

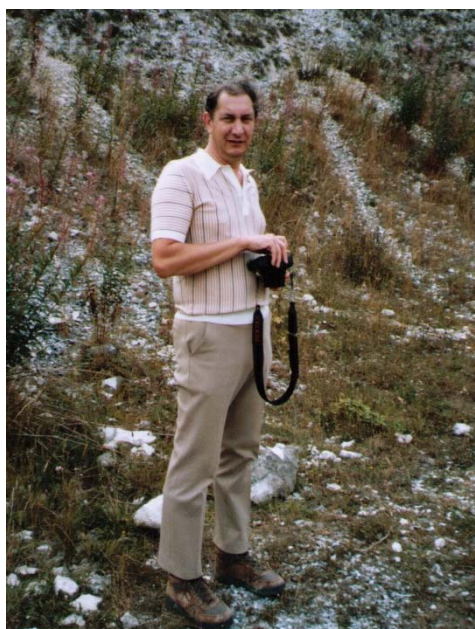
Supplementary project background

This paper was drafted in 2019 and commemorates the 30th anniversary of the summer of 1989 Chalk Group field season in the Lincolnshire Wolds.



Paul Dodsworth at Caistor Limes Quarry, 30th August 1989.

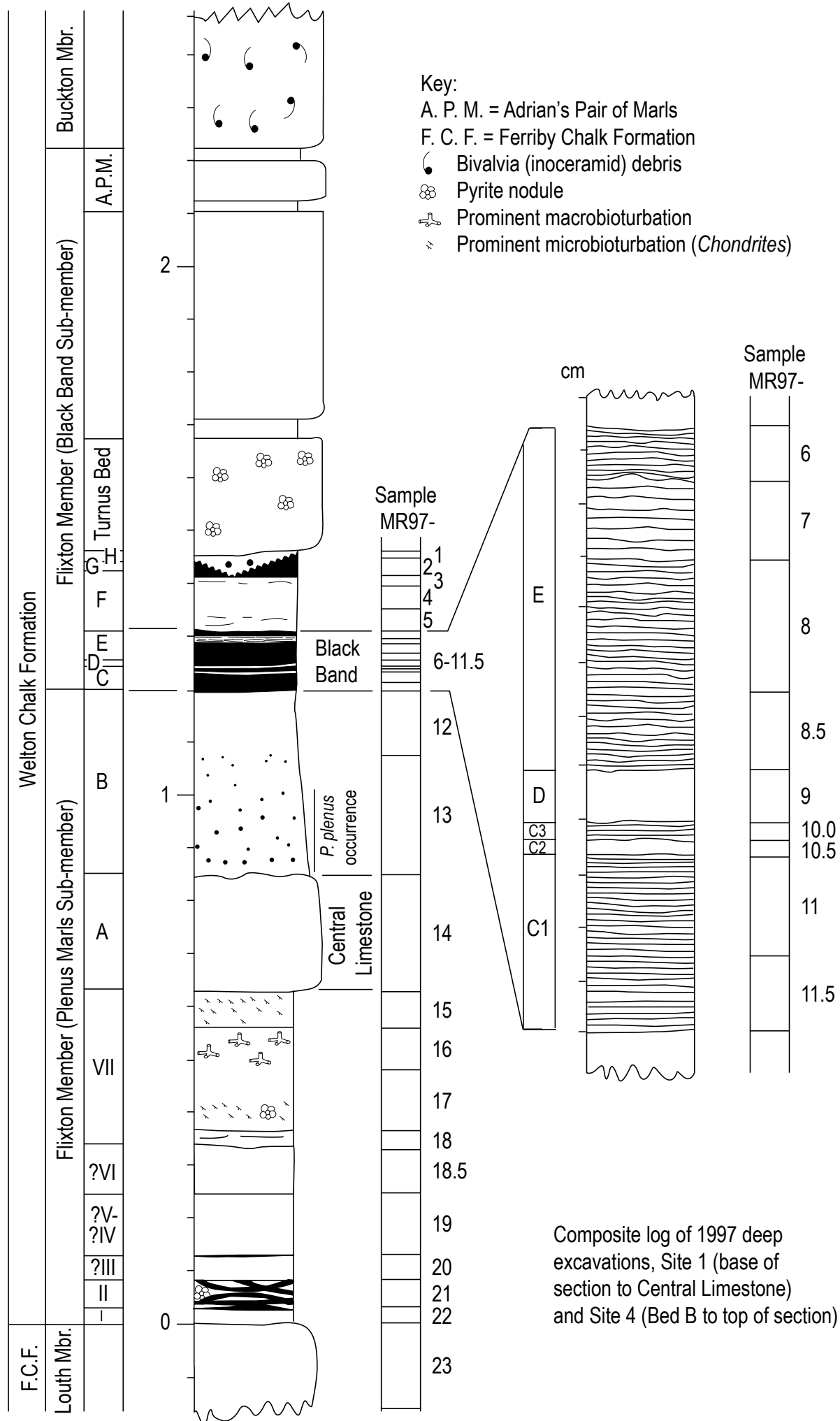
Paul Dodsworth was an undergraduate at Plymouth University from 1987–1990. He undertook fieldwork in Lincolnshire during the summer of 1989 for his B.Sc. Hons. Applied Geology dissertation, supervised by Malcolm Hart. The field logs and samples from their project were later published in Hart *et al.* (1991, 1993). Their co-worker and palynologist Ailbhe M. Duane inspired Paul to apply to Sheffield University and specialise in palynology (M.Sc., 1992; Ph.D., 1997). He published a follow-up Chalk study from Lincolnshire and Yorkshire in Dodsworth (1996). He has since worked as a biostratigraphic consultant, and founded StrataSolve Ltd in 2006. Following Rory Mortimore and the late Chris Wood's initial report on the 'anomalous succession' at Melton Ross Quarry (Wood & Mortimore 1995), Paul visited and sampled the quarry in February 1997. Some preliminary results were published in Dodsworth (2000), along with a palynological calibration of the base of Turonian GSSP at Pueblo, Colorado; and the Plenus Marls at Durdle Door, Lulworth, southern England.



Malcolm B. Hart at Claxby Quarry, 24th August 1989.

James S. Eldrett joined Shell Exploration and Production in 2006 as a biostratigrapher. Between 2011 and 2015, James worked in the Integrated Geoscience Research Team based in Houston, US. Here, he commissioned Paul to assist with palynological calibration of Eagle Ford Group outcrops and cores of Cenomanian and Turonian age in Texas. James has published integrated studies of the stratigraphy and geochemistry of the Eagle Ford, both with Paul, and other colleagues and collaborators (Eldrett *et al.* 2014, 2015a, 2015b, 2017; Minisini *et al.* 2018; Dodsworth & Eldrett 2019a, 2019b).

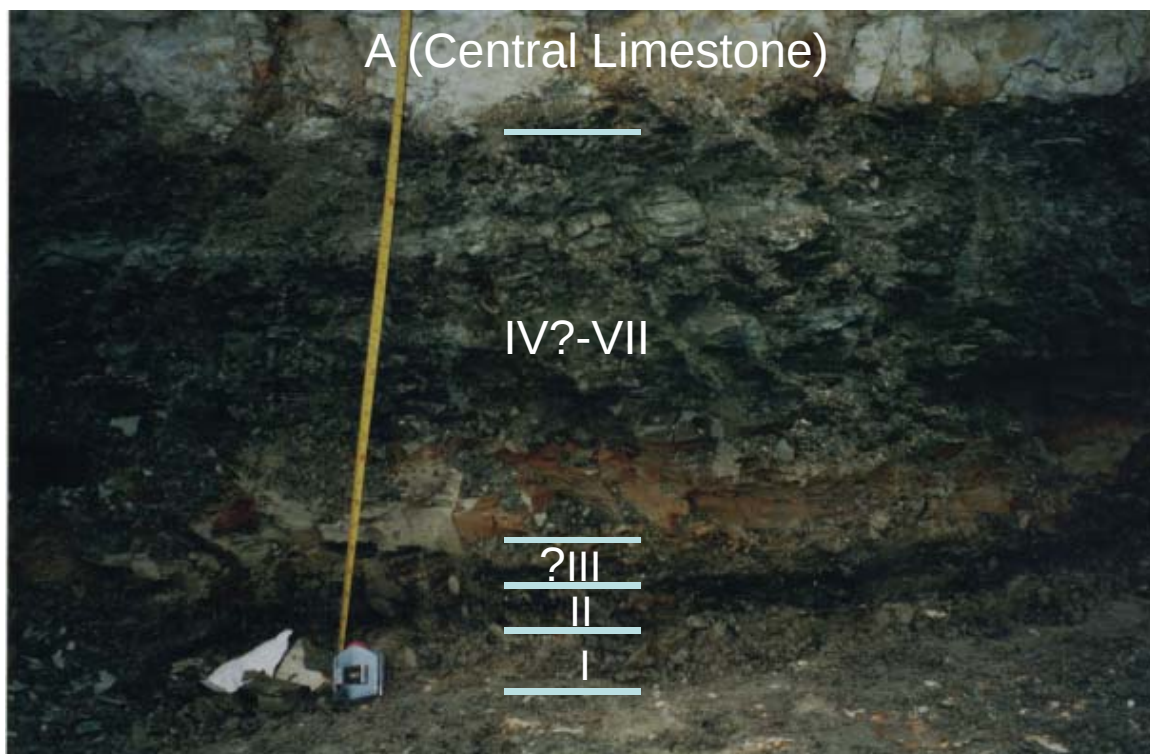
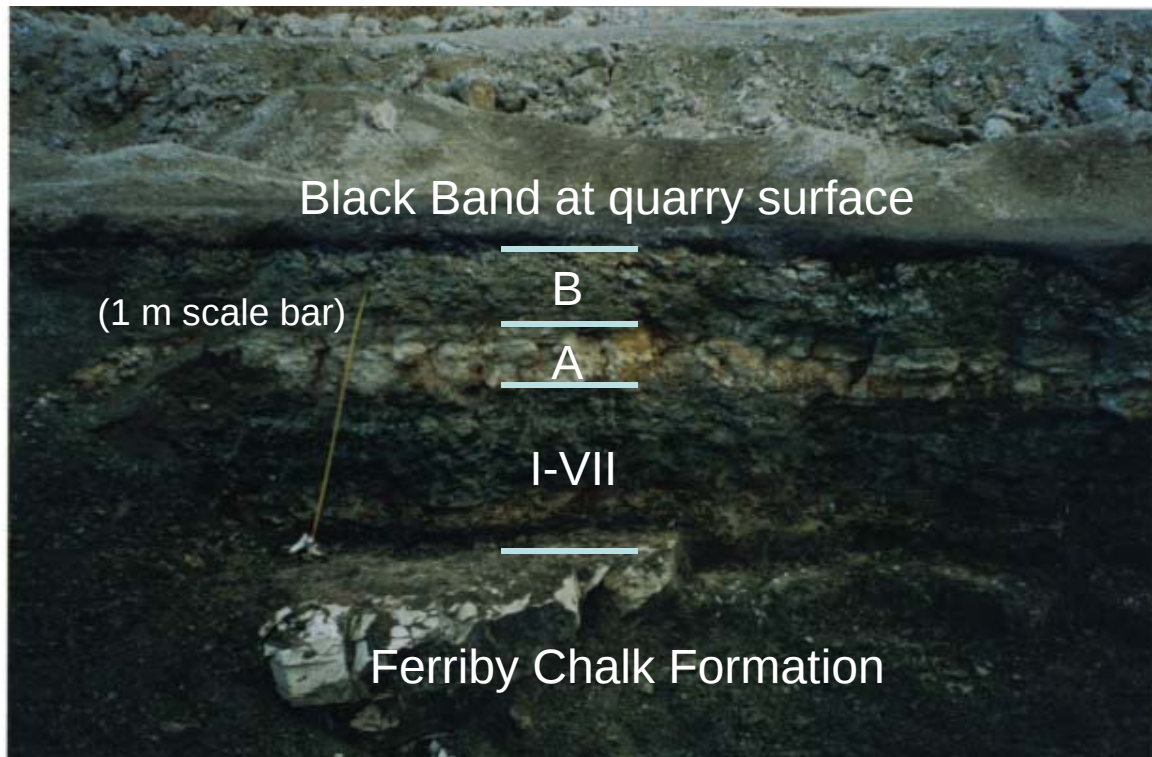
Malcolm B. Hart is an Emeritus Professor at the Faculty of Science and Engineering, Plymouth University, with a research role in micropalaeontology, stratigraphy, ocean acidification and global environmental change. He has published the first (Hart & Bigg 1981) and most recent (Hart 2019) micropalaeontological studies across the Cenomanian–Turonian boundary in eastern England, and plans to analyse the Melton Ross samples that are documented here for palynology and geochemistry.



Supplementary Figure. Detailed sample positions.

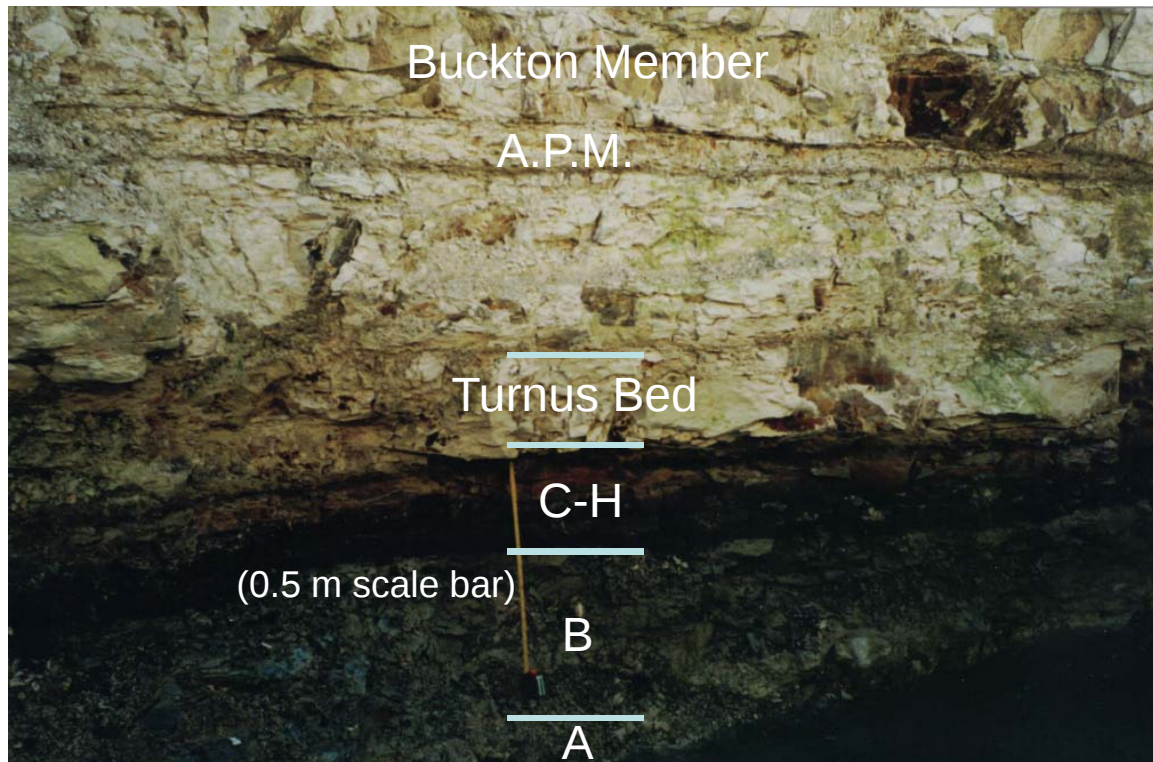
Supplementary quarry photographs

Melton Ross Quarry, Site 1, 24th February 1997



Supplementary quarry photographs

Melton Ross Quarry, Site 4, 24th February 1997



Supplementary Appendix

Lithological description of dried rock samples from Melton Ross.

Location: Samples MR97-23 to MR97-14 were collected from the northern end of a temporary trench that was described in Wood & Mortimore (1995), and subsequently identified as Site 1 in Wood *et al.* (1997). Samples MR97-13 to MR97-1 were collected from a temporary excavation approximately 50 m to the north of the trench which is presumed to correspond to Site 4 of Wood *et al.* (1997). Rock colours are from Goddard *et al.* (1948).

MR97-23, -15 cm to 0 cm. Limestone (chalk). Top of the Ferriby Chalk Formation.

Description: Limestone (chalk). Silt grade; massive; indurated; white (N9).

MR97-22, 0 to 3 cm. Marl. Base of the Welton Chalk Formation, local Bed I of Wood *et al.* (1997).

Description: Silty-clay grade; non-fissile; yellowish grey (5Y 8/1); weakly laminated, fairly homogenous with rare (<1 %) grey (N6) discontinuous laminae and specks (micro-burrow fills?).

MR97-21, 3 to 8 cm. Marl. Local Bed II of Wood *et al.* (1997).

Description: Silty-clay grade; non-fissile; medium grey (N5; 10 %), medium light grey (N6; 60 %), yellowish-grey (5Y 8/1; 30 %); macro- and micro-bioturbation with traces of lamination; in the field, darker laminae were observed to be patchily developed, patches ca. 100 cm², disrupted by bioturbation and probable dewatering/compaction structures.

MR97-20, 8 to 13 cm. Marl. Local ?Bed III of Wood *et al.* (1997)

Description: Silty-clay grade; non-fissile; greenish grey (5GY 6/1); incompetent, crumbly texture; contorted laminae (cf. Bed H, MR97-1).

MR97-19, 13 to 25 cm. Marl. Local ?Beds IV–V of Wood *et al.* (1997).

Description: Silty-clay grade; non-fissile; yellowish-grey (5Y 8/1); massive though tends to cleave parallel to bedding, possibly indicating lamination in relatively homogenous material.

MR97-18.5, 25 to 33cm. Marl. Local ?Bed VI of Wood *et al.* (1997).

Description: Silty-clay grade; non-fissile; greenish grey (5G 6/1); massive, possibly with weak lamination and occasional macro- and micro-bioturbation (*Chondrites*); with very light grey (N8) burrow fills (< 1 %); occasional ?chlorite crystals (ca. 1 mm diameter) present.

MR97-18, 33 to 37 cm. Marl. Local Bed VII of Wood *et al.* (1997).

Description: Silty-clay grade; non-fissile; greyish green (10GY 5/2; 10 %), greenish grey (5G 7/1; 40 %), light greenish grey (5GY 8/1; 50 %); prominent macro-bioturbation; occasional ?chlorite crystals (ca. 1 mm diameter) present.

MR97-17, 37 to 48 cm. Marl. Local Bed VII of Wood *et al.* (1997).

Description: Silty-clay grade; non-fissile; greenish grey (5G 7/1; 70 %), light greenish grey (5GY 8/1; 30 %); prominent micro-bioturbation (*Chondrites*) in the ?lower part of the sample while macro-bioturbation is more marked in the ?upper part of the sample.

MR97-16, 48 to 56 cm. Marl. Local Bed VII of Wood *et al.* (1997).

Description: Silty-clay grade; non-fissile; very light greenish grey (5GY 9/1; 80 %), light greenish grey (5G 8/1; 20 %); prominent macro-bioturbation and occasional micro-bioturbation (*Chondrites*).

MR97-15, 56 to 63 cm. Marl. Local Bed VII of Wood *et al.* (1997).

Description: Silty-clay grade; non-fissile; greenish grey (5G 7/1; 70 %), very light greenish grey (5GY 9/1; 20 %), white (N9; 10 %); prominent intense micro-bioturbation (*Chondrites*) and occasional macro-burrows, usually with lighter-coloured material as burrow fills.

MR97-14, 63 to 85 cm. Limestone (chalk). "Central Limestone", Bed 3 of Wood *et al.* (1997), Bed A of Dodsworth (1996).

Description: Silt grade; massive; indurated; white (N8.5) to yellowish grey (5Y 8/1). Brachiopod, ?*Orbirhynchia* fragment.

MR97-13, 85 to 108 cm. Marl/limestone. Bed 5 of Wood *et al.* (1997), Bed B (lower) of Dodsworth (1996).

Description: Clayey-silt grade; massive; light greenish grey (5GY 8/1); un-weathered pyrite crystals (ca. 2 mm diameter) present.

MR97-12, 108 to 120 cm. Marl. Bed 6 of Wood *et al.* (1997), Bed B (upper) of Dodsworth (1996).

Description: Silty-clay grade; non-fissile; light greenish grey (5GY 8/1); fairly massive though occasional macro-burrows are present, one with medium grey (N5) burrow fill.

MR97-11.5, 120 to 121.3 cm. Marl. Bed 7a of Wood *et al.* (1997), Bed C(1) of Dodsworth (1996).

Description: Clay grade; non-fissile; dark grey (N3) to medium light grey (N6), fairly massive with little lithological contrast; occasional yellowish grey (5Y 8/1) macro-burrow fill observed.

MR97-11, 121.3 to 123.3 cm. Marl. Bed 7a of Wood *et al.* (1997), Bed C(1) of Dodsworth (1996).

Description: Mainly clay grade with minor silt grade component; non-fissile; medium dark grey (N4; 30 %), medium grey (N5; 50 %), medium grey (N6; 20 %); laminated with occasional macro- and ?micro-bioturbation.

MR97-10.5, 123.3 to 123.6 cm. Marl. Bed 7a of Wood *et al.* (1997), Bed C(2) of Dodsworth (1996).

Description: Silty-clay grade; non-fissile; laminated; medium light grey (N6).

MR97-10, 123.6 to 123.9 cm. Marl. Bed 7a of Wood *et al.* (1997), Bed C(3) of Dodsworth (1996).

Description: Silty-clay grade; non-fissile; dark grey (N3) to medium dark grey (N4).

MR97-9, 123.9 to 124.9 cm. Marl. Bed 7b of Wood *et al.* (1997), Bed D of Dodsworth (1996).

Description: Silty-clay grade; non-fissile; light grey (N7; 90 %), medium dark grey (N4; 10 %); laminated with macro-bioturbation (N4-coloured burrow fills).

MR97-8.5, 124.9 to 126.4 cm. Marl. Bed 7c of Wood *et al.* (1997), Bed E of Dodsworth (1996).

Description: Clay grade; non-fissile; dark grey (N3.5; 40 %), medium grey (N5; 58 %), yellowish grey (5Y 8/1; 2 %); laminated with macro-bioturbation.

MR97-8, 126.4 to 128.9 cm. Marl. Bed 7c of Wood *et al.* (1997), Bed E of Dodsworth (1996).

Description: Silty-clay grade; non-fissile; medium dark grey (N4; 50 %), medium grey (N5; 25 %), light grey (N6.5; 25 %); laminated with macro-bioturbation and occasional micro-bioturbation (*Chondrites*).

MR97-7, 128.9 to 130.4 cm. Marl. Bed 7c of Wood *et al.* (1997), Bed E of Dodsworth (1996).

Description: Silty-clay grade; non-fissile; light grey (N7); laminated with macro- and micro-bioturbation (*Chondrites*).

MR97-6, 130.4 to 131.4 cm. Marl. Bed 7c of Wood *et al.* (1997), Bed E of Dodsworth (1996).

Description: Silty-clay grade; non-fissile; medium grey (N5.5; 75 %), yellowish grey (5Y 8/1; 25 %); ?laminated with macro- and micro-bioturbation; pyrite crystals (< 2 mm diameter) present.

MR97-5, 131.4 to 135.5 cm. Marl. Bed 8 of Wood *et al.* (1997), Bed F of Dodsworth (1996).

Description: Silty-clay grade; non-fissile; light grey (N7; 60 %), very light grey (N8; 25 %), medium light grey (N6; 15 %); ?laminated with macro- and micro-bioturbation (*Chondrites*); un-weathered pyrite crystals (< 2 mm diameter) present.

MR97-4, 135.5 to 139.5 cm. Marl. Bed 8 of Wood *et al.* (1997), Bed F of Dodsworth (1996).

Description: Silty-clay grade; non-fissile; yellowish grey (5Y 8/1; 97 %), light grey (N7; 3 %); micro-bioturbation (*Chondrites*).

MR97-3, 139.5 to 142 cm. Marl. Bed 8 of Wood *et al.* (1997), Bed F of Dodsworth (1996).

Description: Silty-clay grade; non-fissile; yellowish grey (5Y 8/1; 85 %), light grey (N7; 15 %); macro- and micro-bioturbation with light grey burrow fills. Pyrite nodules up to 2 cm diameter present.

MR97-2, 142 to 144 cm. Marl. Bed 9 of Wood *et al.* (1997), Bed G of Dodsworth (1996).

Description: Silty-clay grade; non-fissile; lowest 5 mm is dark grey (N3; 85 %), medium grey (N5; 15 %); upper 15 mm is medium grey (N5; 50 %), light grey (N7; 25 %), yellowish grey (5Y 8/1; 25 %); laminated with the proportion of lighter coloured laminae increasing upwards; occasional macro- and micro-bioturbation, including a chalk-filled macro-burrow; an un-weathered pyrite nodule, ca. 1.5 cm diameter, is present on the upper, pale surface.

MR97-1, 144 to 145 cm. Marl. Bed 10 of Wood *et al.* (1997), Bed H of Dodsworth (1996).

Description: Silty-clay grade; non-fissile; crumbly texture, incompetent; light greenish grey (5GY 8/1); erosional contact with Bed G, in places containing reworked Bed G clasts (medium grey N5 to light grey N7 in colour), 1 mm to 7 mm in diameter.

References.

Dodsworth, P. 1996. Stratigraphy, microfossils and depositional environments of the lowermost part of the Welton Chalk Formation (late Cenomanian to early Turonian, Cretaceous) in eastern England. *Proceedings of the Yorkshire Geological Society*, **51**, 45–64.

Dodsworth, P. 2000. Trans-Atlantic dinoflagellate cyst stratigraphy across the Cenomanian–Turonian (Cretaceous) Stage boundary. *Journal of Micropalaeontology*, **19**, 69–84.

Dodsworth, P. & Eldrett, J.S. 2019(a). A dinoflagellate cyst zonation of the Cenomanian and Turonian (Upper Cretaceous) in the Western Interior, United States. *Palynology*, **43**, 701–723.

Dodsworth, P. & Eldrett, J.S. 2019(b). A new marine palynomorph from the Turonian (Upper Cretaceous) in the USA. *Review of Palaeobotany and Palynology*, **262**, 10–16.

Eldrett, J.S., Minisini, D. & Bergman, S.C. 2014. Decoupling of the carbon cycle during Oceanic Anoxic Event 2. *Geology*, **42**, 567–570.

Eldrett, J.S., Ma, C., Bergman, S.C., Lutz, B., Gregory, J.G., Dodsworth, P., Phipps, M., Hardas, P., Minisini, D., Ozkan, A., Ramezani, J., Bowring, S.A., Kamo, S.L., Ferguson, K., Macaulay, C. & Kelly, A. 2015(a). An astronomically calibrated stratigraphy of the Cenomanian, Turonian and earliest Coniacian from the Cretaceous Western Interior Seaway, USA: Implications for global chronostratigraphy. *Cretaceous Research*, **56**, 316–344.

Eldrett, J.S., Ma, C., Bergman, S.C., Ozkan, A., Minisini, D., Lutz, B., Jackett, S.J., Macaulay, C. & Kelly, A.E., 2015(b). Origin of limestone–marlstone cycles: astronomic forcing of organic-rich sedimentary rocks from the Cenomanian to early Coniacian of the Cretaceous Western Interior Seaway, USA. *Earth and Planetary Science Letters*, **423**, 98–113.

Eldrett, J.S., Dodsworth, P., Bergman, S.C., Wright, M. & Minisini, D. 2017. Water-mass evolution in the Cretaceous Western Interior Seaway of North America and equatorial Atlantic. *Climate of the Past*, **13**, 855–878.

Goddard, E.N., Trask, P.D., de Ford, R.K., Rove, O.N., Singewald, J.T. Jr. & Overbeck, R.M. 1948. *Rock-color chart*. Geological Society of America. Boulder, Colorado.

Hart, M.B. 2019. The ‘Black Band’: local expression of a global event. *Proceedings of the Yorkshire Geological Society*, **62**, 217–226.

Hart, M.B. & Bigg, P.J. 1981. Anoxic events in late Cretaceous chalk seas of North-West Europe. In: Neale, J.W. & Brasier, M.D. (eds) *Microfossils of Recent and Fossil Shelf Seas*. Horwood, Chichester, 177–185.

Hart, M.B., Dodsworth, P., Ditchfield, P.W., Duane, A.M. & Orth, C.J. 1991. The late Cenomanian event in eastern England. *Historical Biology*, **5**, 339–354.

Hart, M.B., Dodsworth, P. & Duane, A.M. 1993. The late Cenomanian event in eastern England. *Cretaceous Research*, **14**, 495–508.

Minisini, D., Eldrett, J.S., Bergman, S.C. & Forkner, R. 2018. Chronostratigraphic framework and depositional environments in the organic-rich, mudstone-dominated Eagle Ford Group, Texas, USA. *Sedimentology*, **65**, 1520–1557.

Wood, C.J., Batten, D.J., Mortimore, R.N. & Wray, D.S. 1997. The stratigraphy and correlation of the Cenomanian–Turonian boundary interval succession in Lincolnshire, eastern England. *Freiberger Forschungsheft*, **C468**, 333–346.

Wood, C.J. & Mortimore, R.N. 1995. An anomalous Black Band succession (Cenomanian–Turonian boundary interval at Melton Ross, Lincolnshire, eastern England and its international significance. *Berliner Geowissenschaft Abhandlungen*, **E16** (Gundolf Ernst Festschrift), 277–287. Berlin.

Locality: Melton Ross. (Not to scale.)											
Lithostrat.	Lithology	Sample	Mass on coverslip	TOC (%)	HCl 35%	HF 40%	Schulze's solution	HNO3 70%	KOH 2%	KMnO4	Ultra-sonic
	limestone										
Bed H		MR97-1	1/8g	0.21	Y	Y	30 min.		Rinse		
Bed G		MR97-2	1/32g	3.47	Y	Y	18 hours		30 sec.		30 sec.
Bed F	light marl	MR97-3	1/2g	0.18	Y	Y					
		MR97-4	2.5g	0.12	Y	Y					
		MR97-5	1/2g	0.34	Y	Y					
Bed E	dark marl	MR97-6	1/4g	0.4	Y	Y			Rinse		
		MR97-7	1/8g	0.67	Y	Y			Rinse		
		MR97-8	1/32g	2.18	Y	Y		18 hours	2 min.	2 min.	2 min.
		MR97-8.5	1/32g	2.74	Y	Y		18 hours	1 min.	1 min.	1 min.
Bed D		MR97-9	1/2g	0.36	Y	Y			Rinse		
Bed C		MR97-10	1/16g	2.19	Y	Y		18 hours	2 min.	2 min.	2 min.
		MR97-10.5	1/4g	0.7	Y	Y					
	dark marl	MR97-11	1/16g	1.43	Y	Y		24 hours	1 min.	1 min.	1 min.
		MR97-11.5	1/16g	2.2	Y	Y		24 hours	1.5 min.	1.5 min.	1.5 min.
Bed B		MR97-12	2.5g	0.2	Y	Y					
		MR97-13	10g	0.12	Y	Y		1 min.			
Bed A	limestone	MR97-14	10g	0.1	Y	Y					
Bed VII	light marl	MR97-15	5g	0.15	Y	Y			Rinse		
		MR97-16	5g	0.11	Y	Y			Rinse		
		MR97-17	10g	0.14	Y	Y		1 min.			
		MR97-18	5g	0.13	Y	Y		1 min.			
		MR97-18.5	5g	0.21	Y	Y			Rinse		
Bed ?VI		MR97-19	5g	0.14	Y	Y					
Bed ?IV-V		MR97-20	5g	0.16	Y	Y		1 min.			
Bed ?III		MR97-21	1g	0.28	Y	Y			Rinse		
Bed II		MR97-22	5g	0.12	Y	Y					
Bed I		MR97-23	N/A	0.04	N	N					
	limestone										

Supplementary Table A. Palynological laboratory processing records.

Locality: Melton Ross.											
(Not to scale.)											
Lithostrat.	Lithology	Sample	Mass on coverslip	Coverslip count from 1 central traverse (1/44 of total area)						Est. c. slip /mass	Counts per g (total)
				A	B	C	D	av.	x44		
	limestone										
Bed H		MR97-1	1/8g	99	110	118	63	97.5	4,290	34,320	34,320
Bed G		MR97-2	1/32g	78	56	48	73	63.75	2,805	89,760	89,760
Bed F	light marl	MR97-3	1/2g	103	67	71	63	76	3,344	6,688	6,688
		MR97-4	2.5g	75	92			83.5	3,674	1,470	1,470
		MR97-5	1/2g	108	83	110	93	98.5	4,334	8,668	8,668
Bed E	dark marl	MR97-6	1/4g	100	81	107	103	97.75	4,301	17,204	17,204
		MR97-7	1/8g	100	95	76	74	86.25	3,795	30,360	30,360
		MR97-8	1/32g	54	61	52	75	60.5	2,662	85,184	85,184
		MR97-8.5	1/32g	174	154	113	183	156	6,864	219,648	219,648
Bed D		MR97-9	1/2g	234	210	283	342	267.25	11,759	23,518	23,518
Bed C		MR97-10	1/16g	182	179	196	142	174.75	7,689	123,024	123,024
		MR97-10.5	1/4g	300	282	348	281	302.75	13,321	53,284	53,284
	dark marl	MR97-11	1/16g	123	179	165	110	144.25	6,347	101,552	101,552
		MR97-11.5	1/16g	134	152	119	91	124	5,456	87,296	87,296
Bed B		MR97-12	2.5g	327 palynomorphs from 220 sq mm (484 sq mm coverslip)							288
		MR97-13	10g	Full count of 282							28
Bed A	limestone	MR97-14	10g	2 palynomorphs (possible contaminants) full count							<1
Bed VII	light marl	MR97-15	5g	Barren sample							0
		MR97-16	5g	2 questionable palynomorphs (possible contaminants) full count							<1
		MR97-17	10g	Full count of 265							27
		MR97-18	5g	Full count of 25							5
		MR97-18.5	5g	Full count of 38							8
Bed ?VI		MR97-19	5g	300 palynomorphs from 330 sq mm (484 sq mm coverslip)							88
Bed ?III		MR97-20	5g	238 palynomorphs from 242 sq mm (484 sq mm coverslip)							95
Bed II		MR97-21	1g	243	327	251	307	282	12,408	12,408	12,408
Bed I		MR97-22	5g	263 palynomorphs from whole coverslip							53
	limestone	MR97-23	N/A								

Supplementary Table B. Calculation of total concentration of palynomorphs (counts per gramme).

Locality: Melton Ross. (Not to scale.)														
Lithostrat.	Lithology	Sample	Counts per g (total)	T/M total	T/M ratio	Terrigen. c.p.g.	Dino total	Dinofl. c.p.g.	Prasinoph. total	Prasinoph. c.p.g.	Acantho. total	Acantho. c.p.g.	FTL c.p.g.	Algae c.p.g.
	limestone													
Bed H		MR97-1	34,320	30/270	0.111	3432	245/300	28028	17/300	1945	8/300	915		
Bed G		MR97-2	89,760	41/259	0.158	12267	205/300	61336	19/300	5685	35/300	10472		
Bed F	light marl	MR97-3	6,688	9/291	0.031	201	286/300	6376	2/300	45	2/300	44	22	
		MR97-4	1,470	0/300	0	0	296/300	1450	4/300	20	0/300	0		
		MR97-5	8,668	8/292	0.027	231	289/300	8350	2/300	58	1/300	29		
Bed E	dark marl	MR97-6	17,204	19/281	0.068	1090	274/300	15713	4/300	229	2/300	115		57
		MR97-7	30,360	30/270	0.111	3036	248/300	25098	14/300	1417	7/300	708		101
		MR97-8	85,184	37/263	0.141	10506	232/300	65876	18/300	5111	12/300	3407		284
		MR97-8.5	219,648	38/262	0.145	27822	248/300	181576	5/300	3661	8/300	5857		732
Bed D		MR97-9	23,518	0/300	0	0	300/300	23518	0/300	0	0/300	0		
Bed C		MR97-10	123,024	32/268	0.119	13123	260/300	106621	3/300	1230	5/300	2050		
		MR97-10.5	53,284	1/299	0.003	178	297/300	52751	0/300	0	1/300	178	177	
	dark marl	MR97-11	101,552	14/286	0.049	4739	277/300	93766	2/300	677	7/300	2370		
		MR97-11.5	87,296	23/277	0.083	6693	272/300	79148	2/300	582	3/300	873		
Bed B		MR97-12	288	1/299	0.003	1	299/300	287	0/300	0	0/300	1		
		MR97-13	28	8/274	0.029	< 1	272/282	27	0/282	0	2/282	1		
Bed A	limestone	MR97-14	< 1											
Bed VII	light marl	MR97-15	0				Palynologically barren interval							
		MR97-16	< 1											
		MR97-17	27	0/265	0	0	265/265	27	0/265	0	0/265	0		
		MR97-18	5	0/25	0	0	25/25	5	0/25	0	0/25	0		
		MR97-18.5	8	0/37	0	0	37/37	8	0/37	0	0/37	0		
Bed ?VI		MR97-19	88	0/300	0	0	300/300	88	0/300	0	0/300	0		
Bed ?IV-V		MR97-20	95	1/299	0.003	< 1	298/300	94	1/300	1	0/300	0		
Bed ?III		MR97-21	12,408	2/298	0.007	83	295/300	12201	3/300	124	0/300	0		
Bed II		MR97-22	53	3/297	0.01	< 1	292/300	52	5/300	1	0/300	0		
Bed I		MR97-23												
	limestone													

Supplementary Table C. Concentration (counts per gramme) calculation for different palynomorph groups.

Locality: Melton Ross. (Not to scale.)								Kerogen (> 10 microns) - %					
Lithostrat.	Lithology	Sample	Total dinofl.	P-cysts count	G-cysts count	P/G ratio	Other dinofl.	Phytoclasts				AOM	Palynom.
								Opaque	Translucent	Queried	Total		
	limestone												
Bed H		MR97-1	245/300	58	179	0.24	8	9	3		12	71	17
Bed G		MR97-2	205/300	66	129	0.34	10	2	2		4	92	4
Bed F	light marl	MR97-3	286/300	58	218	0.21	10	9	4		13	58	29
		MR97-4	296/300	94	166	0.31	36	14	26	9	49	9	42
		MR97-5	289/300	43	229	0.16	17	15	18		33	41	26
Bed E	dark marl	MR97-6	274/300	65	200	0.25	9	14	13	3	30	42	28
		MR97-7	248/300	86	154	0.36	8	16	13	4	33	31	36
		MR97-8	232/300	73	154	0.32	5	4	3	1	8	83	9
		MR97-8.5	248/300	85	155	0.35	8	6	5		11	71	18
Bed D		MR97-9	300/300	8	282	0.03	10	17	12	1	30	19	51
Bed C		MR97-10	260/300	74	177	0.29	9	4	4	1	5	81	10
		MR97-10.5	297/300	10	275	0.04	12	13	8	8	29	27	44
	dark marl	MR97-11	277/300	83	189	0.31	5	10	5	1	16	63	21
		MR97-11.5	272/300	92	171	0.35	9	11	4		15	71	14
Bed B		MR97-12	299/300	3	221	0.01	75	No reliable kerogen counts from sample -12 to sample -19, due to sparse recovery and pyritic material.					
		MR97-13	272/282	15	250	0.06	7						
Bed A	limestone	MR97-14											
Bed VII	light marl	MR97-15	Palynologically barren interval										
		MR97-16											
		MR97-17	265/265	3	2		260						
		MR97-18	25/25				25						
Bed ?VI		MR97-18.5	37/37		1		36						
Bed ?IV-V		MR97-19	300/300				300						
Bed ?III		MR97-20	298/300	97	38	0.72	163	26	63		89	1	10
Bed II		MR97-21	295/300	128	154	0.45	13	17	9		26	2	72
Bed I		MR97-22	292/300	172	90	0.66	30	18	72		90	4	6
	limestone	MR97-23											

Supplementary Table D. Calculation of dinoflagellate cyst P/G ratio, and kerogen count records.

Locality: Melton Ross.											
(Not to scale.)											
Lithostrat.	Lithology	Sample	c.p.g. (total)	Terrest. total %	Terrigen. c.p.g.	Gymnosp. %	Gymnosp. c.p.g.	Pteridoph. %	Pteridoph. c.p.g.	Angiosp. %	Angiosp. c.p.g.
	limestone										
Bed H		MR97-1	34,320	10	3432	9.7	3329	0.3	103	< 0.3	P
Bed G		MR97-2	89,760	13.7	12267	11	9874	2.3	2094	0.3	299
Bed F	light marl	MR97-3	6,688	3	201	3	201	< 0.3	P	< 0.3	P
		MR97-4	1,470	< 0.3	0	< 0.3	P	< 0.3	P	0	0
		MR97-5	8,668	2.7	231	2.7	231	< 0.3	P	0	0
Bed E	dark marl	MR97-6	17,204	6.3	1090	5	860	1	172	0.3	58
		MR97-7	30,360	10	3036	9.7	2935	0.3	101	< 0.3	P
		MR97-8	85,184	12.3	10506	9.7	8234	2.6	2272	< 0.3	P
		MR97-8.5	219,648	12.7	27822	12.3	27090	0.3	732	< 0.3	P
Bed D		MR97-9	23,518	< 0.3	0	< 0.3	P	0	0	0	0
Bed C		MR97-10	123,024	10.7	13123	10	12303	0.3	410	0.3	410
		MR97-10.5	53,284	0.3	178	0.3	178	0	0	< 0.3	P
	dark marl	MR97-11	101,552	4.7	4739	4	4062	< 0.3	P	0.7	677
		MR97-11.5	87,296	7.7	6693	7.3	6402	< 0.3	P	0.3	291
Bed B		MR97-12	288	0.3	1	0.3	1	0	0	0	0
		MR97-13	28	1.8	< 1	1.4	P	0.4	P	0	0
Bed A	limestone	MR97-14	<1								
Bed VII	light marl	MR97-15	0								
		MR97-16	<1								
		MR97-17	27	0	0	0	0	0	0	0	0
		MR97-18	5	0	0	0	0	0	0	0	0
		MR97-18.5	8	0	0	0	0	0	0	0	0
Bed ?VI		MR97-19	88	0	0	0	0	0	0	0	0
Bed ?IV-V		MR97-20	95	0.3	< 1	0.3	P	0	0	0	0
Bed ?III		MR97-21	12,408	0.7	83	0.7	83	< 0.3	P	< 0.3	P
Bed II		MR97-22	53	1	< 1	1	P	0	0	0	0
Bed I		MR97-23	N/A								
	limestone										

Supplementary Table E. Calculation of concentration of terrigenous palynomorph groups (note that 'P' = Present, not quantified).

Supplementary Table F (1/2). Palynological slides curated in the MPA and MPK collections of the BGS.

BGS Slide No	Sample	Slide number	Slide label	England Finder holotype reference
MPA 70686	MR97-1	1	MR-1(A) KEROGEN	
MPA 70687	MR97-1	2	MR-1(B) KEROGEN	
MPA 70688	MR97-1	3	MR-1(C) KEROGEN	
MPA 70689	MR97-1	4	MR-1(D) KEROGEN	
MPA 70690	MR97-1	5	MR-1(A)	
MPA 70691	MR97-1	6	MR-1(B)	
MPA 70692	MR97-1	7	MR-1(C)	
MPA 70693	MR97-1	8	MR-1(D)	
MPA 70694	MR97-2	9	MR-2(A) KEROGEN	
MPA 70695	MR97-2	10	MR-2(B) KEROGEN	
MPA 70696	MR97-2	11	MR-2(A)	
MPA 70697	MR97-2	12	MR-2(B)	
MPA 70698	MR97-2	13	MR-2(C)	
MPA 70699	MR97-2	14	MR-2(D)	<i>Trithyrodinium maculatum</i>
MPA 71640	MR97-3	15	MR-3(A) KEROGEN	S32/3 MPK 14662
MPA 70700	MR97-3	16	MR-3(B) KEROGEN	
MPA 70701	MR97-3	17	MR-3(C) KEROGEN	
MPA 70702	MR97-3	18	MR-3(D) KEROGEN	
MPA 70703	MR97-4	19	MR-4(A) KEROGEN	
MPA 70704	MR97-4	20	MR-4(B) KEROGEN	
MPA 70705	MR97-5	21	MR-5 KEROGEN	
MPA 70706	MR97-5	22	MR-5(A)	
MPA 70707	MR97-5	23	MR-5(B)	
MPA 70708	MR97-5	24	MR-5(C)	
MPA 70709	MR97-5	25	MR-5(D)	
MPA 70710	MR97-6	26	MR-6 KEROGEN	
MPA 70711	MR97-6	27	MR-6(A)	
MPA 70712	MR97-6	28	MR-6(B)	
MPA 70713	MR97-6	29	MR-6(C)	
MPA 70714	MR97-6	30	MR-6(D)	
MPA 70715	MR97-7	31	MR-7 KEROGEN	
MPA 70716	MR97-7	32	MR-7(A)	
MPA 70717	MR97-7	33	MR-7(B)	
MPA 70718	MR97-7	34	MR-7(C)	
MPA 70719	MR97-7	35	MR-7(D)	
MPA 70720	MR97-8	36	MR-8 KEROGEN	
MPA 70721	MR97-8	37	MR-8(A)	
MPA 70722	MR97-8	38	MR-8(B)	
MPA 70723	MR97-8	39	MR-8(C)	
MPA 70724	MR97-8	40	MR-8(D)	
MPA 70725	MR97-8.5	41	MR-8.5(A) KEROGEN	
MPA 70726	MR97-8.5	42	MR-8.5(B) KEROGEN	
MPA 70727	MR97-8.5	43	MR-8.5(A)	
MPA 70728	MR97-8.5	44	MR-8.5(B)	
MPA 70729	MR97-8.5	45	MR-8.5(C)	
MPA 70730	MR97-8.5	46	MR-8.5(D)	
MPA 70731	MR97-9	47	MR-9 KEROGEN	

Supplementary Table F (2/2). Palynological slides curated in the MPA and MPK collections of the BGS.

MPA 70732	MR97-9	48	MR-9(A)	
MPA 70733	MR97-9	49	MR-9(B)	
MPA 70734	MR97-9	50	MR-9(C)	
MPA 70735	MR97-9	51	MR-9(D)	
MPA 70736	MR97-10	52	MR-10 KEROGEN	
MPA 70737	MR97-10	53	MR-10(A)	
MPA 70738	MR97-10	54	MR-10(B)	
MPA 70739	MR97-10	55	MR-10(C)	
MPA 70740	MR97-10	56	MR-10(D)	
MPA 70741	MR97-10.5	57	MR-10.5(A) KER.	
MPA 70742	MR97-10.5	58	MR-10.5(B) KER.	
MPA 70743	MR97-10.5	59	MR-10.5(C) KER.	
MPA 70744	MR97-10.5	60	MR-10.5(D) KER.	
MPA 70745	MR97-11	61	MR-11 KEROGEN	
MPA 70746	MR97-11	62	MR-11(A)	<i>Canninginopsis ? lindseyensis</i>
MPA 71641	MR97-11	63	MR-11(B)	P44/3 MPK 14663
MPA 70747	MR97-11	64	MR-11(C)	
MPA 70748	MR97-11	65	MR-11(D)	
MPA 70749	MR97-11.5	66	MR-11.5 KEROGEN	
MPA 70750	MR97-11.5	67	MR-11.5(A)	
MPA 70751	MR97-11.5	68	MR-11.5(B)	
MPA 70752	MR97-11.5	69	MR-11.5(C)	
MPA 70753	MR97-11.5	70	MR-11.5(D)	
MPA 70754	MR97-12	71	MR-12(A) KER.	
MPA 70755	MR97-12	72	MR-12(B) KER.	
MPA 70756	MR97-12	73	MR-12(C) KER.	
MPA 70757	MR97-12	74	MR-12(D) KER.	
MPA 70758	MR97-12	75	MR-12 'Heavies' from swirl	
MPA 70759	MR97-13	76	MR-13	
MPA 70760	MR97-13	77	MR-13 'Heavies' from swirl	
MPA 70761	MR97-14	78	MR-14 KER.	
MPA 70762	MR97-15	79	MR-15(A)	
MPA 70763	MR97-15	80	MR-15(B)	
MPA 70764	MR97-16	81	MR-16(A)	
MPA 70765	MR97-16	82	MR-16(B)	
MPA 70766	MR97-17	83	MR-17	
MPA 70767	MR97-18	84	MR-18(A)	
MPA 70768	MR97-18	85	MR-18(B)	
MPA 70769	MR97-18.5	86	MR-18.5(A)	
MPA 70770	MR97-18.5	87	MR-18.5(B)	
MPA 70771	MR97-20	88	MR-20(A)	
MPA 70772	MR97-20	89	MR-20(B)	
MPA 70773	MR97-21	90	MR-21(A)	
MPA 70774	MR97-21	91	MR-21(B)	
MPA 70775	MR97-21	92	MR-21(C)	
MPA 70776	MR97-21	93	MR-21(D)	
MPA 70777	MR97-22	94	MR-22(A)	
MPA 70778	MR97-22	95	MR-22(B)	
MPA 71642	MR97-11	96	MR-11(E)	

Locality: Melton Ross. (Not to scale.)				Corrected using two standards from Worksheet <i>Standards</i>				NBS-18 NBS-19
Lithostrat.	Lithology	Sample	TOC (%)	s.d.	Corrected d13C/d12C	s.d.	Corrected d18O/d16O	Oxford University analyses 18323-18349, 23rd April 2019
	limestone							
Bed H		MR97-1	0.21	0.067	3.135	0.108	-5.412	
Bed G		MR97-2	3.47	0.048	3.770	0.045	-6.458	
Bed F	light marl	MR97-3	0.18	0.045	3.394	0.059	-5.019	
		MR97-4	0.12	0.059	3.343	0.059	-4.788	
		MR97-5	0.34	0.061	3.383	0.048	-4.842	
Bed E	dark marl	MR97-6	0.4	0.048	3.519	0.083	-4.749	
		MR97-7	0.67	0.059	3.607	0.04	-5.345	
		MR97-8	2.18	0.065	3.761	0.035	-5.989	
		MR97-8.5	2.74	no data	no data	no data	no data	
Bed D		MR97-9	0.36	0.116	3.817	0.068	-4.583	
Bed C		MR97-10	2.19	no data	no data	no data	no data	
		MR97-10.5	0.7	0.091	3.847	0.11	-4.749	
	dark marl	MR97-11	1.43	0.039	3.792	0.071	-5.346	
		MR97-11.5	2.2	0.076	3.907	0.06	-5.401	
Bed B		MR97-12	0.2	0.061	4.170	0.052	-4.573	
		MR97-13	0.12	0.026	4.209	0.044	-3.248	
Bed A	limestone	MR97-14	0.1	0.048	4.252	0.052	-3.033	
Bed VII	light marl	MR97-15	0.15	0.105	3.014	0.071	-3.753	
		MR97-16	0.11	0.048	3.410	0.07	-3.577	
		MR97-17	0.14	0.098	3.099	0.091	-3.497	
		MR97-18	0.13	0.137	2.425	0.099	-4.454	
		MR97-18.5	0.21	0.055	2.381	0.083	-4.016	
Bed ?VI		MR97-19	0.14	0.079	3.047	0.091	-3.828	
Bed ?IV-V		MR97-20	0.16	0.148	1.861	0.226	-5.118	
Bed ?III		MR97-21	0.28	0.078	3.332	0.097	-4.476	
Bed II		MR97-22	0.12	0.073	3.055	0.091	-3.609	
Bed I		MR97-23	0.04	0.035	2.485	0.03	-4.071	
	limestone							

Supplementary Table G. Carbonate stable isotopes, corrected results.

Locality: Melton Ross. (Not to scale.)											
Lithostrat.	Lithology	Sample	TOC (%)	S1 (mg/g)	S2 (mg/g)	S3 (mg/g)	Tmax degrees C	HI (mg HC/ g TOC)	OI (mg CO2/ g TOC)	PI	PP (mg/g)
	limestone										
Bed H		MR97-1	0.21								
Bed G		MR97-2	3.47	0.5	7.06	0.57	426	203	16	0.07	7.56
Bed F	light marl	MR97-3	0.18	0.16	0.09	0.18	352*	50	101	0.64	0.25
		MR97-4	0.12	0.13	0.09	0.19	328*	78	165	0.59	0.22
		MR97-5	0.34	0.23	0.23	0.17	390*	67	49	0.5	0.46
Bed E	dark marl	MR97-6	0.4	0.16	0.16	0.25	366*	40	62	0.5	0.32
		MR97-7	0.67	0.18	0.41	0.29	436	61	43	0.31	0.59
		MR97-8	2.18	0.3	2.66	0.56	432	122	26	0.1	2.96
		MR97-8.5	2.74	0.36	3.05	0.5	432	111	18	0.11	3.41
Bed D		MR97-9	0.36	0.19	0.19	0.2	395*	53	56	0.5	0.38
Bed C		MR97-10	2.19	0.42	2.76	0.34	430	126	16	0.13	3.18
		MR97-10.5	0.7	0.35	0.49	0.19	416	70	27	0.42	0.84
	dark marl	MR97-11	1.43	0.16	1.12	0.24	436	78	17	0.13	1.28
		MR97-11.5	2.2	0.43	3.97	0.34	428	180	15	0.1	4.4
Bed B		MR97-12	0.2								
		MR97-13	0.12								
Bed A	limestone	MR97-14	0.1								
Bed VII	light marl	MR97-15	0.15								
		MR97-16	0.11								
		MR97-17	0.14								
		MR97-18	0.13								
		MR97-18.5	0.21								
Bed ?VI		MR97-19	0.14								
Bed ?IV-V		MR97-20	0.16								
Bed ?III		MR97-21	0.28	0.18	0.11	0.15	339*	39	53	0.62	0.29
Bed II		MR97-22	0.12								
Bed I		MR97-23	0.04								
	limestone										

Rock-Eval data key
 * Tmax value unreliable due to very low S2 signal
 HI = Hydrogen Index (S2/TOC*100)
 OI = Oxygen Index (S3/TOC*100)
 PI = Production index (S1/S1+S2)
 PP = Production Potential (S1+S2)
 Data provided by APT UK Ltd, 4th March 2019

Supplementary Table H. Total organic carbon (TOC) and Rock-Eval pyrolysis data for selected samples.

Locality: Flixton, Yorkshire (former quarry exposure). (Not to scale.)								
Litho-strat.	Lithology	Sample	T/M ratio	Dinoflag. %	Prasino. %	Acantho. %	Counts per g (total)	Notes on (former) outcrop
Bed E		Ysa-131	0.273	57	14	1.7	183,392	Samples collected from a ca. 30 cm interval. See Jeans et al. (1991) & Dodsworth (1996) for lithological logs and sample positions.
Bed D		Ysa-90	0	100	0	0	205	
Bed C3		Ysa-89	0.207	72.6	5.7	1	17,688	
Bed C2		Ysa-88	0.037	94	1	1.3	7,216	
Bed C1	dark marl	Ysa-87	0.5	40.3	9.3	0.3	306,944	
		Ysa-86	0.547	38.7	6	0.7	196,768	

Dark marls 17,688 - 306,944 (176,198 cpg):

Phytoplankton 14,027 - 153,472 (97,490 cpg);

Pollen/spores 3,661 - 153,472 (78,708 cpg).

Notes:

Ysa samples are splits of those analysed for geochemistry by Jeans et al. (1991).

Locality: Speeton (Buckton Cliffs), Yorkshire coast. (Not to scale.)								
Litho-strat.	Lithology	Sample	T/M ratio	Dinoflag. %	Prasino. %	Acantho. %	Counts per g (total)	Outcrop position of beds
Bed G		SP-1	0.187	74.6	5	1.7	57,933	0 to 3 cm
Bed F	limestone	SP-2	0.117	83.3	3.7	1.3	66,733	3 to 43 cm
		SP-3	0.01	94.7	1.3	3	99,733	
Bed E		SP-4	0.043	90.3	1.3	4	50,336	43 to 57 cm
Bed D		SP-5	n.d.	n.d.	n.d.	n.d.	n.d.	57 to 64 cm
Bed C	dark marl	SP-6	0.11	80.3	3.7	5	123,200	64 to 72 cm
		SP-7	0.163	73.7	7.7	2	156,053	
		SP-8	0.043	89.7	1.7	4	187,733	
B1/B4		SP-9	0.057	87.7	3	3	10,795	72 to 73 cm

Dark marls 57,933 - 187,733 (105,960 cpg):

Phytoplankton 47,331 - 179,660 (96,196 cpg);

Pollen/spores 977 - 25,437 (9,764 cpg).

Notes:

Bed F passes laterally from marl to limestone lithology to the north of Market Weighton (Jeans et al. 1991; Dodsworth 1996; Mitchell 2000).

Samples SP-2 & SP-3 are from the upper 8 cm and lower 10 cm of Bed F, respectively, where dark grey marl laminae are present in chalk; the intervening 22 cm of Bed F is massive chalk limestone. Most or all palynomorphs in SP-2 & -3 may be derived from the dark marl laminae.

Supplementary Table I (1/6). Palynomorph concentration data from two Yorkshire localities in the northerly Cleveland Basin.

Sources: Flixton, Dodsworth (1996); Speeton, formerly unpublished data (P. Dodsworth).

Locality: East Knapton Quarry, Yorkshire. (Not to scale.)								
Litho-strat.	Lithology	Sample	T/M ratio	Dinoflag. %	Prasino. %	Acantho. %	Counts per g (total)	Outcrop position of beds
Bed F	limestone	EK-1					0	45 to 84 cm
		EK-2	0	0	100	0	17*	
Bed E	dark marl	EK-3	0.01	95.7	3.3	0	8595*	84 to 121 cm
		EK-4	0.04	90.3	5	0	38,896	
		EK-6	0.02	96.7	1.3	0	3,879	
		EK-7	0.11	84.7	4.3	0	22,440	
	dark marl	EK-8	0.02	96	1	1	3,527	
		EK-9	0.083	86.7	5	0	101,024	
		EK-10	0.03	90	7	0	49,632	
		EK-11	0.053	86.7	7.7	0	68,112	
Bed D	light marl	EK-12	0.013	98.7	0	0	6,365	121 to 134 cm
		EK-13	0	100	0	0	1,558	
		EK-14	0.007	99.3	0	0	407	
Bed C3		EK-15	0.17	77.7	4.7	0.7	52,565	134 to 135 cm
Bed C2		EK-16	0.057	94	0.3	0	1,287	135 to 140 cm
Bed C1	dark marl	EK-17	0.15	81	4	0	31,856	140 to 156 cm
		EK-18	0.14	84	2	0	36,784	
		EK-19	0.33	62	5	0	14,256	
		EK-20	0.04	77.3	18.7	0	1,328*	
Bed B4	light marl	EK-21	0.003	99.7	0	0	235*	156 to 161 cm
		EK-22	0.08	86	6	0	5*	
B2-B3		EK-23					0	161 to 170 cm

Dark marls 14,256 - 101,024 (46,174 cpg):
Phytoplankton 9,552 - 92,639 (41,610 cpg);
Pollen/spores 1,489 - 8,936 (4,564 cpg).

Notes:

* = heavily weathered samples (poor palynomorph preservation) excluded from range and mean figures.

Dominance of prasinophytes in sample EK-2 may be mainly due to their preferential preservation in weathered sample.

Bed F passes laterally from marl to limestone lithology to the north of Market Weighton (Jeans et al. 1991; Dodsworth 1996; Mitchell 2000).

See the correlation panel in Dodsworth (1996, fig.2) for lithological log of this section.

Supplementary Table I (2/6). Palynomorph concentration data from East Knapton, Yorkshire.
Source: Formerly unpublished data (P. Dodsworth).

Locality: Bishop Wilton Disused Quarry, Yorkshire. (Not to scale.)								
Litho-strat.	Lithology	Sample	T/M ratio	Dinoflag. %	Prasino. %	Acantho. %	Counts per g (total)	Outcrop position of beds
Bed G		BW-1	0	6.3	93.7	0	537*	20 to 23 cm
Bed F	limestone	BW-2					0	23 to 60 cm
		BW-3					0	
		BW-4					0	
		BW-5	0.047	93.7	1.7	0	3777*	
	light marl	BW-6	0.097	85.7	4.3	0.3	24,787	
Bed E	dark marl	BW-7	0.02	97.3	0.3	0.3	41,243	60 to 74 cm
		BW-8	0.07	86.7	5.3	0.7	63,947	
		BW-9	0.09	88.7	1.7	0.7	59,253	
Bed D		BW-10	0.08	89	1.7	1.3	20,533	74 to 80 cm
		BW-11	0.02	95.3	2	0	6,600	
Bed C	dark marl	BW-12	0.02	94.7	3	0.3	28,600	80 to 89 cm
		BW-13	0.093	83.3	7	0	71,280	
B1/B4		BW-14	0.01	98.3	0.7	0	279*	89 to 90 cm

Dark marls 28,600 - 71,280 (52,865 cpg):

Phytoplankton 28,028 - 64,651 (49,423 cpg);

Pollen/spores 572 - 6,629 (3,442 cpg).

Notes:

Bed F passes laterally from marl to limestone lithology to the north of Market Weighton (Jeans et al. 1991; Dodsworth 1996; Mitchell 2000).

Sample BW-2 is from the upper 5 cm of Bed F and samples BW-5 & -6 are from its lower 10 cm, where dark grey marl laminae are present; the intervening 22 cm of Bed F is massive chalk limestone. Most or all palynomorphs from BW-5 & -6 may be derived from the dark marl laminae.

* = heavily weathered samples (poor palynomorph preservation).

Dominance of prasinophytes in sample BW-1 may be mainly due to their preferential preservation in weathered sample.

See the correlation panel in Dodsworth (1996, fig.2) for lithological log of this section.

Supplementary Table I (3/6). Palynomorph concentration data from Bishop Wilton, Yorkshire.

Source: Formerly unpublished data (P. Dodsworth).

Locality: Market Weighton (Goodmanham Black Band exposure), Yorkshire.								
(Not to scale.) East Yorkshire Regionally Important Sites Group, Site number EY18.								
Litho-strat.	Lithology	Sample	T/M ratio	Dinoflag. %	Prasino. %	Acantho. %	Counts per g (total)	Outcrop position of beds
	limestone	MW-1					0	0 to 10 cm
Bed ?H		MW-2					0	10 to 14 cm
Bed G (upper)	light marl	MW-3	0	86	13.7	0.3	80*	14 to 23 cm
		MW-4	0.02	91.3	6.7	0	399*	
		MW-5	0	98	2	0	657*	
Bed G	dark marl	MW-6	0.03	95.3	1.7	0	1173*	23 to 36 cm
		MW-7	0.07	87.3	2.7	3	74,389	
		MW-8	0.037	93.3	1	2	10,465	
Bed F	light marl	MW-9	0.007	99.3	0	0	593	36 to 46 cm
		MW-10	0.003	97	0.3	2.3	8,411	
Bed E	dark marl	MW-11	0.027	96.3	0	1	17,805	46 to 63 cm
		MW-12	0.123	85	1.7	1	56,203	
		MW-13	0.073	90.7	1	1	73,685	
		MW-14	0.16	80.7	3	0.3	95,979	
Bed D		MW-15	0.043	94.7	0.7	0.3	58,197	63 to 67 cm
Bed C		MW-16	0.13	82.3	4.3	0.3	70,048	67 to 75 cm
		MW-17	0.087	90.3	0.7	0	52,037	
Bed B4	light marl	MW-18	0.007	98.3	0.3	0.7	4,063	75 to 85 cm
		MW-19	0.017	98.3	0	0	167*	85 to 95 cm
Bed B3		MW-20	0.01	98.7	0.3	0	36*	
		MW-21					3*	
Bed B2		MW-22					4*	95 to 100 cm

Dark marls 10,465 - 95,979 (56,534 cpg):

Phytoplankton 10,078 - 80,622 (51,510 cpg);

Pollen/spores 387 - 15,357 (5,024 cpg).

Notes:

Bed D tentatively picked on slightly lighter marl at Market Weighton (sample MW-15).

* = heavily weathered samples (poor palynomorph preservation) excluded from range and mean figures.

Relatively large proportion of prasinophytes in sample MW-3 may be mainly due to their preferential preservation in weathered sample.

See the correlation panel in Dodsworth (1996, fig.2) for lithological log of this section.

Supplementary Table I (4/6). Palynomorph concentration data from Market Weighton, Yorkshire.

Source: Formerly unpublished data (P. Dodsworth).

Locality: Bigby Disused Quarry, Lincolnshire. (Not to scale.)								
Litho-strat.	Lithology	Sample	T/M ratio	Dinoflag. %	Prasino. %	Acantho. %	Counts per g (total)	Outcrop position of beds
Bed H	light marl	B-1					0	0 to 1.5 cm
Bed F		B-2					0	1.5 to 16 cm
		B-3					0	
		B-4					0	
		B-5	0	75	25	0	285*	
		B-6	0	83.3	16.7	0	797*	
Bed E	dark marl	B-7	0.027	81	16.3	0	3733*	16 to 20 cm
		B-8	0.01	93	6	0	3910*	
Bed D	slightly lighter marl	B-9	0.16	57	27	0	15,579	20 to 28 cm
	B-10	0.073	81.7	11	0	69,184		
	B-11	0.017	97.3	1	0	52,992		
Bed C	dark marl	B-12	0.04	92.7	3	0.3	96,048	28 to 36 cm
	B-13	0.047	88.7	6.3	0.3	96,600		
	B-14	0.073	86	6.7	0	53,360		
Bed B4	light marl	B-15	0.003	96.7	3	0	6,555	36 to 50 cm
		B-16	0.013	86	12.7	0	407*	
		B-17	0.007	70.3	28.7	0.3	10*	
		B-18	0.02	95.2	2.8	0	7*	
		B-19					0	
Bed B3 to B2		B-20					0	50 to 69 cm
	B-21						0	
	B-22						0	
Bed B1		B-23					0	69 to 70 cm
Bed A	limestone	B-24					0	70 - 82 cm

Dark marls 15,579 - 96,600 (63,961 cpg):
 Phytoplankton 13,086 - 92,206 (60,507 cpg);
 Pollen/spores 901 - 5,050 (3,454 cpg).

Notes:

Bed D tentatively picked on slightly lighter marl at Bigby (sample B-9 to B-11).

* = heavily weathered samples (poor palynomorph preservation) excluded from range and mean figures.

Large proportions of prasinophytes in samples B-5 to B-7 and B-16 to B-18 may be mainly due to their preferential preservation in weathered samples. However, their abundant occurrence in better preserved samples B-9 and B-10 may indicate relatively high numbers at this location.

See the correlation panel in Dodsworth (1996, fig.2) for lithological log of this section.

Palynologically barren sample localities: Louth & South Thoresby (Lincolnshire), Heacham (Norfolk).

Supplementary Table I (5/6). Palynomorph concentration data from Bigby.

Source: Formerly unpublished data (P. Dodsworth).

Locality: South Ferriby Middlegate Quarry (south wall), Lincolnshire. (Not to scale.)								
Litho-strat.	Lithology	Sample	T/M ratio	Dinoflag. %	Prasino. %	Acantho. %	Counts per g (total)	Outcrop position of beds
Bed G		SF-1	0	53	47	0	280*	0 to 4.5 cm
		SF-2	0	84	16	0	61*	
Bed F	light marl	SF-3	0	90	9	0	27*	4.5 to 13 cm
		SF-4	0.02	86	12	0	380*	
Bed E	dark marl	SF-5	0.03	86	11	0	7,600	13 to 17.5 cm
		SF-6	0.02	93	4	1	26,000	
Bed D		SF-7	0.09	76	15	0	11,000	17.5 to 19 cm
Bed C	dark marl	SF-8	0.03	88	9	0	13,000	19 to 25 cm
		SF-9	0.01	97	2	0	4,000	
		SF-10	0.04	82	14	0	3,400	
		SF-11	0	99	1	0	2,800	
Bed B4	light marl	SF-12	0	97	3	0	160*	25 to 39 cm
Bed B3		SF-13					0	
Bed B2		SF-14					0	
Bed ?B1		SF-15	0.01	84	15	0	120*	

Locality: Caistor Limes Quarry, Lincolnshire. (Not to scale.)								
Litho-strat.	Lithology	Sample	T/M ratio	Dinoflag. %	Prasino. %	Acantho. %	Counts per g (total)	Outcrop position of beds
Bed H	light marl	CL-0					0	0 to 2 cm
Bed F		CL-1					0	2 to 13.5 cm
		CL-2					0	
		CL-3					0	
		CL-4	0	71	29	0	5*	
Bed E	dark marl	CL-5	0	73	27	0	340*	13.5 to 19 cm
		CL-6	0.08	65	27	0	480*	
Bed D		CL-7	0.08	75	17	0	6,000	19 to 22 cm
Bed C	dark marl	CL-8	0.01	94	5	0	22,000	22 to 28 cm
		CL-9	0.01	93	6	0	17,000	
Bed B4		CL-10	0.02	94	4	0	850*	28 to 38 cm
		CL-11	0.1	87	3	0	820*	
		CL-12					0	
B3-B2		CL-13	0.01	76	23	0	35*	38 to 48 cm
		CL-14	0	100	0	0	3*	

South Ferriby

Dark marls 2,800 - 26,000 (10,680 cpg):

Phytoplankton 2,800 - 25,480 (10,468 cpg);

Pollen/spores 0 - 520 (212 cpg).

Notes:

Bed D tentatively picked on slightly lighter marl at Caistor (sample CL-7).

* = heavily weathered samples (poor palynomorph preservation) excluded from range and mean figures.

See the correlation panel in Dodsworth (1996, fig.2) for lithological logs of these sections.

Caistor

Dark marls 6,000 - 22,000 (15,000 cpg):

Phytoplankton 4,980 - 21,362 (14,107 cpg);

Pollen/spores 638 - 1,020 (893 cpg).

Supplementary Table I (6/6). Palynomorph concentration data from two Lincolnshire localities.

Sources: Formerly unpublished data (P. Dodsworth).

