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Palynology of Faroe-Shetland Basin well 204/27a-1 between 2059.91 and 2137.00 m

Energy Systems and Basin Analysis Programme
Commissioned Report CR/17/070

BRITISH GEOLOGICAL SURVEY

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J B Riding

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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 204/27a-1 was undertaken. Forty-four core samples were taken for palynology between 2059.91 and 2137.00 m in order to provide age determinations and additional facies information. The samples were somewhat variable, but generally were relatively poor in productivity throughout and several horizons proved devoid of palynomorphs. The productive samples were generally dominated by poorly preserved terrestrially derived pollen and spores. Marine palynomorphs, where present, were also poorly preserved and of low diversity. A marine setting is indicated by the productive horizons.

The 37 samples between 2059.91 and 2122.77 m in this well are of Early–Mid Volgian to Ryazanian–Valanginian transition in age. The uppermost sample (1) at 2059.91 m is assigned to the Ryazanian–Valanginian transition due to the occurrence of the chorate dinoflagellate cyst *Systematophora palmula*. The succession from 2061.95 to 2078.05 m (samples 2 to 7) is deemed to be Mid Volgian to Ryazanian in age largely on the basis of the occurrence of *Cribroperidinium hansenii*. The following interval between 2081.47 and 2113.20 m (samples 8 to 25) is assigned to the Mid Volgian on dinoflagellate cyst evidence. The key taxa are *Cribroperidinium gigas*, *Cribroperidinium hansenii*, *Muderongia simplex* ('sp. A') and *Senoniasphaera jurassica*. Specifically, range tops of *Muderongia simplex* ('sp. A') and *Senoniasphaera jurassica* at 2081.47 m indicate the Mid Volgian Kerberus zone. The lowermost seven samples (38–44) between 2123.60 and 2137.00 m proved barren of palynomorphs, and hence cannot be dated. The succession between 2113.90 and 2122.77 m (samples 26 to 37) is interpreted as being no older than Volgian, and hence Early to Mid Volgian, on the basis of the sporadic presence of the highly ornamented spore genus *Cicatricosisporites*.

1 Introduction

As part of detailed sedimentological logging of conventional core from offshore well 204/27a-1, forty-four samples between 2059.91 and 2137.00 m were collected for palynological analysis in order to provide biostratigraphical ages and palaeoecological information. The samples were all prepared using standard acid-based techniques. The samples, aqueous residues and microscope slides are held in the BGS collections at Keyworth, Nottingham. Details of the 44 samples are listed in Appendix 1. The zones referred to are standard ammonite zones.

2 Palynology

Summary descriptions of the biostratigraphy of five intervals follow in this section. The data supporting this is set out in the three range charts which comprise Appendix 2. A full range chart in the form of a spreadsheet has been archived.

2.1 SAMPLE 1 (2059.91 M) – RYAZANIAN–VALANGINIAN TRANSITION

This sample produced a moderately abundant palynoflora (Table 1 of Appendix 2). The chorate (spine-bearing) dinoflagellate cyst *Systematophora palmula* is present. Consistent records of this distinctive species have a well-defined stratigraphical range of Late Ryazanian (intra *Stenomphalus* Zone) to earliest Valanginian (*Paratollia* Zone) (Davey, 1982, fig. 3; Heilmann-Clausen, 1987, fig. 4; Costa and Davey, 1992, fig. 3.3). Questionable material of *Systematophora daveyi* was also observed in sample 1. This species ranges from the Kimmeridgian to the Early Ryazanian (*Cymodoce* to *Kochi* zones) (Davey, 1982, p. 13; Riding and Thomas, 1988, p. 86).

The material of *Systematophora daveyi* is deemed too equivocal to use it as a marker, hence sample 1 is interpreted as being of Late Ryazanian to earliest Valanginian age. The remainder of the palynoflora is entirely consistent with this age assessment. The relatively abundant marine palynomorphs indicate a marine depositional setting.

2.2 SAMPLES 2 TO 7 (2061.95 TO 2078.05 M) – MID VOLGIAN TO RYAZANIAN

These six samples produced moderately abundant palynofloras (Table 1 of Appendix 2). These six samples are interpreted as being Mid Volgian to Ryazanian in age. The base of this interval is interpreted as being Mid Volgian in age as it directly overlies strata assigned to the intra-Mid Volgian Kerberus Zone (subsection 2.3). *Cribroperidinium gigas* (sample 7 only) and *Cribroperidinium hansenii* are present in relatively prominent proportions. *Cribroperidinium hansenii* is known from the Mid Volgian (Albani zone) to the Late Ryazanian (Stenomphalus Zone). The species is especially consistent and prominent in the Mid–Late Volgian (Okusensis to Primitivus zones) (Davey, 1982; Heilmann-Clausen, 1987; Poulsen, 1996). Hence this interval is most likely to be Mid to Late Volgian in age. The presence of *Cribroperidinium gigas* in sample 7, and the questionable presence of *Senoniasphaera jurassica* in samples 4 and 3, is consistent with this age assessment (Raynaud, 1978; Riding and Thomas, 1992). Samples 7 to 2 cannot be younger than Ryazanian due to the presence of *Systematophora palmula* in the overlying sample (subsection 2.1). The consistent occurrence of marine palynomorphs indicates a marine depositional setting.

2.3 SAMPLES 8 TO 25 (2081.47 TO 2113.20 M) – MID VOLGIAN

The 18 samples in this interval generally produced moderately abundant palynofloras (Table 2 of Appendix 2). Sample 25 (2113.20 m) is the range base of common dinoflagellate cysts in this succession. These, and other marine indices, are present throughout the succession examined upsection from 2113.20 m. The marine palynomorphs indicate a consistent marine influence throughout this interval.

The range bases of *Cribroperidinium gigas* and *Cribroperidinium hansenii* indicates that 2113.20 m is no older than Mid Volgian (Albani zone) (Davey, 1982; Poulsen, 1996). The range tops of *Muderongia simplex* (previously '*Muderongia* sp. A') and *Senoniasphaera jurassica* are in sample 8 (2081.47 m). These bioevents indicate the Mid Volgian Kerberus zone (Poulsen and Riding, 1992; Riding et al., 2000). The remaining dinoflagellate cyst taxa including *Amphorula expirata*, *Cribroperidinium* spp., *Cyclonephelium* spp., *Kleithriasphaeridium porosispinum*, *Leptodinium* spp., *Systematophora* spp. and *Tubotuberella apatela* are entirely consistent with a Mid Volgian age. In terms of the kerogen associations, there is an increase in proportion in amorphous organic material (AOM) upsection.

2.4 SAMPLES 26 TO 37 (2113.90 TO 2122.77 M) – EARLY TO MID VOLGIAN

These six samples produced relatively sparse, low-diversity palynofloras (Table 3 of Appendix 2). Samples 26 to 37 proved extremely sparse palynologically; the low diversity palynofloras are largely long-ranging pollen and spores. It is overlain by a proven Mid Volgian succession (subsection 2.3). The spores include the distinctive genus *Cicatricosisporites*. This genus is indicative of an age no older than Volgian. Thus this interval is interpreted as being of Early to Mid Volgian age. The kerogen associations are dominated by wood and plant tissue, suggesting that this interval is a coherent genetic unit.

2.5 SAMPLES 38 TO 44 (2123.60 TO 2137.00 M) – INDETERMINATE

These seven samples produced residues that are virtually entirely devoid of palynomorphs, and hence cannot be positively dated palynologically. However sample 43 produced a single smooth fern spore; this is not biostratigraphically significant. The samples were also largely devoid of

kerogen. These samples were, therefore, highly organic-lean and apparently part of the same genetic sedimentary unit.

3 Conclusions

The 37 productive palynology samples from well 204/27a-1 between 2059.91 and 2122.77 m are of Early to Mid Volgian to the Ryazanian–Valanginian transition in age. The uppermost sample (1) at 2059.91 m is assigned to the Ryazanian–Valanginian transition due to the occurrence of the chorate dinoflagellate cyst *Systematophora palmula*. The succession from 2061.95 to 2078.05 m (samples 2 to 7) is deemed to be Mid Volgian to Ryazanian in age largely on the basis of the occurrence of *Cribroperidinium hansenii*. The interval between 2081.47 and 2113.20 m (samples 8 to 25) is assigned to the Mid Volgian on dinoflagellate cyst evidence. The key taxa are *Cribroperidinium gigas*, *Cribroperidinium hansenii*, *Muderongia simplex* ('sp. A') and *Senoniasphaera jurassica*. Specifically, range tops of *Muderongia simplex* ('sp. A') and *Senoniasphaera jurassica* at 2081.47 m indicate the Mid Volgian Kerberus Zone. The succession between 2113.90 and 2122.77 m (samples 26 to 37) is interpreted as being no older than Volgian, and hence Early to Mid Volgian, on the basis of the sporadic presence of the highly ornamented spore genus *Cicatricosisporites*. The lowermost seven samples (38–44) between 2123.60–2137.00 m proved barren of palynomorphs, and hence cannot be dated.

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APPENDIX 1- LIST OF SAMPLES (measured depths)

Informal No.	BGS Registration No.	Depth (m)
1	MPA 67481	2059.91
2	MPA 67480	2061.95
3	MPA 67479	2065.83
4	MPA 67478	2068.60
5	MPA 67477	2071.61
6	MPA 67476	2075.14
7	MPA 67475	2078.05
8	MPA 67474	2081.47
9	MPA 67473	2084.32
10	MPA 67472	2087.36
11	MPA 67471	2091.16
12	MPA 67470	2093.96
13	MPA 67469	2094.29
14	MPA 67468	2094.42
15	MPA 67467	2094.33
16	MPA 67466	2098.99
17	MPA 67465	2099.61
18	MPA 67464	2104.08
19	MPA 67463	2105.70
20	MPA 67462	2107.00
21	MPA 67461	2107.81
22	MPA 67460	2109.85
23	MPA 67459	2111.57
24	MPA 67458	2112.42
25	MPA 67457	2113.21
26	MPA 67456	2113.90
27	MPA 67455	2115.35
28	MPA 67454	2116.66
29	MPA 67453	2117.35
30	MPA 67452	2118.37
31	MPA 67451	2119.61
32	MPA 67450	2120.00
33	MPA 67449	2120.92
34	MPA 67448	2121.82

35	MPA 67447	2122.29
36	MPA 67446	2122.55
37	MPA 67445	2122.77
38	MPA 67444	2123.60
39	MPA 67443	2126.08
40	MPA 67442	2131.56
41	MPA 67441	2133.18
42	MPA 67440	2133.75
43	MPA 67439	2134.90
44	MPA 67438	2137.00

APPENDIX 2- PALYNOMORPH DATA

Table 1 Palynomorph range chart for samples 1 to 7 inclusive.

204/27a-1							
Number	1	2	3	4	5	6	7
MPA Number	67481	67480	67479	67478	67477	67476	67475
Depth (?)	2059.91	2061.95	2065.83	2068.6	2071.61	2075.14	2078.05
Age interpretation	Ryaz/Val	Mid Volgian to Ryazanian					
Palaeoenvironment	marine						
PTERIDOPHYTE SPORES:							
Coronatispora valdensis							X
Cyathidites spp.		27					X
Ischyosporites vaerigatus			X				
spores - indeterminate	1	5			X		X
GYMNOSPERM POLLEN:							
bisaccate pollen - undifferentiated	109	99	X	X	X		X
Callialasporites dampieri	1						
Callialasporites turbatus	2						
Cerebropollenites macroverrucosus	4	4		X		X	X
Classopollis spp.	10	21	X				X
Perinopollenites elatoides	15	14	X				X
pollen - indeterminate	22						
Vitreisporites pallidus	X						
DINOFAGELLATE CYSTS:							
chorate dinoflagellate cysts - indet.	19		X	X			
Cribroperidinium gigas							X
Cribroperidinium hanseni		2	X	X	X	X	X
Cribroperidinium spp. (thick-w alled)	X	3	?	X	X	X	X
Cyclonephelium spp.	8	X					
dinoflagellate cysts - indet.	32	71	X	X	X	X	
gonyaulacoid dinoflagellate cysts - indet.	10	6		X			
Leptodinium sp.						?	?
Senoniasphaera jurassica			?	?			
Sentusidinium spp.		1	X	X	X		
Surculosphaeridium sp.	?1			X			
Systematophora areolata	1		X	X			
Systematophora daveyi	?1						
Systematophora palmula	1 + ?1			?			
Systematophora spp.	...		X	X	X		
MISCELLANEOUS:							
Botryococcus	1		X				
foraminiferal test linings	17	7	X	X	X	X	X
Pterospermella	1	1			X	X	
Tasmanites spp.	3	28	X	X	X	X	X
KEROGEN TYPE PERCENTAGES							
w ood	13	12	18	12	15	13	15
plant fragments	5	7	5	23	13	5	13
palynomorphs	10	8	5	7	10	10	12
amorphous organic material (AOM)	72	73	72	58	62	72	60

Table 2 Palynomorph range chart for samples 8 to 25 inclusive.

20427a-1																		
Number	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
MPA Number	67474	67473	67472	67471	67470	67469	67468	67467	67466	67465	67464	67463	67462	67461	67460	67459	67458	67457
Depth (7)	2081.47	2084.32	2087.36	2091.16	2093.96	2094.29	2094.42	2094.33	2098.99	2099.61	2104.06	2105.7	2107	2107.81	2109.85	2111.57	2112.42	2113.21
Age interpretation	Mid Volgian																	
Palaeoenvironment	marine																	
PTERIDOPHYTE SPORES:																		
Cicatricosisporites spp.							X											
Cyathidites spp.	X		X	X	X		X		X	X	X	X	X		X	X		X
Foveosporites pseudooveolatus	X										X							
Gleicheniidites senonicus					X													
Ischyrosporites vaerigatus												X		X				
Retriletes spp.									X				X					
spores - indeterminate							X			X				X	X			X
GYMNASPERM POLLEN:																		
biaccate pollen - undifferentiated	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	1	X
Cerebropollenites macroverrucosus	X	X		X	X			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
Penninopollenites elatoides		X												X				X
Vitresporites pallidus		X											X	X	X			
DINORLAGELLATE CYSTS:																		
Amphoula spirinata									X									
chorate dinoflagellate cysts - indet.	X	X							X	X		X			X	X		X
Cribroperidinium gigas	X	X	X		X	?	X		X	X	X	X	X	X	X	X		X
Cribroperidinium hanseni	X	X					X		X	X	X	X	X	X	X	X		X
Cribroperidinium spp. (thick-walled)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1	X
Olenidinium sp.										X	X	X	X	?	X	X	X	X
dinoflagellate cysts - indet.	X		X	X				X	X	X	X	X			X	X	X	4
gonyaulacoid dinoflagellate cysts - indet.									X									
Hyaltrichodinium pulchrum	X																	
Kleinfasphaeridium porosispinum									X			?		X				?
Lepidodinium sp.	X	X											X	?	...	?		
Muderongia simplex (sp. A)	X	X							X			X						
Oligosphaeridium patulum																?		
Rotosphaeropsis thula																		?
Senoniasphaera jurassica	X	?							X						X			
Santusidinium spp.		X		X			X											
Stanfordella sp.	?																	
Systematophora areolata	X												X					
Systematophora palmula												?					?	
Systematophora spp.	X		X					X	X	X		X	X	X	X	X		
Tubocuberella spetala	X	?																
MISCELLANEOUS:																		
Botryococcus								X										
Cymatospheera spp.								X										
foraminiferal tests (frag.)	X	X	X	X	X				X	X	X		X	X	X	X		
Pterosperma	X			X				X				X						
Tasmanites spp.		X		X	X				X			X	X	X	X	X		
KEROGEN TYPE PERCENTAGES																		
wood	25	10	18	28	57	43	33	33	25	35	43	42	32	50	50	37	82	77
plant fragments	5	10	7	10	13	8	7	7	15	8	17	7	14	20	20	15	9	10
palynomorphs	8	8	8	3	5	7	8	7	13	12	13	8	27	13	13	20	...	3
amorphous organic material (AOM)	62	72	67	59	25	42	52	53	47	45	27	43	27	17	17	28	9	10

Table 3 Palynomorph range chart for samples 26 to 37 inclusive.

204/27a-1												
Number	26	27	28	29	30	31	32	33	34	35	36	37
MPA Number	67456	67455	67454	67453	67452	67451	67450	67449	67448	67447	67446	67445
Depth (?)	2113.9	2115.35	2116.66	2117.35	2118.37	2119.61	2120	2120.92	2121.82	2122.29	2122.55	2122.77
Early to Mid Volgian												
Age interpretation												
Palaeoenvironment	Terrestrial taxa only						? Marine			Terrestrial taxa only		
PTERIDOPHYTE SPORES:												
Cicatricosisporites spp.					?	X						
Coronatipora valdensis					X		X			X		X
Cyathidites spp.					X	X	X					X
Gleicheniidites senonicus										X		
Ischyosporites vaerigatus								X		X		
Retitriletes spp.					X	X	X		X	X		X
spores - indeterminate	3				X	X	X		X	X	?	X
?spore with spiral ornament				12								
GYMNOSPERM POLLEN:												
bisaccate pollen - undifferentiated	5				X	X	X		?	X		X
Callialasporites turbatus									?			
Classopollis spp.						X	X					
Perinopollenites elatoides									X			
Vitreisporites pallidus											X	
DINOFLAGELLATE CYSTS:												
chorate dinoflagellate cysts - indet.	3	1										
Criboveridinium spp. (thick-walled)	3											
dinoflagellate cysts - indet.									?			
Sentusidinium spp.			1									
MISCELLANEOUS:												
foraminiferal test linings	1											
Tasmanites spp.									X			
KEROGEN TYPE PERCENTAGES												
wood	75	...	93	85	71	55	80	95	83	52	90	28
plant fragments	17	...	5	10	17	10	7	2	5	23	10	52
palynomorphs	1	...	0	0	7	9	3	0	10	15	0	3
amorphous organic material (AOM)	7	...	2	5	5	26	10	3	2	10	0	17