X							X
Foveosporites sp.	X																	
Gleicheniidites cirniidites	X												X					
Gleicheniidites delcourti				?														
Gleicheniidites minor	X	X	X					X	X					X			X	X
Gleicheniidites sp.												X		X			X	
Granulatisporites sp.												X	X					
Impardecispora sp.?																	X	
Ischyosporites sp.	X			X				X			X	X					X	
Leptolepidites sp.								X										
Maculatisporites granulatus						X		X										
Maculatisporites microverrucatus						?												
Maculatisporites sp.							X	X										
Neoraistrickia sp.				X				X			X					X		
Obtusisporis canadensis									X		X		X			X	X	
Obtusisporis sp.				X														
Pilosisporites sp.	X																	
Punctatisporites major										X						X		?
Punctatisporites sp.														X	X	X		X
Retitriletes austroclavatidites									X	X	X				X			
Retitriletes clavatoides				?													X	X
Retitriletes semireticulatus												X	X					
Retitriletes triarcuatus										X			X					
Retitriletes sp.		X	X	X				X										X
Rubinella major									X				?		X			
Rubinella sp.							?											
Spore - indeterminate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Staplinisporites caminus									?									
Trilobospoites sp.										X			X					
Tuberositriletes grossetuberculatus		X									X	X		?		X		
Tuberositriletes sp.														X			X	X
GYMNOSPERM POLLEN																		
Araucariacites australis									X	X		X	X	X				?
Araucaricites sp.	X	X	X	X		X	X				X	X	X	X	X	X	X	
Bisaccate pollen undiff.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Callialasporites dampieri			X				X	X	X	X	X		X	X			X	X
Callialasporites turbatus	X							X	X		X						X	X
Callialasporites sp.	X	X			X	X						X		X		X		
Cerebropllenites macroverrucosus			X						X	X		X	X	X	X		X	X
Cerebropollenites sp.	X	X		X			X	X					X		X	X		
Classopollis spp.	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
Exesipollenites scabratus	X	X	X				X	X	X	X		X	X	X	X	X	X	
Inaperturate pollen spp.	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X
Monocolpate pollen			X			X		X			X	X		X		X	X	X
Perinopollenites elatoides	X	X	X	X			X	X	X	X		X	X	X	X	X	X	X
Tricolpate pollen sp.	X					X											X	
DINOFLAGELLATE CYSTS																		
Cribroperidinium globatum Gp.		X	X					X	X	X						X	X	
Ctenidodinium sp.									X									
Cyclonephelium hystrix	?							X	X							X		X
Dinoflagellate cysts indet.		X	X			X		X	X	X	X	X	X	X			X	
Endoscrinium sp.										X								
Gochteodinia mutabilis		X	X															
Hystrichosphaerina orbifera								X										
Kleithriasphaeridium porosispinum		X																
Leptodinium subtile								X										
Liasidinium variabile													R					
Occisucysta sp.									X									
Pareodinia halosa	X								X						X			
Pareodinia sp.									?									
Sentusidinium sp.													?					
Systematophora cf. daveyi			?					?									X	
Systematophora spp.		X					X	X	X					X				X
MISCELLANEOUS																		
Foraminiferal test lining	X	X	X				X	X	X					X		X		X
Micrhystridium spp.	X	X	X			X	X	X	X	X		X	X	X	X	X	X	X
Veryhachium spp.															X			
KEROGEN TYPE PERCENTGES																		
Wood	23	34	8	14	40	22	32	25	28	44	12	46	28	23	16	32	37	21
Plant fragments	37	13	36	5	21	30	46	0	9	15	27	8	17	30	8	35	17	15
Palynomorphs	19	43	49	30	1	19	18	73	56	18	39	29	39	24	53	6	34	49
Amorph. organic material (AOM)	21	10	7	51	38	29	4	2	7	23	22	17	16	23	23	27	12	15