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zenaidae Ilovaiski, Preston Grit, Redclig D/C/90, x 1. (G, H) *Cardioceras (Vertebriceras) quadrarium* S. Buckman. Red Nodule Bed, Furzy Cliff, D/O/35, x 1. (I) *Cardioceras (Cardioceras) costicardia* S. Buckman, Red Nodule Bed, Furzy Cliff, D/O/20, x 1. (J) *Perisphinctes (Dichotomosphinctes)* sp. Weymouth Member, Bowleaze Clay, Furzy Cliff, D/O/41, x0.58. (K) *Cardioceras (Scarburgiceras) praecordatum* Douvillé, East Fleet section, just north-west of the Lynch Cove GCR site, D/O/1, x 1. (Photos: (A, C, D) K. D'Souza; (F), K. Denyer; (B, E, G–K), J.K. Wright. Collections: Prefix 'D', J.K. Wright collection; prefix , Sedgwick Museum Collection, Cambridge.)

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(Figure 2.29) Exposure of Abbotsbury Ironstone at Blind Lane, Abbotsbury. (Photo: A6478, reproduced with kind permission of the Director, British ,Geological Survey ©NERC.)

(Figure 2.30) Locality map for sites around Westbury. Geological information from BGS Sheet 281 (Frome) (1965).

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(Figure 2.44) View of the main north–south face at Dry Sandford Quarry, showing the Lower Trigonia Bed (Bed 6) and Upper Trigonia Bed (Bed 8) separated by shelly sand (Bed 7) marked by the hammer (shaft length, 30 cm). (Photo: J.K. Wright.)

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(Photo: J.K. Wright.)

(Figure 2.49) Correlation of sections in Magdalen Quarry, Cross Roads Quarry and Windmill Quarry (after Arkell, 1927, fig. 11), showing the transition from Coral Rag reef facies on the right into Wheatley Limestone facies on the left.

(Figure 2.50) View of the main east–west face at Magdalen Quarry showing the irregularly bedded Wheatley Limestone. The 'First Headington Hard' (Bed 5, 0.35 m) is just below the level of the mapcase (36 cm long). (Photo: J.K. Wright.)

(Figure 2.51) The type specimen of *Pectinatites (Virgatosphinctoides) wheatleyensis* (Neaverson) as figured by Neaverson (1925, p1.1, fig. 1). Natural size.

(Figure 2.52) Graphic sections showing the Kimmeridgian stratigraphy at the Littleworth Brick Pit and other sections in Oxfordshire and Buckinghamshire, after Horton *et al.* (1995, fig. 17). AmC, Ampthill Clay; CB, Crussoliceras Band; ES, Elmhurst Silt; HBS, Holman's Bridge Shale; HwS, Hartwell Silt; KC, Kimmeridge Clay; LGS, Lower Greensand; LLB, Lower Lydite Bed; PI, Portland Formation; PS, Pectinatus Sand; SwC, Swindon Clay; TS, Thame Sand; ULB, Upper Lydite Bed; WC, Watermead Clay; WNB, Wheatley Nodule Bed; WS, Wheatley Sand; VL, Virgula Limestone.

(Figure 3.1) Geological sketch map showing the location of the GCR sites described in Chapter 3. Extensive drift deposits are omitted for clarity 1, Upware South Pit; 2, Upware; 3, Warboys Clay Pit; 4, Roslyn Hole, Ely; 5, South Ferriby.

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(Figure 3.3) Locality map of quarries in the Upware inlier. Outcrop of the Upware Limestone (mapped as 'West Walton Beds'), Ampthill and Kimmeridge clays from BGS Sheet 188 (Cambridge) (1981) and Wright *et al.* (2000).

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(Figure 3.6) Log of the Oxford Clay succession in Warboys Pit (after Callomon, 1968).

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(Figure 3.8) View of a degraded section of Lower Kimmeridge Clay at Roslyn Hole showing the prominent marker band (arrowed) formed by a line of cementstone nodules in Bed 23 (KC30). Ely Cathedral is seen in the background. (Photo: A13722, reproduced by kind permission of the Director, British Geological Survey © NERC.)

(Figure 3.9) Graphic section of the Kimmeridge Clay at Roslyn Hole and borehole sections in Norfolk showing the southwards attenuation towards Ely (after Gallois, 1988, fig. 14).

(Figure 3.10) General view of the South Ferriby GCR site in 1987. (Photo: A14379, reproduced by kind permission of the Director, British Geological Survey ©NERC.)

(Figure 3.11) Correlation between the Oxfordian–Kimmeridgian boundary beds at South Ferriby and those in Dorset and Skye (after Page and Cox, 1995, fig. 2). A. = *Amoeboceras, P. = Pictonia, Ra. = Rasenia, Ri. = Ringsteadia.*

(Figure 4.1) Map showing the solid geology of the Oxfordian and Kimmeridgian beds in the Cleveland Basin, with the principal stuctural and geographical features. (Based on Versey, 1929, fig. 1; BGS 1:250 000 Solid Sheet 54N 02W (Tyne-Tees) (1981); BGS 1:1 500 000 Tectonic map of Britain, Ireland and adjacent areas (1996) and BGS 1:50 000 Sheet 54 (Scarborough) (1998)). In the Vale of Pickering there is a thick cover of Quaternary lacustrine deposits.

(Figure 4.2) Zones of the Oxfordian and Kimmeridgian stages, showing the stratigraphical ages of each of the formations present in the Cleveland Basin, and the age range of the exposure at each GCR site.

(Figure 4.3) Stratigraphical cross-section of the Yorkshire Corallian Group on the north side of the Vale of Pickering from Helmsley to Filey (after Rawson and Wright, 1995, fig. 15).

(Figure 4.4) Stratigraphical cross-section of the Yorkshire Corallian Group on the south-west side of the Vale of Pickering from the I lambleton Hills to Malton.

(Figure 4.5) P Selection of ammonites from the Corallian Group of the Cleveland Basin. (A) Amoeboceras nunningtonense Wright (holotype), Spaunton Sandstone, Leysthorpe Quarry, m27, x 1. (B) A. glosense (Bigot and Brasil), Newbridge Member, Leysthorpe Quarry, U/1/14, x 1. (C) A. transitorium Spath, Newbridge Member, Leysthorpe Quarry, U/1/5, x 1. (D) A. ilovaiskii (M. Sokolov), Spaunton Sandstone, Newbridge Quarry, U/2/38, x1. (E) A. newbridgense Sykes and Callomon, Spaunton Sandstone, Newbridge Quarry, U/2/20, x 1. (F) Perisphinctes (Pseudarisphinctes) pachachii Arkell, Spaunton Sandstone, Spaunton Moor Quarry, U/3/63, x0.33. (G) P. (Dichotomosphinctes) sp. Newbridge Beds, Leysthorpe Quarry, U/1/103, x0.7. (H) Cardioceras (Cardioceras) persecans S. Buckman, Birdsall Calcareous Grit, Filey Brigg, YM1983/45F, x 1. (I) C. (C.) cordatum (J. Sowerby), Birdsall Calcareous Grit, Flassen Gill, YM1983/36F, x 1. (1) C. (Vertebriceras) aff. dorsale S. Buckman, Hambleton Oolite, Spikers Hill Quarry, C/2/17, x 1. (K) C. (Plasmatoceras) popilaniense Boden, Hambleton Oolite, Spikers Hill Quarry, C/2/59, x 1. (L) C. (Scarburgiceras) harmonicum Arkell, Tenants' Cliff Member, Tenants' Cliff, YM1983/17F, x 1. (M) C. (S.) reesidei Maire, Tenants' Cliff Member, Tenants' Cliff, YM1983/20F, x 1. (N) C. (Vertebriceras) aff. phillipsi Arkell, Tenants' Cliff Member, Tenants' Cliff, YM1983/23F, x 1. (O) C. (S.) praecordatum (Douvillé), Weymouth Member, Cayton Bay Waterworks, YM1983/9F, x 1. (P) C. (S.) scarburgense (Young and Bird), Weymouth Member, Cornelian Bay, YM1983/3F, x 1. (Photos: (A-E), (H, I), (L-P), J.K Wright; (F, G), K. D'Souza; (J, K) K. Denyer. Collections: Prefixes 'U', 'C', J.K. Wright Collection; 'YM', Yorkshire Museum Collection, York; 'm', Woodend Museum, Scarborough.)

(Figure 4.6) Map showing the locations of Oxfordian and Kimmeridgian GCR sites in north-east Yorkshire, and other localities mentioned in the text.

(Figure 4.7) The type specimen of *Subdichotomoceras lamplughi* Spath, type species of the genus, from the Eudoxus Zone at Speeton, as figured by Pavlow and Lamplugh (1892, p. 111). Approximately natural size.

(Figure 4.8) Sketch map of the geology of Filey Brigg (after Rawson and Wright, 2000, fig. 33).

(Figure 4.9) Log of the Corallian succession at Filey Brigg (after Rawson and Wright, 2000, fig. 34).

(Figure 4.10) View of the southern side of Filey Brigg showing fossiliferous Hambleton Oolite (Upper Leaf) overlying Birdsall Calcareous Grit in the rock platform. The junction is where the figure is pointing with the hammer. (Photo: J.K. Wright.)

(Figure 4.11) Locality map of the Tenants' Cliff and Cornelian Bay GCR sites. Outcrop of the Oxford Clay and Lower Calcareous Grit from Wright (1968, fig. 9).

(Figure 4.12) Log of the Lower Calcareous Grit succession at Tenants' Cliff; as measured by J.K. Wright in 1982.

(Figure 4.13) Exceptionally well-preserved ammonites from the Tenants' Cliff Member. (A) *Mirosphinctes frickensis* (Moesch) (Tethyan), LG744; (B) *Neocampylites delmontanus* (Oppel) (Tethyan), LG742; (C) *Cardioceras* (*Scarburgiceras*) *bukowskii* Maire (Boreal), LG736. (Photos: K. D'Souza. Specimens in the J.K. Wright Collection. Natural size.)

(Figure 4.14) General view of the southern end of Cornelian Bay showing the Middle Jurassic Ravenscar Group (on the left) faulted against easterly dipping Osgodby Formation sandstones (Callovian) overlain by Weymouth Member Oxford Clay. (Photo: J.K. Wright.)

(Figure 4.15) Log of the Upper Callovian–Lower Oxfordian sequence at Cornelian Bay (after Wright, 1969, fig. C4).

(Figure 4.16) Locality map for Hackness Head showing the outcrop of the Coral–Sponge Bed (Subdivision 3). (After Wilson, 1949, fig. 43.)

(Figure 4.17) Cross-section of Hackness Head showing the two quarry sections, as measured by J.K. Wright in 1991.

(Figure 4.18) View of the eastern quarry at Hackness Head, showing the massive, bioclastic limestones of Subdivision 2 overlain by coral rubble (Subdivision 3) just below the grass at the top. Hammer shaft (mid-left of picture) is 30 cm. (Photo: J.K. Wright.)

(Figure 4.19) Facies distribution across the central and eastern parts of the Cleveland Basin during deposition of the Hackness Coral–Sponge Bed (after Wright, 1992, fig. 10).

(Figure 4.20) Locality map of the Betton Farm and Spikers Hill GCR sites. Geological outcrops from BGS Sheet 54 (Scarborough) (1998).

(Figure 4.21) View of Betton Farm Quarry (north) showing rounded masses of Thamnasterian reef coral above the hammer (30 cm) resting on oolite (Mahon Oolite). (Photo: J.K. Wright.)

(Figure 4.22) The main east–west face in the Hambleton Oolite at Spikers Hill Quarry. The dark, pisoidal 'Blue Band' (Bed 2) is clearly seen towards the top of the quarry, overlain by beds 3 to 7, which are more thinly bedded than those below. Since this photo was taken, the quarry has been deepened to reveal part of the Passage Beds, Bed '0'. (Photo: J.K. Wright.)

(Figure 4.23) Log of the Corallian succession at Spikers Hill Quarry, as measured by J.K. Wright in 1991.

(Figure 4.24) Locality map of Newbridge Quarry. Outcrop of the Upper Calcareous Grit from BGS Sheet 53 (Pickering) (1973).

(Figure 4.25) Log of the Upper Calcareous Grit at Newbridge Quarry, as measured by J.K. Wright in 1998.

(Figure 4.26) Simplified geological drift sketch map of the Vale of Pickering showing localities cited in the text (based on Geological Survey 1:50 000 sheets 53 and 54). The Green Lane Pit and Golden Hill Pit GCR sites are located at Marton. *Other drift deposits are omitted for clarity.

(Figure 4.27) Composite graphic log of the section at which weathers to form a prominent overhang. Golden Hill Pit (after Wignall, 1993, fig. 3).

(Figure 4.28) Locality map of Shaw's Gate Quarry. Outcrop of the Hambleton Oolite from BGS Sheet 52 (Thirsk) (1992).

(Figure 4.29) Log showing the slump structures at Shaw's Gate Quarry (after Powell et al., 1992).

(Figure 4.30) View of Shaw's Gate Quarry showing a slump fold in oobiosparite (Bed 5). The flanks of the fold are filled with laminated sandy limestone (Bed 6). A load ball in Bed 3 is visible on the lower right. Height of face 1.5 m. (Photo: J.K. Wright.)

(Figure 4.31) Local ty map of Snape Hill Quarry. Geological information from BGS Sheet 52 (Thirsk) (1992).

(Figure 4.32) North Grimston Cementstone (Bed 1) at Snape Hill Quarry. Alternations of limestone and calcareous mudstone are overlain by massive, flaggy weathering limestone. Mapcase 35 cm. (Photo: J.K. Wright.)

(Figure 4.33) Sketch of the main north–south face at Snape Hill Quarry showing the two separate successions, as seen by J.K. Wright in 1997.

(Figure 4.34) Map showing the locations of the principal exposures WSW of Nunnington. Geological information from BGS Sheet 53 (Pickering) (1973).

(Figure 4.35) Log of the CoraRine Oolite Formation in Leysthorpe Quarry, as measured by Mr D. Sharp and J.K. Wright, 1991–1992.

(Figure 4.36) View of the northern face at Leysthorpe Quarry, showing the thick Malton Oolite sequence, with, at the top, a thin development of Coral Rag overlain by thin-bedded, flaggy Upper Calcareous Grit. (Photo: J.K. Wright.)

(Figure 4.37) Locality map of the Wath Quarries. Outcrop of the Coralline Oolite from BGS Sheet 53 (Pickering) (1973).

(Figure 4.38) Weathering profile of the upper Malton Oolite and Coral Rag at Wath Old Quarry, as measured by J.K. Wright in 1997.

(Figure 4.39) Wath Old Quarry, showing the irregular, erosive junction of Coral Rag resting on Malton Oolite. The lower rubbly coral–shell bed of the Coral Rag and the upper coralliferous micritic limestone are easily distinguished. Hammer shaft is 32 cm long. (Photo: J.K. Wright.)

(Figure 4.40) View of the eastern face of Wath New Quarry showing, near the base, Mahon Oolite dipping gently north (to the left), overlain by giant cross-sets of Malton Oolite dipping south, and at the top of the quarry, Coral Rag dipping gently north. (Photo: J.K. Wright.)

(Figure 5.1) Map of northern Scotland, showing the principal Jurassic sedimentary basins and their structural controls, and the locations of Oxfordian and Kimmeridgian GCR sites. Based on BGS 1:1 500 000 Tectonic Map of Britain, Ireland and Adjacent Areas (1996) and BGS 1:1 000 000 Geological Map of the United Kingdom, Ireland and the Adjacent Continental Shelf (1991).

(Figure 5.2) Schematic cross-section to show the relations of the near-shore and distal members in the Hebrides and Inner Moray Firth Basins. Beds such as the Brora Sandstone and the Ardassie Limestone originally extended eastwards over the Scottish landmass but have been removed by Kimmeridgian erosion. The Helmsdale Boulder Beds continue up into the Portlandian Stage.

(Figure 5.3) Locality map of the Balintore GCR site. Geological information from BGS Sheet 94 (Cromarty) (1973).

(Figure 5.4) Stratigraphical log of the Balintore section (after Sykes, 1975, fig. 4).

(Figure 5.5) Ammonites from the Balintore Formation of eastern Scotland. (A) *Cardioceras (Subvertebriceras) densiplicatum* Boden. Bed 4, Port-an-Righ Ironstone Member, Balintore, ES3, x1. (B) *C. (Plasmatoceras) tenuicostatum* Nikitin. Ardassie Limestone, Brora, ES2, x 1. (Photos: K. D'Souza. Specimens in the J.K. Wright Collection.)

(Figure 5.6) Locality map of the Brora GCR site. Geological information from BGS Sheet 103E (Helmsdale) (1998).

(Figure 5.7) Stratigraphical log of the Brora section (after Sykes, 1975, fig. 3).

(Figure 5.8) Diagram showing possible post-Jurassic movement on the Great Glen Fault (after Sykes, 1975, fig. 2).

(Figure 5.9) Sketch map of the mainly Kimmeridgian outcrop between (a) Kintradwell and Lothbeg Point, and (b) Lothbeg Point and Dun Glas (after Wignall and Pickering, 1993, figs 10 and 17).

(Figure 5.10) Schematic sections showing the main stratal units of the Helmsdale GCR site (based on Macdonald and Trewin, 1993, fig. 2 and Wignall and Pickering, 1993, fig. 15).

(Figure 5.11) Kintradwell Boulder Beds at Kintradwell showing compaction features around the large boulders. (Photo: C1980, reproduced by kind permission of the Director, British Geological Survey ©NERC.)

(Figure 5.12) The 'fallen stack' in the Helmsdale Boulder Beds near Portgower. (Photo: C1975, reproduced by kind permission of the Director, British Geological Survey ©NERC.)

(Figure 5.13) Simplified reconstruction of depositional conditions adjacent to the Helmsdale Fault during the Kimmeridgian (after Wignall and Pickering, 1993, fig. 21).

(Figure 5.14) Locality map of the Staffin and Kildorais GCR sites (after Cox and Sumbler, in press).

(Figure 5.15) General log of the Staffin Shale succession (after Morton and Hudson, 1995, table 4).

(Figure 5.16) Map of the foreshore at Digg, with detailed logs (after Morton and Hudson, 1995, figs 39, 40).

(Figure 5.17) Map of the foreshore at Flodigarry, with detailed log (after Morton and Hudson, 1995, fig. 42).

(Figure 5.18) View looking north along the beach at Flodigarry, showing the 0.3–0.4 m limestone of Bed 40 dipping steeply west, and curving round under the large boulder in the middle distance. The large boulder is the one in the middle of (Figure 5.17). (Photo: J.K. Wright.)

(Figure 5.19) Graphic section of the Kimmeridgian and uppermost Oxfordian parts of the Staffin Shale Formation, Flodigarry Shale Member, at Kildorais.

(Figure 5.20) Locality map of the North Elgol Coast GCR site. Outcrop of the Oxfordian beds from BGS Sheet 71W (Broadford) (1976).

(Figure 5.21) Stratigraphical log of the Elgol section (after Sykes, 1975, fig. 6).

References



(Figure 1.1) Major Jurassic subdivisions. ¹ geological time terms ² chronostratigraphical (time-rock) terms Harland et al. (1990) * Gradstein and Ogg (1996) (95% confidence level).



(Figure 1.2) (a)–(c), (e) Palaeogeographical reconstructions for the British area during the late Mid and Late Jurassic (based on Cope and Rawson in Bradshaw et al., 1992; Cope, 1995b). In many cases, the extent of land areas is uncertain. (d) Main structural elements affecting sedimentation in the British area in the Mid-Late Jurassic (terminology as used in this volume). The 'London Platform' is a structural high, the limits of which remained generally constant. The emergent part of the Platform, the position and limits of which varied, is referred to as the 'London Landmass'. (Compiled from various sources.)



(Figure 1.3) Simplified sketch map showing occurrences of Oxfordian-Kimmeridgian rocks in Britain (onshore area only).

		Substage	Zone	Subzone	Standard "bed"	Ammonite biohorizon
			Pittoni		in Eastern England	
		1 8 1	Rotunda			
			Pallasioides			
		idgi		Paravirgatus		
		Ē	Pecunatus	Eastlecottensis	KC 46-49	
		5	The House of	Encombensis	KC 42 (part)	
		E .	Hudlestoni	Reisiformis	-45	
		<u>ě</u>	Whendersensis	Wheatleyensis	KC 40-	
			w neaseyenais	Smedmorensis	42 (part)	
			Scitulus		KC 37-39	
			Elegans		KC 36	
			Autistiodorensis	and the second	KC 33-35	
		ridgiar	Eudoxus	in the state	KC 24-32	
		Kimme	Mutabilis		KC 15-23	ACCEPTION OF COM
Alternative zor	nation for the		In action of the		1000000000	
Middle-Upper Ox perisphinctid	cfordian based on d ammonites	Low	Cymodoce	poor second o	KC 5-14	The second side
Middle-Upper Os perisphinctic Subzone	cfordian based on d ammonites Zone	Lowe	Cymodoce Baylei		KC 5-14 KC 1-4	Amountainess heading
Middle-Upper Os perisphinctio Subzone Evoluta Pseudocordata	cfordian based on 1 ammonites Zone Pseudocordata	in Low	Cymodoce Baylei Rosenkrantzi		KC 5-14 KC 1-4 AmC 37-42	Antoburna badan
Middle-Upper Os perisphinctic Subzone Evoluta Pseudocordata Pseudoyo Caledonica	cfordian based on 1 ammonites Zone Pseudocordata	fordian Low	Cymodoce Baylei Rosenkrantzi Regulare		KC 5-14 KC 1-4 AmC 37-42 AmC 26-36	Ancobocras bashin
Middle-Upper Os perisphinctic Subzone Evoluta Preudocordata Preudoyo Caledonica Variocostatus	xfordian based on 4 ammonites Zone Pseudocordata	Oxfordian Low	Cymodoce Baylei Rosenkrantzi Regulare	Serranum	KC 5-14 KC 1-4 AmC 37-42 AmC 26-36	Ancebocrnas bandon
Middle-Upper Os perisphinctic Subzone Evoluta Preudocordata Preudoyo Caledonica Variocostatus	cfordian based on 4 ammonites Zone Pseudocordata Cautisnigrae	per Oxfordian Low	Cymodoce Baylei Rosenkrantzi Regulare Setratum	Serratum Koldeweyense	KC 5-14 KC 1-4 AmC 37-42 AmC 26-36 AmC 17-25	Amoebocmat basken
Middle-Upper Os perisphinctic Subzone Evoluta Preudocordata Preudoyo Caledonica Variocostarus Casttisnigrae	cfordian based on d ammonites Zone Pseudocordata Cautisnigrae	Upper Oxfordian Low	Cymodoce Baylei Rosenkrantzi Regulare Setratum	Serratum Koldeweyense Glosense	KC 5-14 KC 1-4 AmC 37-42 AmC 26-36 - AmC 17-25	Amoebocmat basken
Middle-Upper Os perisphinctic Subzone Evoluta Preudocordata Preudoyo Caledonica Variocostarus Casttisnigrae	cfordian based on d ammonites Zone Pseudocordata Cautisnigrae	Upper Oxfordian Low	Cymodoce Baylei Rosenkrantzi Regulare Serratum Glosense	Serrapum Koldeweyense Glosense Bovaiskii	KC 5-14 KC 1-4 AmC 37-42 AmC 26-36 AmC 17-25 AmC 12-16	Amorbocrnat backer
Middle-Upper Os perisphinctic Subzone Evoluta Presidocordata Presidocordata Presidocordata Variocostatus Calcidonica Variocostatus Cautisnigrae Nunningtonense	Contian based on A ammonites Zone Pseudocordata Cautisnigrae Pumilus	u Upper Oxfordian Low	Cymodoce Baylei Rosenkrantzi Regulare Settatum Gilosense	Serrapum Koldeweyense Glosense Blovaiskii Blakei	KC 5-14 KC 1-4 AmC 37-42 AmC 26-36 - AmC 17-25 - AmC 12-16 WWF 11-16	Amorbocrnat basken
Middle-Upper Os perisphinctic Subzone Evoluta Preudocordata Preudoyo Caledonica Variocostatus Cautionigrae Nunningtonense Parandieri	Contian based on A ammonites Zone Pseudocordata Cautisnigrae Pumilus	ddle Upper Oxfordian Low	Cymodoce Baylei Rosenkrantzi Regulare Setratum Glosense Temuiserratum	Serratum Koldeweyense Glosense Ilovaiskii Blakei Tenuiserratum	KC 5-14 KC 1-4 AmC 37-42 AmC 26-36 AmC 17-25 AmC 12-16 \$ WWF 11-16 + AmC 1-11	Amorbocrnat baskin
Middle-Upper Os perisphinctic Subzone Evoluta Presidocordata Presidocordata Presidocordata Variocostanos Caledonica Variocostanos Cautisnigrae Nunningtonense Parandieri Amtecedens	Contian based on A ammonites Zone Pseudocordata Cautisnigrae Pumilus Plicatilis	Middle Upper Oxfordian Low	Cymodoce Baylei Rosenkrantzi Regulare Serratum Glosense Tenuiserratum	Serratum Koldeweyense Glosense Ilovaiskii Blakei Tenuiserratum Maltonense	KC 5-14 KC 1-4 AmC 37-42 AmC 26-36 - AmC 17-25 - AmC 12-16 - WWF 11-16 + AmC 1-11 - WWF 5.10	Amorbocrnat backer
Middle-Upper Os perisphinctic Subzone Evoluta Presidocordata Presidocordata Variocostatus Calcióonica Variocostatus Cautisnigrae Nunningtonense Parandieri Antecedens Vertebrale	Condian based on A ammonites Zone Pseudocordata Cautisnigrae Pumilus Plicatilis	Middle Upper Oxfordian Low	Cymodoce Baylei Rosenkrantzi Regulare Serratum Glosense Tenuiserratum Densiplicatum	Serratum Koldeweyense Glosense Ilovaiskii Blakei Tenuiserratum Maltonense Vertebrale	KC 5-14 KC 1-4 AmC 37-42 AmC 26-36 - AmC 17-25 - AmC 17-25 - AmC 12-16 - WWF 11-16 + AmC 1-11 - WWF 5-10-	Amorbocrnat bankin
Middle-Upper Os perisphinctic Subzone Evoluta Pseudocordata Pseudoyo Caletdonica Variocostatus Cautionigrae Nunningtonense Parandieri Antecedens Vertebrale	ctordian based on d ammonites Zone Pseudocordata Cautisnigrae Pumilus Plicatilis	1 Middle Upper Oxfordian Low	Cymodoce Baylei Rosenkrantzi Regulare Serratum Glosenae Tenuiserratum Densiplicatum	Serranum Koldeweyense Glosense Ilovaiskii Blakei Tenuiserratum Maltonense Vertebrale Cordatum	KC 5-14 KC 1-4 AmC 37-42 AmC 26-36 - AmC 17-25 - AmC 17-25 - AmC 12-16 + AmC 1-11 - WWF 5-10- - WWF 1-4	Amorbocrnat bankin
Middle-Upper Os perisphinctic Subzone Evoluta Pseudoyo Caledonica Variocostarus Cautionigrae Nunningtonense Parandieri Amecedens Vertebrale	Condian based on A ammonites Zone Pseudocordata Cautisnigrae Pumilus Plicatilis	er Middle Upper Oxfordian Low	Cymodoce Baylei Rosenkrantzi Regulare Serratum Glosenae Tenuiserratum Densiplicatum Cordatum	Serratum Koldeweyense Glosense Ilovaiskii Blakei Tenuiserratum Maltonense Vertebrale Cordatum Costicardia	KC 5-14 KC 1-4 AmC 37-42 AmC 26-36 - AmC 17-25 - AmC 17-25 - AmC 12-16 + AmC 1-11 - WWF 5-10- - WWF 1-4	Anosbocrust baddin
Middle-Upper Os perisphinctic Subzone Evoluta Pseudoyo Caledonica Variocostatus Castionigrae Nunningtonense Parandieri Amecedens Vertebrale	Condian based on Ammonites Zone Pseudocordata Cautisnigrae Pumilus Plicatilis	ower Middle Upper Oxfordian Low	Cymodoce Baylei Rosenkrantzi Regulare Setratum Glosenae Tenuiserratum Densiplicatum Cordatum	Serranum Koldeweyense Glosense Ilovaiskii Blakei Tenuiserratum Mahonense Vertebrale Cordanum Costicardia Bukowskii	KC 5-14 KC 1-4 AmC 37-42 AmC 26-36 AmC 17-25 AmC 17-25 AmC 12-16 #WWF 11-16 + AmC 1-11 WWF 5-10- WWF 1-4	Anosbocrus baddin
Middle-Upper Os perisphinctic Subzone Evoluta Presidocordata Presidocordata Presidocordata Variocostantas Calcidonica Variocostantas Castrisnigrae Nunningtonense Parandieri Amecedens Vertebrale	Continue de la contenente de la contenen	Lower Middle Upper Oxfordian Low	Cymodoce Baylei Rosenkrantzi Regulare Setratum Glosense Tensuiserratum Densiplicatum Cordatum Mariae	Serranum Koldeweyense Glosense Ilovaiskii Blakei Trenuiseratum Maltonense Vertebrale Cordanum Costicardia Bukowskii Praecordatum	KC 5-14 KC 1-4 AmC 37-42 AmC 26-36 - AmC 17-25 - AmC 12-16 + AmC 1-11 WWF 11-16 - WWF 1-4	Anosbocrus bashin

(Figure 1.4) Chronostratigraphical subdivisions and ammonite biohorizons recognized in the Oxfordian and Kimmeridgian stages in Britain (for sources, see text). AmC = Ampthill Clay Formation; KC = Kimmeridge Clay Formation; WWF = West Walton Formation. In Dorset, where the Kimmeridgian succession is more complete, additional 'beds' (KC50–63) up to the base of the overlying Portland Group (Portlandian) have been detailed by Gallois (2000). (See the Tyneham Gap–Hounstout GCR site report, this volume.)



(Figure 2.1) Map of southern England showing the outcrop of the Oxfordian–Kimmeridgian beds, and the principal structural and palaeogeographical features (based on Scotchman, 1991a, fig. 1; Bristow et al., 1995, fig. 6 and Newell, 2000, fig. 6).



(Figure 2.2) Correlation of Oxfordian strata in Dorset, Wiltshire and Oxfordshire.



(Figure 2.3) Cross-section of north Dorset, showing the effect of syndepositional faulting on the thicknesses of the Corallian beds (after Bristow et al., 1995, fig. 38).



(Figure 2.4) Locations of Oxfordian and Kimmeridgian GCR sites in southern England.



(Figure 2.5) Sketch map of the solid geology of the Furzy Cliff–Ringstead Bay area (based on Cox and Gallois, 1981, fig. 5 and BGS Sheet 341/342' (West Fleet and Weymouth) 1976).

Substage	Formation		Member			Thickness (metres)	
	as and a state of	Osmington Mills Ironstone (with Ringstead Coral Bed)			0.5		
Upper	Sandsfoot	Ringstead Clay			3.5		
		Sandsfoot Grit			7.35		
Oxfordian	HE TELEVILLE AND STREET	Sa	Sandsfoot Clay			3.9	
Sales and the second	ci. 11.		F	ted Beds	*	2.0	
	Clavellata	C1	C	lay Band	*	0.6	-
		Clavellat	a Chie	f Shell Be	ds*	2.1	
		Sandy Blo			*	2.4	
		Nodular Rubble		3.2			
Middle	Osmington Oolite	Shortlake		5.1			
Here a star		Upton		8.3	C		
Oxfordian	increased and a	Bencliff Grit		6.7			
	n-1-1:4	Nothe Clay			12.0		
	Reacht	Preston Grit			1.5		
		Nothe Grit			9.0		
Lower	Oxford Clay	Warmard	Bowlea: (contain Nodul	ze Clay ing Red e Bed)	*	14.5	
		Member	Jordan Cliff Clay *		9.0	-	
O'ATOTOTATA		Furzedown Clay			*	18.0	

(Figure 2.6) The complete stratal succession at the Osmington GCR site.

Zone	Subzone	Member			
		Osmington Mills Ironstone			
		Ringstead Clay			
Rosenkrantzi		Sandsfoot Grit			
Regulare	19961 1969 1997 - 1995				
Samahum	Serratum	-			
Serratum	Koldeweyense				
Closers	Glosense	Sandsfoot Clay Clavellata			
Glosense	Ilovaiskii				
	Blakei				
Ienuiserratum	Tenuiserratum	Nodular Rubble			
Densializatum	Maltonense	Shortlake Upton			
Densipilcatum	Vertebrale	Bencliff Grit Nothe Clay Preston Grit			
Cordatum	Cordatum	Nothe Grit			
	Costicardia	Bowleaze Clay			
	Bukowskii	Jordan Cliff Clay			
Mai	Praecordatum	Meyer Class			
Mariae	Scarburgense	Furzedown Clay			

(Figure 2.7) The ammonite zones and subzones of the Oxfordian Stage showing the zonal range of the strata present at the Osmington GCR site.



(Figure 2.8) Log of the Corallian Group at Osmington, (after Sun, 1989, figs 6, 7, 10 and 13).



(Figure 2.9) View of the Corallian limestones in the cliffs west of Bran Point. Alternations of marl and concretionary limestone in the base of the cliff and rock platform (Upton Member, A) are overlain by Shortlake Member oolite (B), with Nodular Rubble (C) and Clavellata Formation (D) in the cliff behind. (Photo: J.K. Wright.)

Formation	Sequence	Member	Lithology (generalized)	Systems tract	
		Osmington Mills Ironstone	ironstone, condensed limestone		
		Ringstead Clay	mudstone, unbioturbated, low faunal diversity	Highstand	
Sandsfoot	pot 4	ot 4	Sandsfoot Grit	sandstone, phosphatic, iron ooids	Transgressive
		Sandsfoot Clay	mudstone, bioturbated, moderate faunal diversity	Highstand	
Clavellata	3		condensed sideritic-bioclastic limestone		
		Clavellata	bioclastic-intraclastic limestone	Transgressive	
			bioclastic sandy limestone		
		Nodular Rubble	bioturbated nodular wackestone		
Osmington Oolite	2	2	Shortlake	cross-bedded oolitic limestone	Highstand
F 10		Upton	mudstone, micritic limestone	Transgressive	
- metres		المرجع ويرور وروالي	bioclastic-intraclastic sandy limestone		
0		Bencliff Grit	sharp-based HCS-SCS sandstone bodies	Falling stage	
B-1-1 4		Nothe Clay	mudstone, low faunal diversity	Highstand	
Redchill	1		condensed sideritic limestones	Theorem in	
		Preston Grit	bioclastic-intraclastic sandstone	Transgressive	
		Nothe Grit	bioturbated clayey sandstone	Lowstand	
Oxford Clay		Weymouth	extends downwards into c. 200 metres of marine modstone	crosive bound	

(Figure 2.10) Sequence stratigraphical interpretation of the Corallian sequence at the Osmington GCR site (after Newell, 2000, fig. 2).



(Figure 2.11) Selection of Oxfordian ammonites from the Dorset coast Oxfordian exposures. (A) Ringsteadia evoluta Salfeld, Osmington Mills Ironstone, Black Head, J44969, x0.95. (B) Amoeboceras glosense (Bigot and Brasil), Clavellata Member, Black Head, D/C/25, x0.95. (C) Perisphinctes (Perisphinctes) uptonensis Arkell, Clavellata Member, Black Head, DC42, x0.80. (D) P. (Pseudarisphinctes) pachachii Arkell, Clavellata Member, Black Head, D/C/46, x0.48. (E) Amoeboceras ilovaiskii (M. Sokolov), Clavellata Member, Black Head, D/C/29, x1. (F) Cardioceras (Subvertebriceras) zenaidae Ilovaiski, Preston Grit, Redclig D/C/90, x 1. (G, H) Cardioceras (Vertebriceras) quadrarium S. Buckman. Red Nodule Bed, Furzy Cliff, D/O/35, x 1. (I) Cardioceras (Cardioceras) costicardia S. Buckman, Red Nodule Bed, Furzy Cliff, D/O/20, x 1. (J) Perisphinctes (Dichotomosphinctes) sp. Weymouth Member, Bowleaze Clay, Furzy Cliff, D/O/41, x0.58. (K) Cardioceras (Scarburgiceras) praecordatum Douvillé, East Fleet section, just north-west of the Lynch Cove GCR site, D/O/1, x 1. (Photos: (A, C, D) K. D'Souza; (F), K. Denyer; (B, E, G–K), J.K. Wright. Collections: Prefix 'D', J.K. Wright collection; prefix , Sedgwick Museum Collection, Cambridge.)



(Figure 2.12) Kimmeridge Clay outcrops in the Dorset type area (after Cox and Gallois, 1981, fig. 1).



(Figure 2.13) a. Graphic sections of the lower part of the Kimmeridge Clay at Black Head–Osmington Mills [SY 7239 8195], [SY 7259 8192]–[SY 7258 8200], [SY 7336 8186] and [SY 7342 8174]. (After Cox and Gallois, 1981, pp. 33–4.). b. Graphic section of the lower part of the Kimmeridge Clay at Osmington Mills [SY 7342 8174]. (After Cox and Gallois, 1981, pp. 33–4.)



(Figure 2.14) Correlation between the main sections of Kimmeridge Clay on the Dorset coast. Youngest zones not shown. (After Cox and Gallois, 1981, fig. 5.)



(Figure 2.15) Graphic section of the Eudoxus–Pectinatus zonal interval at Ringstead Bay [SY 7619 8147], [SY 7606 8147] and [SY 765 813]. (After Cox and Gallois, 1981, p. 35.)



(Figure 2.16) Sketch map of the solid geology in the vicinity of the Sandsfoot GCR site.

Substage	Formation	Ν	Aember	Thickness (metres)
Upper	and a second in	Osmington	0.3	
	Sandsfoot	Ring	5.0	
		Sandsfoot Grit		11.3
		Sand	15.5	
Dxfordian		Clavellata	Red Beds [†] *	1.5
State State	Clavellata		Clay Band [†] *	1.0
			Chief Shell Beds [†]	2.02
		Sandy Block [†]		1.57
	Osmington Oolite	Nodular Rubble		1.8+
		* Shortlake		6.1+
Middle Oxfordian		Wpton *		4.5+
		≯ Bencliff Grit		4.0
	Redcliff	Nothe Clay		13.5
	send assessment of senten	Preston Grit		1.8
Lower		Nothe Grit		9.0

(Figure 2.17) The complete stratal succession at the Sandsfoot GCR site.



(Figure 2.18) Weathering profile of the Redcliff Formation between Nothe and Rodwell (after Wright, 1986a, figs 2 and 3).





(Figure 2.20) Weathering profile of the Sandsfoot Grit in the cliff section beneath Sandsfoot Castle (after Wright, 1986a, fig. 5)



(Figure 2.21) Massive Sandsfoot Grit of Unit III below Sandsfoot Castle, showing the intense Thalassinoides bioturbation of the harder bands weathering out in the foreground blocks. (Photo: J.K. Wright.)



(Figure 2.22) Geological map for the Small Mouth, East Fleet and Lynch Cove GCR sites.



(Figure 2.23) Correlation of the basal beds of the Kimmeridge Clay exposed at Wyke Regis, Sandsfoot, Black Head, Osmington Mills and Ringstead Bay (based on Cox and Gallois, 1981, fig. 6 and unpublished borehole data, R.W. Gallois, pers. comm.).



(Figure 2.24) Log of the Corallian succession at East Fleet, after Wright (1986a, fig. 4). Note that Bed 7 is only 0.9 m thick — the thickness of 3.5 m given in Wright (1986a) is a misprint.



(Figure 2.25) Sketch map of the solid geology of the Kimmeridge area, (based on Cox and Gallois, 1981, fig. 7 and Gallois, 2000, fig. 1).



(Figure 2.26) Geological sketch sections of the Kimmeridge Clay exposed in the cliffs between Brandy Bay and Chapman's Pool (based on Cox and Gallois, 1981, fig. 8 and Gallois, 2000, fig. 2).



(Figure 2.27) Generalized vertical section through the upper part of the Kimmeridge Clay exposed in the cliffs east of Clavell's Hard (based on Cox and Gallois, 1981, fig. 13 and Gallois, 2000, figs 4 and 6).



(Figure 2.28) Looking east from Clavell's Hard to Rope Lake Head and St Alban's Head (far distance). The lower part of the cliff face comprises alternating mudstones and ribs of oil shale including the Blackstone, Rope Lake Head Stone Band and Short Joint Coal. The upper part comprises a thick succession of pale calcareous mudstones including, towards the top, the Basalt Stone Band. The cliff is capped by further alternations of mudstone and oil shale including the White Stone Band. (Photo: W.A. Read.)



(Figure 2.29) Exposure of Abbotsbury Ironstone at Blind Lane, Abbotsbury. (Photo: A6478, reproduced with kind permission of the Director, British ,Geological Survey ©NERC.)



(Figure 2.30) Locality map for sites around Westbury. Geological information from BGS Sheet 281 (Frome) (1965).



(Figure 2.31) Locality map for the Steeple Ashton GCR site. Geological information from BGS Sheet 281 (Frome) (1965).



(Figure 2.32) Log of the Corallian succession at Steeple Ashton (after Negus and Beauvais, 1979, fig. 1).


(Figure 2.33) Locality map for the Seend Cleeve GCR site. Outcrop of the Corallian sandstones from BGS Sheet 281 (Frome) (1965).



(Figure 2.34) Weathering profile of the Corallian succession at Seend Cleeve Quarry as seen by J.K. Wright in 1978.



(Figure 2.35) Sketch map of the cutting on the former Midland and South Western Junction Railway. The line is now dismantled. The section south-west of Westlecot Road bridge constitutes the Kimmeridgian GCR site. (Geology based on Arkell, 1948, fig. 1 and British Geological Survey Sheet SU 18 SE.)



(Figure 2.36) The type specimen of Pectinatites (P.) eastlecottensis (Salfeld) as figured by Salfeld (1913) but enlarged to natural size.



(Figure 2.37) Locality map for the Shellingford Crossroads GCR site. Outcrop of the Stanford Formation (mapped as 'Corallian limestone glib') from BGS Sheet 253 (Abingdon) (1971).



(Figure 2.38) Log of the Corallian succession at Shellingford Crossroads Quarry (after Goidring et al., 1998b, fig. 3).



(Figure 2.39) Locality map for the Lamb and Flag Inn Quarry. Corallian outcrops from Arkell (1939a, plate 30).



(Figure 2.40) Weathering profile of the Lamb and Flag Inn Quarry as seen by J.K. Wright in 1983.



(Figure 2.41) Correlation of sections at Shellingford Crossroads Quarry, Lamb and Flag Quarry, and Dry Sandford Quarry (after Johnson, 1983, fig. 2).

deskal stock desk	Coral Rag Member	ford
106	micritic limestone with in situ corals	Stant
9	??Urchin Marl Bed	Ī
8	Upper Trigonia Bed: platy grey and brown-weathering bioturbated shelly limestone, locally divided by clay partings	
7 40 400	sands, bioturbated and cross-laminated, with extensive limonite staining and abundant shell debris	mber
6	Lower Trigonia Bed: impersistent concretions at the level of a pebble bed with rolled, bored limestone, rolled corals, clay, lydite and other fragments	dey Sand Me eston Forma
4		
3 2	bioturbated and cross-bedded coarse sands with pebbly horizons, and courses of bure calcareous doggers	
	$\frac{1}{2}$	
sandstor	ne limestone	
clay	sandy limeston	e
sandy m	arl ••••• pebble bed	

(Figure 2.43) Log of the Corallian succession at Dry Sandford Quarry (after Johnson, 1983, fig. 1B).



(Figure 2.44) View of the main north–south face at Dry Sandford Quarry, showing the Lower Trigonia Bed (Bed 6) and Upper Trigonia Bed (Bed 8) separated by shelly sand (Bed 7) marked by the hammer (shaft length, 30 cm). (Photo: J.K. Wright.)



(Figure 2.45) Locality map for the Cumnor GCR site. Outcrop of Wheatley Limestone and Coral Rag from BGS Sheet 236 (Witney) (1982).



(Figure 2.46) View of the Cumnor site in 1998, showing the 1.2 m high face in flaggy-weathering Wheatley Limestone. (Photo: J.K. Wright.)



(Figure 2.47) Locality map for Cross Roads Quarry and Magdalen Quarry. Outcrop of the Corallian limestones from BGS Sheet 237 (Thame) (1994).



(Figure 2.48) View of the central face at Cross Roads (Rock Edge) Quarry, showing the regular bedding in coralliferous calcarenite of the Wheatley Limestone. The coral clasts rarely exceed 10 mm in diameter. Hammer shaft is 30 cm long. (Photo: J.K. Wright.)



(Figure 2.49) Correlation of sections in Magdalen Quarry, Cross Roads Quarry and Windmill Quarry (after Arkell, 1927, fig. 11), showing the transition from Coral Rag reef facies on the right into Wheatley Limestone facies on the left.



(Figure 2.50) View of the main east–west face at Magdalen Quarry showing the irregularly bedded Wheatley Limestone. The 'First Headington Hard' (Bed 5, 0.35 m) is just below the level of the mapcase (36 cm long). (Photo: J.K. Wright.)



(Figure 2.51) The type specimen of Pectinatites (Virgatosphinctoides) wheatleyensis (Neaverson) as figured by Neaverson (1925, p1.1, fig. 1). Natural size.



(Figure 2.52) Graphic sections showing the Kimmeridgian stratigraphy at the Littleworth Brick Pit and other sections in Oxfordshire and Buckinghamshire, after Horton et al. (1995, fig. 17). AmC, Ampthill Clay; CB, Crussoliceras Band; ES, Elmhurst Silt; HBS, Holman's Bridge Shale; HwS, Hartwell Silt; KC, Kimmeridge Clay; LGS, Lower Greensand; LLB, Lower Lydite Bed; PI, Portland Formation; PS, Pectinatus Sand; SwC, Swindon Clay; TS, Thame Sand; ULB, Upper Lydite Bed; WC, Watermead Clay; WNB, Wheatley Nodule Bed; WS, Wheatley Sand; VL, Virgula Limestone.



(Figure 3.1) Geological sketch map showing the location of the GCR sites described in Chapter 3. Extensive drift deposits are omitted for clarity 1, Upware South Pit; 2, Upware; 3, Warboys Clay Pit; 4, Roslyn Hole, Ely; 5, South Ferriby.

tage	stage	Zone	Standard bed numbers ¹	not to scale			
Kimmeridgian	Palls Pector Hoot Sec El	Fittoni					
		Rotunda		non-sequenc	c		
		Pallasioides		N.			
		Pectinatus	KC46-49	A	-	hadihadihadik	T
		Hudlestoni	KC42 (part)-45	silts in Buckinghamshire			
		Wheatleyensis	KC40-42 (part)	and the second se			
		Scitulus	KC37-39		5	Kimmeridge Clay Formation	
		Elegans	KC36				
	Lower	Autissiodorensis	KC33-35		ly developed one at Elsham, Lincolnshire		
		Eodoxus	KC24-32				1
		Mutabilis	KC15-23	locally developed sandstone at Elsham,			1
		Cymodoce	KC5-14	north Lincolnshire			(0)
		Baylei	KC1-4			Correlation the	
Oxfordian	Upper	Rosenkrantzi	AmC37-42			hit, dag kha 1 adr lo actu 1 adr lo actu 1 adr loga	holme G
		Regulare	AmC26-36				
		Serratum	AmC17-25			Ampthill Clay Formation	
		Glosense	AmC12-16 ²			and Applying the	
	Tenuiserratum Densiplicatum	AmC1-11	THE STREET	12 de			
		Densiplicatum	WWF11-16 WWF5-10	locally developed limestones at Elsworth and Upware,	West Walton		
	10120		WWF1-4	Cambridgeshire		- Commission	
	wer	Cordatum	States and	and the second second	United and		
	Lo	Mariae		Weymouth Member		Oxford Clay Formation	
	Ca	llovian					

(Figure 3.2) Lithostratigraphical classification of Oxfordian–Kimmeridgian strata in the East Midlands.



(Figure 3.3) Locality map of quarries in the Upware inlier. Outcrop of the Upware Limestone (mapped as 'West Walton Beds'), Ampthill and Kimmeridge clays from BGS Sheet 188 (Cambridge) (1981) and Wright et al. (2000).



(Figure 3.4) Log of the 'Corallian' succession in Dimmock's Cote Quarry (after Wright et al., 2000, fig. 4).



(Figure 3.5) View of the central part of the eastern face of Dimmock's Cote Quarry. Blocks of the tough Crinoid Bed are in the foreground, with the manly limestones of Bed 7 and Bed 9 being excavated in the distance. (Photo: J.K. Wright.)



(Figure 3.6) Log of the Oxford Clay succession in Warboys Pit (after Callomon, 1968).



(Figure 3.7) View of the upper part of Warboys Pit showing Cordatum Zone Oxford Clay overlain by West Walton Formation, beds 9–12, with the Warboys Rock', the distinctive pale band, close to the top of the section. (Photo: J.K. Wright.)



(Figure 3.8) View of a degraded section of Lower Kimmeridge Clay at Roslyn Hole showing the prominent marker band (arrowed) formed by a line of cementstone nodules in Bed 23 (KC30). Ely Cathedral is seen in the background. (Photo: A13722, reproduced by kind permission of the Director, British Geological Survey © NERC.)



(Figure 3.9) Graphic section of the Kimmeridge Clay at Roslyn Hole and borehole sections in Norfolk showing the southwards attenuation towards Ely (after Gallois, 1988, fig. 14).



(Figure 3.10) General view of the South Ferriby GCR site in 1987. (Photo: A14379, reproduced by kind permission of the Director, British Geological Survey ©NERC.)



(Figure 3.11) Correlation between the Oxfordian–Kimmeridgian boundary beds at South Ferriby and those in Dorset and Skye (after Page and Cox, 1995, fig. 2). A. = Amoeboceras, P. = Pictonia, Ra. = Rasenia, Ri. = Ringsteadia.



(Figure 4.1) Map showing the solid geology of the Oxfordian and Kimmeridgian beds in the Cleveland Basin, with the principal stuctural and geographical features. (Based on Versey, 1929, fig. 1; BGS 1:250 000 Solid Sheet 54N 02W (Tyne-Tees) (1981); BGS 1:1 500 000 Tectonic map of Britain, Ireland and adjacent areas (1996) and BGS 1:50 000 Sheet 54 (Scarborough) (1998)). In the Vale of Pickering there is a thick cover of Quaternary lacustrine deposits.



(Figure 4.2) Zones of the Oxfordian and Kimmeridgian stages, showing the stratigraphical ages of each of the formations present in the Cleveland Basin, and the age range of the exposure at each GCR site.



(Figure 4.3) Stratigraphical cross-section of the Yorkshire Corallian Group on the north side of the Vale of Pickering from Helmsley to Filey (after Rawson and Wright, 1995, fig. 15).



(Figure 4.4) Stratigraphical cross-section of the Yorkshire Corallian Group on the south-west side of the Vale of Pickering from the I lambleton Hills to Malton.



(Figure 4.5) P Selection of ammonites from the Corallian Group of the Cleveland Basin. (A) Amoeboceras nunningtonense Wright (holotype), Spaunton Sandstone, Leysthorpe Quarry, m27, x 1. (B) A. glosense (Bigot and Brasil), Newbridge Member, Leysthorpe Quarry, U/1/14, x 1. (C) A. transitorium Spath, Newbridge Member, Leysthorpe Quarry, U/1/5, x 1. (D) A. ilovaiskii (M. Sokolov), Spaunton Sandstone, Newbridge Quarry, U/2/38, x1. (E) A. newbridgense Sykes and Callomon, Spaunton Sandstone, Newbridge Quarry, U/2/20, x 1. (F) Perisphinctes (Pseudarisphinctes) pachachii Arkell, Spaunton Sandstone, Spaunton Moor Quarry, U/3/63, x0.33. (G) P. (Dichotomosphinctes) sp. Newbridge Beds, Leysthorpe Quarry, U/1/103, x0.7. (H) Cardioceras (Cardioceras)persecans S. Buckman, Birdsall Calcareous Grit, Filey Brigg, YM1983/45F, x 1. (I) C. (C.) cordatum (J. Sowerby), Birdsall Calcareous Grit, Flassen Gill, YM1983/36F, x 1. (1) C. (Vertebriceras) aff. dorsale S. Buckman, Hambleton Oolite, Spikers Hill Quarry, C/2/17, x 1. (K) C. (Plasmatoceras)popilaniense Boden, Hambleton Oolite, Spikers Hill Quarry, C/2/59, x 1. (L) C. (Scarburgiceras) harmonicum Arkell, Tenants' Cliff Member, Tenants' Cliff, YM1983/17F, x 1. (M) C. (S.)reesidei Maire, Tenants' Cliff Member, Tenants' Cliff, YM1983/20F, x 1. (N) C. (Vertebriceras) aff. phillipsi Arkell, Tenants' Cliff Member, Tenants' Cliff, YM1983/23F, x 1. (O) C. (S.)praecordatum (Douvillé), Weymouth Member, Cayton Bay Waterworks, YM1983/9F, x 1. (P) C. (S.)scarburgense (Young and Bird), Weymouth Member, Cornelian Bay, YM1983/3F, x 1. (Photos: (A-E), (H, I), (L-P), J.K Wright; (F, G), K. D'Souza; (J, K) K. Denyer. Collections: Prefixes 'U', 'C', J.K. Wright Collection; 'YM', Yorkshire Museum Collection, York; 'm', Woodend Museum, Scarborough.)



(Figure 4.6) Map showing the locations of Oxfordian and Kimmeridgian GCR sites in north-east Yorkshire, and other localities mentioned in the text.



(Figure 4.7) The type specimen of Subdichotomoceras lamplughi Spath, type species of the genus, from the Eudoxus Zone at Speeton, as figured by Pavlow and Lamplugh (1892, p. 111). Approximately natural size.



(Figure 4.8) Sketch map of the geology of Filey Brigg (after Rawson and Wright, 2000, fig. 33).



(Figure 4.9) Log of the Corallian succession at Filey Brigg (after Rawson and Wright, 2000, fig. 34).



(Figure 4.10) View of the southern side of Filey Brigg showing fossiliferous Hambleton Oolite (Upper Leaf) overlying Birdsall Calcareous Grit in the rock platform. The junction is where the figure is pointing with the hammer. (Photo: J.K. Wright.)



(Figure 4.11) Locality map of the Tenants' Cliff and Cornelian Bay GCR sites. Outcrop of the Oxford Clay and Lower Calcareous Grit from Wright (1968, fig. 9).



(Figure 4.12) Log of the Lower Calcareous Grit succession at Tenants' Cliff; as measured by J.K. Wright in 1982.



(Figure 4.13) Exceptionally well-preserved ammonites from the Tenants' Cliff Member. (A) Mirosphinctes frickensis (Moesch) (Tethyan), LG744; (B) Neocampylites delmontanus (Oppel) (Tethyan), LG742; (C) Cardioceras (Scarburgiceras) bukowskii Maire (Boreal), LG736. (Photos: K. D'Souza. Specimens in the J.K. Wright Collection. Natural size.)



(Figure 4.14) General view of the southern end of Cornelian Bay showing the Middle Jurassic Ravenscar Group (on the *left*) faulted against easterly dipping Osgodby Formation sandstones (Callovian) overlain by Weymouth Member Oxford Clay. (Photo: J.K. Wright.)



(Figure 4.15) Log of the Upper Callovian–Lower Oxfordian sequence at Cornelian Bay (after Wright, 1969, fig. C4).


(Figure 4.16) Locality map for Hackness Head showing the outcrop of the Coral–Sponge Bed (Subdivision 3). (After Wilson, 1949, fig. 43.)



(Figure 4.17) Cross-section of Hackness Head showing the two quarry sections, as measured by J.K. Wright in 1991.



(Figure 4.18) View of the eastern quarry at Hackness Head, showing the massive, bioclastic limestones of Subdivision 2 overlain by coral rubble (Subdivision 3) just below the grass at the top. Hammer shaft (mid-left of picture) is 30 cm. (Photo: J.K. Wright.)



(Figure 4.19) Facies distribution across the central and eastern parts of the Cleveland Basin during deposition of the Hackness Coral–Sponge Bed (after Wright, 1992, fig. 10).



(Figure 4.20) Locality map of the Betton Farm and Spikers Hill GCR sites. Geological outcrops from BGS Sheet 54 (Scarborough) (1998).



(Figure 4.21) View of Betton Farm Quarry (north) showing rounded masses of Thamnasterian reef coral above the hammer (30 cm) resting on oolite (Mahon Oolite). (Photo: J.K. Wright.)



(Figure 4.22) The main east–west face in the Hambleton Oolite at Spikers Hill Quarry. The dark, pisoidal 'Blue Band' (Bed 2) is clearly seen towards the top of the quarry, overlain by beds 3 to 7, which are more thinly bedded than those below. Since this photo was taken, the quarry has been deepened to reveal part of the Passage Beds, Bed '0'. (Photo: J.K. Wright.)

bonense ;		Malton Oolite Member	1
	B.H.H.H.	Middle Calcareous Grit Member	
Vertebrale Saboone	4.4.4		
Cordinant Subsone		Hambleton Oolite Member	Coralline Oolite Formation
		0	1
Contstandia	A	Passage Beds Member	-
	uartz sand	er er lithoclasts	
	hale/clay	bioclasts	
	ebio	Corallite	
	oncoids	lanvinae	
torestant b	loe-grey		

(Figure 4.23) Log of the Corallian succession at Spikers Hill Quarry, as measured by J.K. Wright in 1991.



(Figure 4.24) Locality map of Newbridge Quarry. Outcrop of the Upper Calcareous Grit from BGS Sheet 53 (Pickering) (1973).



(Figure 4.25) Log of the Upper Calcareous Grit at Newbridge Quarry, as measured by J.K. Wright in 1998.



(Figure 4.26) Simplified geological drift sketch map of the Vale of Pickering showing localities cited in the text (based on Geological Survey 1:50 000 sheets 53 and 54). The Green Lane Pit and Golden Hill Pit GCR sites are located at Marton. *Other drift deposits are omitted for clarity.



(Figure 4.27) Composite graphic log of the section at which weathers to form a prominent overhang. Golden Hill Pit (after Wignall, 1993, fig. 3).



(Figure 4.28) Locality map of Shaw's Gate Quarry. Outcrop of the Hambleton Oolite from BGS Sheet 52 (Thirsk) (1992).

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(Figure 4.29) Log showing the slump structures at Shaw's Gate Quarry (after Powell et al., 1992).



(Figure 4.30) View of Shaw's Gate Quarry showing a slump fold in oobiosparite (Bed 5). The flanks of the fold are filled with laminated sandy limestone (Bed 6). A load ball in Bed 3 is visible on the lower right. Height of face 1.5 m. (Photo: J.K. Wright.)



(Figure 4.31) Local ty map of Snape Hill Quarry. Geological information from BGS Sheet 52 (Thirsk) (1992).



(Figure 4.32) North Grimston Cementstone (Bed 1) at Snape Hill Quarry. Alternations of limestone and calcareous mudstone are overlain by massive, flaggy weathering limestone. Mapcase 35 cm. (Photo: J.K. Wright.)



(Figure 4.33) Sketch of the main north–south face at Snape Hill Quarry showing the two separate successions, as seen by J.K. Wright in 1997.



(Figure 4.34) Map showing the locations of the principal exposures WSW of Nunnington. Geological information from BGS Sheet 53 (Pickering) (1973).



(Figure 4.35) Log of the CoraRine Oolite Formation in Leysthorpe Quarry, as measured by Mr D. Sharp and J.K. Wright, 1991–1992.



(Figure 4.36) View of the northern face at Leysthorpe Quarry, showing the thick Malton Oolite sequence, with, at the top, a thin development of Coral Rag overlain by thin-bedded, flaggy Upper Calcareous Grit. (Photo: J.K. Wright.)



(Figure 4.37) Locality map of the Wath Quarries. Outcrop of the Coralline Oolite from BGS Sheet 53 (Pickering) (1973).



(Figure 4.38) Weathering profile of the upper Malton Oolite and Coral Rag at Wath Old Quarry, as measured by J.K. Wright in 1997.



(Figure 4.39) Wath Old Quarry, showing the irregular, erosive junction of Coral Rag resting on Malton Oolite. The lower rubbly coral–shell bed of the Coral Rag and the upper coralliferous micritic limestone are easily distinguished. Hammer shaft is 32 cm long. (Photo: J.K. Wright.)



(Figure 4.40) View of the eastern face of Wath New Quarry showing, near the base, Mahon Oolite dipping gently north (to the left), overlain by giant cross-sets of Malton Oolite dipping south, and at the top of the quarry, Coral Rag dipping gently north. (Photo: J.K. Wright.)



(Figure 5.1) Map of northern Scotland, showing the principal Jurassic sedimentary basins and their structural controls, and the locations of Oxfordian and Kimmeridgian GCR sites. Based on BGS 1:1 500 000 Tectonic Map of Britain, Ireland and Adjacent Areas (1996) and BGS 1:1 000 000 Geological Map of the United Kingdom, Ireland and the Adjacent Continental Shelf (1991).

w	Hebri	des Basin		Inner Moray	Firth Basin E
	Staffin	Elgol	Scottish landmass	Kintradwell– Portgower–Brora	Balintore
Lower Kimmeridgian	not preserved	not preserved (Cretaceous erosion) Camasunary	Heimsdale Boulder Bed Kintradwo Boulder Be		clays with Allt na Cuile Sandstone nodules
Upper	Shale	Camasunary Sandstone	3	Clynekirkton	?clays with limestone nodules
- Oxfordian	Digg Siltstone Glashvin Silt	Scaladal Sandstone	Ş	Ardassie Limesto	Port an Righ one Silfstone Ironstone
Lower	Dunans Clay	Tobar Ceann Siltstone	<u>ک</u>	Sandstone	Shandwick Siltstone
0 ,k	ilometres 10			- 8//	0 kilometres 10
0.000	boulder bed	medium/fine sar	nd	silty clay	limestone
	coarse sand	siltstone	100	clay	ironstone

(Figure 5.2) Schematic cross-section to show the relations of the near-shore and distal members in the Hebrides and Inner Moray Firth Basins. Beds such as the Brora Sandstone and the Ardassie Limestone originally extended eastwards over the Scottish landmass but have been removed by Kimmeridgian erosion. The Helmsdale Boulder Beds continue up



(Figure 5.3) Locality map of the Balintore GCR site. Geological information from BGS Sheet 94 (Cromarty) (1973).



(Figure 5.4) Stratigraphical log of the Balintore section (after Sykes, 1975, fig. 4).



(Figure 5.5) Ammonites from the Balintore Formation of eastern Scotland. (A) Cardioceras (Subvertebriceras) densiplicatum Boden. Bed 4, Port-an-Righ Ironstone Member, Balintore, ES3, x1. (B) C. (Plasmatoceras) tenuicostatum Nikitin. Ardassie Limestone, Brora, ES2, x 1. (Photos: K. D'Souza. Specimens in the J.K. Wright Collection.)



(Figure 5.6) Locality map of the Brora GCR site. Geological information from BGS Sheet 103E (Helmsdale) (1998).

Middle Oxfordian	Zone Densiplicatum	Subzones recognised Vertebrale		Ardassie Limestone Member	Balintore Formation
Lower Oxfordian	Cordatum			Brora Sandstone Member	
	Mariae				Brora Arenaceous Formation
Callovian	Lamberti			Clynelish Quarry Sandstone Member	[¹⁰
			NAME.	Fascally Sandstone Member	e metres 0

(Figure 5.7) Stratigraphical log of the Brora section (after Sykes, 1975, fig. 3).



(Figure 5.8) Diagram showing possible post-Jurassic movement on the Great Glen Fault (after Sykes, 1975, fig. 2).



(Figure 5.9) Sketch map of the mainly Kimmeridgian outcrop between (a) Kintradwell and Lothbeg Point, and (b) Lothbeg Point and Dun Glas (after Wignall and Pickering, 1993, figs 10 and 17).



(Figure 5.10) Schematic sections showing the main stratal units of the Helmsdale GCR site (based on Macdonald and Trewin, 1993, fig. 2 and Wignall and Pickering, 1993, fig. 15).



(Figure 5.11) Kintradwell Boulder Beds at Kintradwell showing compaction features around the large boulders. (Photo: C1980, reproduced by kind permission of the Director, British Geological Survey ©NERC.)



(Figure 5.12) The 'fallen stack' in the Helmsdale Boulder Beds near Portgower. (Photo: C1975, reproduced by kind permission of the Director, British Geological Survey ©NERC.)



(Figure 5.13) Simplified reconstruction of depositional conditions adjacent to the Helmsdale Fault during the Kimmeridgian (after Wignall and Pickering, 1993, fig. 21).



(Figure 5.14) Locality map of the Staffin and Kildorais GCR sites (after Cox and Sumbler, in press).



(Figure 5.15) General log of the Staffin Shale succession (after Morton and Hudson, 1995, table 4).



(Figure 5.16) Map of the foreshore at Digg, with detailed logs (after Morton and Hudson, 1995, figs 39, 40).



(Figure 5.17) Map of the foreshore at Flodigarry, with detailed log (after Morton and Hudson, 1995, fig. 42).



(Figure 5.18) View looking north along the beach at Flodigarry, showing the 0.3–0.4 m limestone of Bed 40 dipping steeply west, and curving round under the large boulder in the middle distance. The large boulder is the one in the middle of (Figure 5.17). (Photo: J.K. Wright.)



(Figure 5.19) Graphic section of the Kimmeridgian and uppermost Oxfordian parts of the Staffin Shale Formation, Flodigarry Shale Member, at Kildorais.



(Figure 5.20) Locality map of the North Elgol Coast GCR site. Outcrop of the Oxfordian beds from BGS Sheet 71W (Broadford) (1976).

Upper Oxfordian	Zones recognised Rosenkrantzi	Subzones recognised		Camasunary Siltstone Member	[10 metres
1	?		83.9 metres	Sandstone Member	L	0
Middle Oxfordian	Densiplicatum	Maltonense		Scaladal Sandstone Member	Staffin Shale Formation	
		Vertebrale				
Lower Oxfordian	Cordatum Mariae	Costicardia Bukowskii Praecordatum Scarburgense		Tobar Ceann Siltstone Member		
Callovian	Athleta Coronatum	Grossouvrei				

(Figure 5.21) Stratigraphical log of the Elgol section (after Sykes, 1975, fig. 6).