Chapter 2 The Middle Jurassic stratigraphy of Wessex

B.M. Cox and K.N. Page

Introduction

B.M. Cox

The region covered in this chapter extends from the Dorset coast northwards as far as Bath, the southern limit of the Cotswold Hills (Figure 2.1). The Middle Jurassic strata are the sediments that accumulated in the Mid Jurassic depositional area known as the 'Wessex Basin', but also, north of the Mendips, within the southernmost part of the 'Worcester Basin' (see (Figure 1.6)d, Chapter 1). Deposition was largely fault-controlled with evidence of syndepositional normal-faulting in the Aalenian, Bajocian and Bathonian successions (Holloway in Whittaker, 1985; Callomon and Cope, 1995). The rocks of the Aalenian–Bajocian stages are together typically less than 10 m thick, though they may range up to about 40 m. The thinner successions, often of highly fossiliferous, 'iron-shot' limestones, are developed on the crests of tilted blocks on the upthrown sides of major E–W-trending fault-systems (Holloway in Whittaker, 1985; Hawkes *et al.,* 1998). The strata make strong features in the landscape, forming scarps and the caps of small hills. The characteristic features of the Aalenian–Bajocian succession in this region are (1) the general thinness of individual beds, which are often sharply delimited by partings or erosion-planes that may be bored and covered in large stromatolitic crusts or other epibiota, and may cut through fossils such as ammonites in the underlying bed; (2) the intensive bioturbation of the beds, often with large in-situ burrows; and (3) the rich fossil, particularly ammonite, content (Callomon and Cope, 1995). In the neighbourhood of the Palaeozoic rocks of the Mendip Hills, the Aalenian and Lower Bajocian parts of the succession were removed by erosion beneath the transgressive Upper Bajocian Substage, which crosses, almost unchanged, the easternmost outcrop of Lower Carboniferous limestones (Callomon and Cope, 1995); in this context, the Vallis Vale GCR site is of outstanding geological interest.

During Bathonian and Early Callovian times, considerable differential subsidence, associated with growth-faults, took place (Holloway in Whittaker, 1985). Unlike the Bathonian succession in other areas of Britain (see Chapters 3–6) it here consists largely of marine mudstones with some thin, micritic and, less commonly, shell-detrital limestones. In the northern part of the region, about 8 km south of Bath, the lithologies change, within a short distance, to ooidal and shell-detrital limestones indicative of a shallow-marine, high-energy carbonate environment (Figure 2.2). This lithological transition is characterized by a complex interdigitation of facies, which Arkell (1933) recognized as a 'master problem' of Middle Jurassic stratigraphy. This has since been investigated by Green and Donovan (1969) and Penn and Wyatt (1979). The latter authors concluded that the Mendip High was an important influence on sedimentation during at least part of the Bathonian Stage. A marine transgression in Early Callovian times led to a long period of regional subsidence during which very few faults were active, such that the Callovian Stage is represented by a relatively uniform succession of marine, elastic, mainly mudstone, sediments (Holloway in Whittaker, 1985).

The literature concerning the Aalenian–Bajocian stratigraphy in this region (which includes notable coastal sections (e.g. Burton Cliff; see Burton Cliff and Cliff Hill Road Section GCR site report, this volume) and is by far the most important in Britain for Aalenian–Bajocian ammonite biostratigraphy) is dominated by the name of S.S. Buckman (1860–1929) (Lang, 1960; Callomon and Chandler, 1990; Callomon, 1995). From the age of three, Buckman was brought up on his father's farm at Bradford Abbas in north Dorset and attended nearby Sherborne School (then known as 'King's School'). His interest in geology was undoubtedly nurtured by his father, James, who had previously been Professor of Geology and Botany at the Royal Agricultural College in Cirencester, and who himself published a number of papers on the Middle Jurassic deposits of Wessex (Buckman, J., 1866, 1877, 1879, 1881). As a boy, the young S.S. Buckman would have had plenty of opportunity to collect fossils, which were extracted in abundance from the numerous quarries working at that time in the Sherborne area. Indeed, according to Callomon and Chandler (1990), the area in which Buckman spent his boyhood includes one of the most richly fossiliferous developments of Jurassic rocks in the world. After studying in Germany, Buckman returned to this country where, after a few years, he moved to Gloucestershire to set up a farm in Hampen, near Andoversford. He later moved to Stonehouse, near Stroud and then to Charlton Kings, near Cheltenham, by which time he was apparently able to devote almost all his time and energy to palaeontology and stratigraphy. Finally, in 1904 and in poor health, he moved to near Thame in Oxfordshire where he remained until his death. Although he had left the Middle Jurassic rocks of Dorset nearly 50 years previously, he always lived on or near a Middle Jurassic outcrop. Aalenian–Bajocian ammonites from Dorset and Somerset continued to be sent to him for determination, notably by L.F. Richardson, who, in numerous papers, added much local detail to what was previously known of the Wessex Middle Jurassic succession (Richardson, 1907a, 1908, 1909a–c, 1913, 1914, 1915, 1916a,b, 1919, 1928, 1929a, 1930, 1932; Richardson and Walker, 1907; Richardson and Paris, 1908, 1912; Richardson *et al.,* 1911; Richardson and Butt, 1912; Richardson and Thacker, 1920). Buckman's own papers on Wessex were published over some 50 years (1878, 1881, 1883a,b, 1886, 1887–1907, 1889a,b, 1891, 1893a,b, 1910a,b, 1922a) and ammonites from there were described in his privately published *Type Ammonites* (Buckman, 1909–1930), which, despite some curious idiosyncrasies, continues to be the most comprehensive description of the British Jurassic ammonite fauna (Callomon, 1995; see also Chapter 1). Buckman's association with Wessex continued even in death for, at his request, his ashes were scattered by his sons at Golden Cap on the Dorset coast (Lang, 1960).

Subsequent work on the Wessex Middle Jurassic succession includes faunal monographs by Muir-Wood (1936) and Arkell (1951–1958), [British] Geological Survey memoirs by Arkell (1947a) and Wilson *et al.* (1958), and local section and palaeontological details by Arkell (1957), Fowler (1957), and Sylvester-Bradley and Hodson (1957). Other notes appeared in the 'Geology Reports' of the *Proceedings of the Dorset Natural History and Archaeological Society.* In the 1960s and 1970s, H.S. Torrens, himself a Sherborne alumnus, and C.F. Parsons revisited all of the classic localities described by Buckman and Richardson. Between them, they produced a number of papers, as well as their individual unpublished theses, elucidating the stratigraphy and recording further section details (Parsons, 1974a, 1975a,b, 1976a, 1977a, 1980a,b; Torrens, 1964, 1966, 1969a,b, 1974, 1980b). More recently, these localities, new temporary sections, and the ammonite biostratigraphy, have been investigated by J.H. Callomon, R.B. Chandler and their associates (Chandler, 1982; Callomon and Chandler, 1990, 1994; Morton and Chandler, 1994; Callomon and Cope, 1995; Callomon, 1995; Chandler, 1996; Dietze and Chandler, 1997).

The current lithostratigraphical scheme for the Middle Jurassic rocks of the Wessex (Dorset–Somerset) region divides the succession into the Inferior Oolite Formation and the Great Oolite Group, capped by the Kellaways and Oxford Clay formations. The Inferior Oolite Formation is generally so thin and variable at outcrop that attempts to construct a formal lithostratigraphy are problematic (Parsons, 1980a). It will not be easy to formulate a modern lithostratigraphical scheme such as that recently proposed for the Cotswolds where, as elsewhere, the Inferior Oolite is given the status of 'Group' (Barron *et al.,* 1997; see also Chapter 3). Recent mapping in the Shaftesbury and Wincanton districts by the British Geological Survey (Bristow *et al.,* 1995, 1999) recognized five units within the Inferior Oolite Formation that are given 'Member' status largely following the subdivisions used by Parsons (1980a). The members have been named from classic localities described by Buckman (1893a), Richardson (1916a, 1932), White (1923) and Parsons (1976a). Elsewhere, the lithostratigraphy has not been formalized and the units shown in (Figure 2.3) are those traditionally used. Lithostratigraphical subdivision of the Great Oolite Group is shown in (Figure 2.4). This mainly follows Torrens (1980b) but incorporates the Frome Clay Formation of Penn and Wyatt (1979) and consequent amendments to the Fuller's Earth Formation (see also Wyatt, 1998). Many of the stratal names originated in the time of William Smith (see Chapter 3).

Middle Jurassic ammonites are more abundant in the Wessex region than in any other area of Britain. The Inferior Oolite Formation has a rich ammonite fauna with each bed typically having its own assemblage (Callomon and Chandler, 1990; Callomon, 1995; Callomon and Cope, 1995). These have been used to construct the scheme of ammonite biohorizons within the established zonation as detailed in Chapter 1 and shown in (Figure 1.3) and (Figure 1.4) (Chapter 1). The Great Oolite Group in this region is also more ammonitiferous than elsewhere and has yielded the majority of known British Bathonian ammonites and from the greatest number of stratigraphical horizons. These occurrences, and the zonation that they underpin, have been reviewed by Page (1996a) who demonstrated the feasibility of applying a single ammonite-based zonation to the Bathonian succession of the whole of Europe (see Chapter 1).

Further details of the main lithologies, thicknesses and depositional environments are included in the site descriptions that follow. In the following list of sites (arranged generally south to north), (A) indicates that the site belongs to the Aalenian–Bajocian GCR Block, (B) indicates the Bathonian GCR Block and (C) the Callovian GCR Block. The location of sites is shown in (Figure 2.1).

Shipmoor Point–Butterstreet Cove, Dorset (B)

Tidmoor Point–East Fleet Coast, Dorset (C)

Crookhill Brickpit, Dorset (C)

Ham Cliff, Redcliff Point, Dorset(C)

Burton Cliff and Cliff Hill Road Section, Dorset (A)

Watton Cliff, Dorset (B)

Peashill Quarry, Dorset (A)

Horn Park Quarry Dorset (A)

Conegar Hill, Dorset (A)

Ryewater, Corscombe, Dorset (C)

Seavington St Mary Quarry, Somerset (A)

Troll Quarry Dorset (B)

Bradford Abbas Railway Cutting, Dorset (A)

Louse Hill Quarry Dorset (A)

Halfway House Cutting and Quarry Dorset (A)

Sandford Lane Quarry, Dorset (A)

Frogden Quarry Dorset (A)

Goathill, Dorset (B)

Holway Hill Quarry, Dorset (A)

Milborne Wick Section, Somerset (A)

Laycock Railway Cutting, Somerset (B)

Shepton Montague, Somerset (B)

Godminster Lane Quarry and Railway Cutting, Somerset (A)

Bruton Railway Cutting, Somerset (B)

Doulting Railway Cutting, Somerset (A and B)

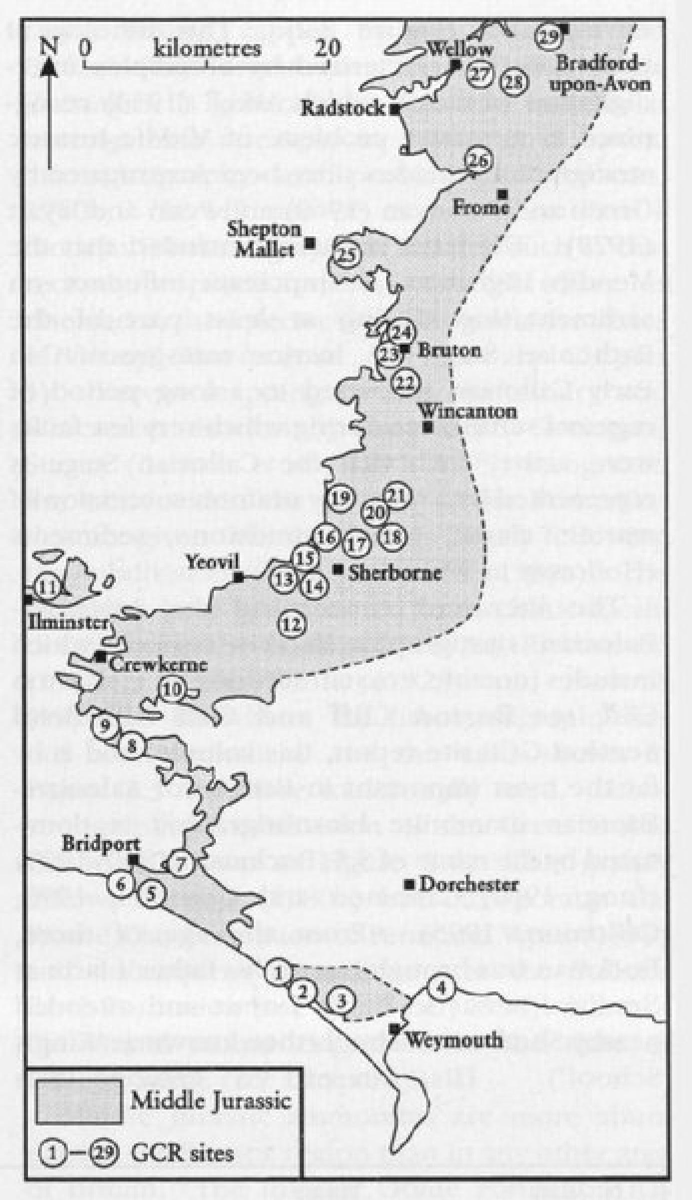
Vallis Vale, Somerset (A)

Hinton Hill, Wellow, Somerset (B)

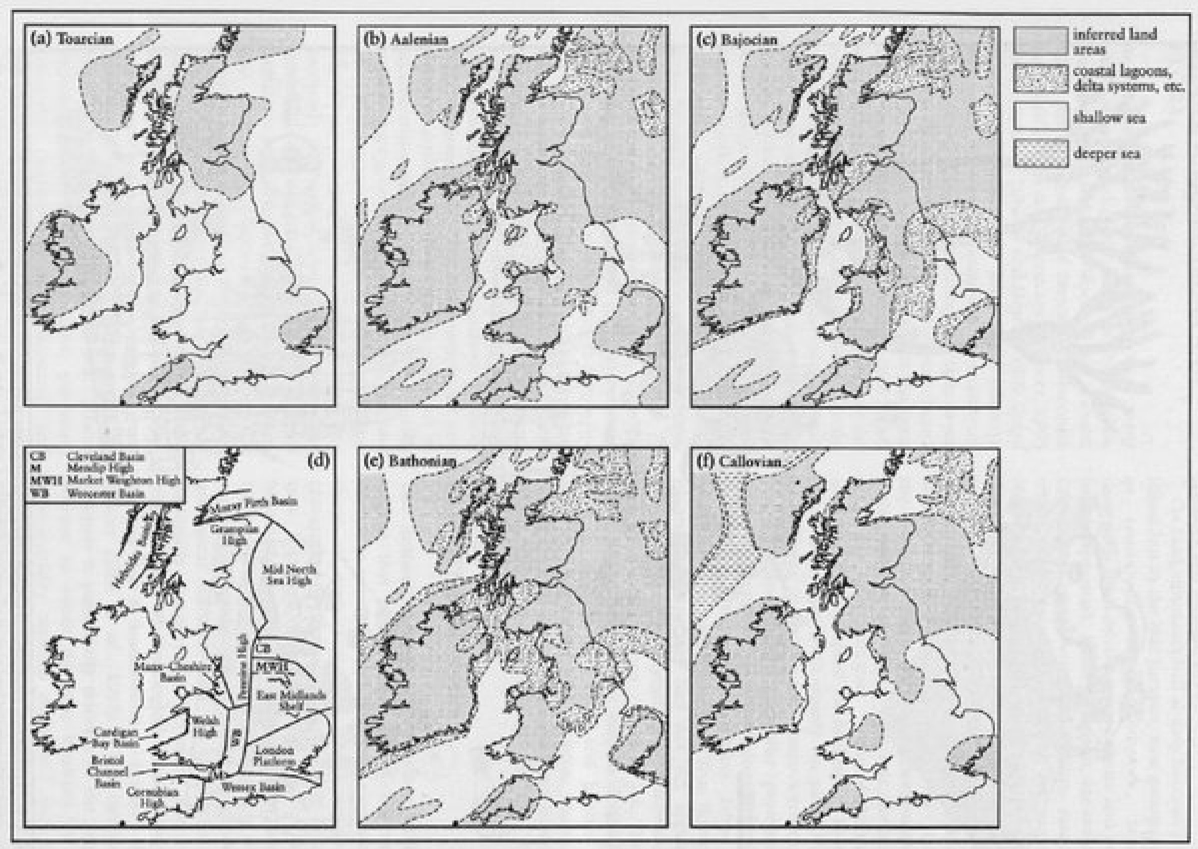
Hinton Charterhouse, Somerset (B)

Gripwood Quarry Wiltshire (B)

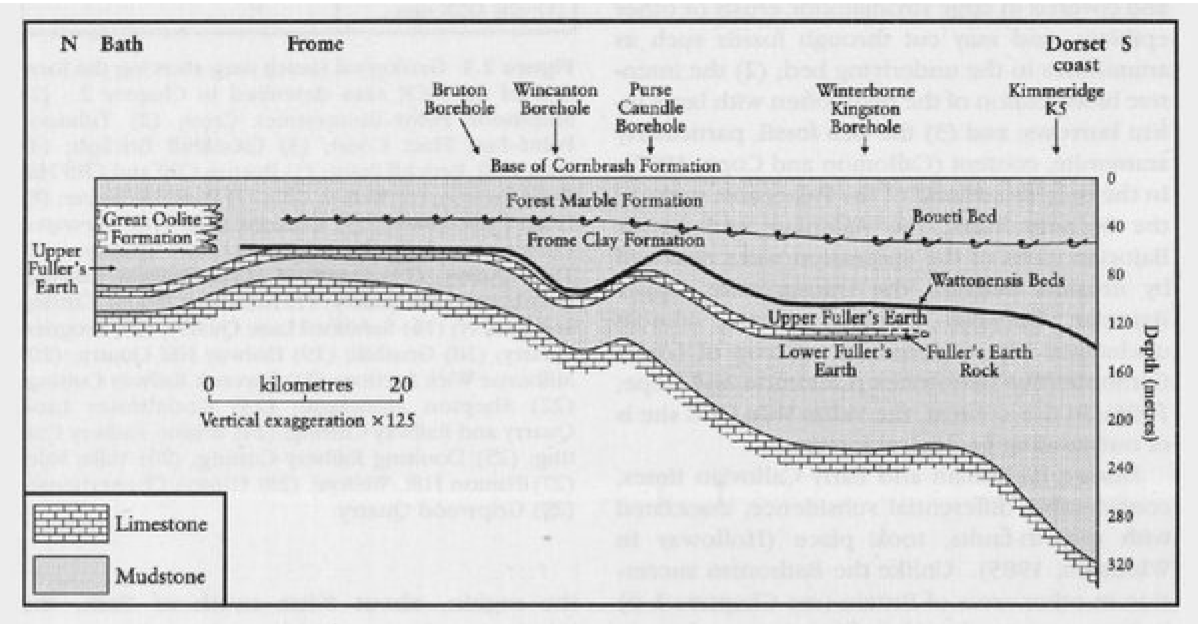
References



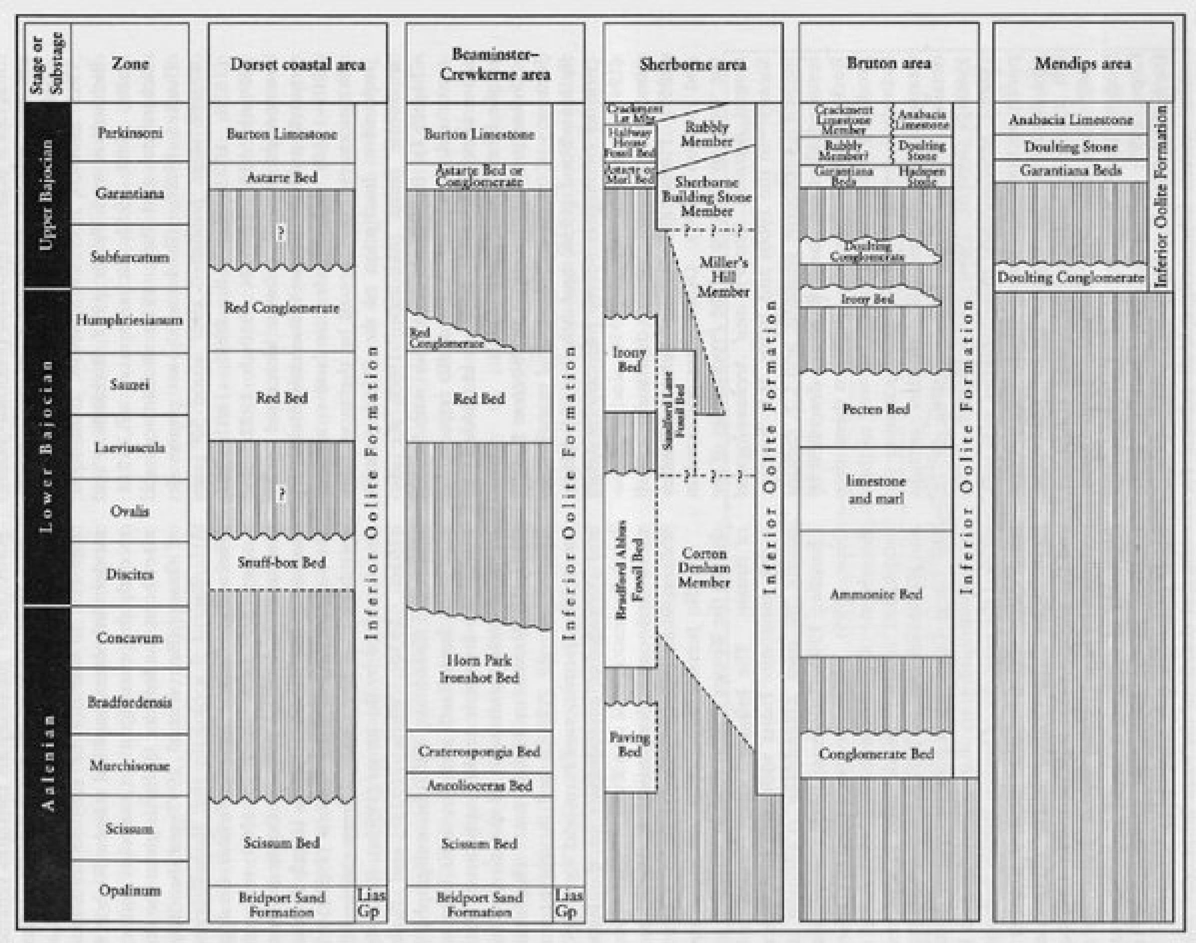
(Figure 2.1) Geological sketch map showing the location of the GCR sites described in Chapter 2. (1) Shipmoor Point–Butterstreet Cove; (2) Tidmoor Point–East Fleet Coast; (3) Crookhill Brickpit; (4) Ham Cliff, Redcliff Point; (5) Burton Cliff and Cliff Hill Road Section; (6) Watton Cliff; (7) Peashill Quarry; (8) Horn Park Quarry; (9) Conegar Hill; (10) Ryewater, Corscombe; (11) Seavington St Mary Quarry; (12) Troll Quarry; (13) Bradford Abbas Railway Cutting; (14) Louse Hill Quarry; (15) Halfway House Cutting and Quarry; (16) Sandford Lane Quarry; (17) Frogden Quarry; (18) Goathill; (19) Holway Hill Quarry; (20) Milborne Wick Section; (21) Laycock Railway Cutting; (22) Shepton Montague; (23) Godminster Lane Quarry and Railway Cutting; (24) Bruton Railway Cutting; (25) Doulting Railway Cutting; (26) Vallis Vale; (27) Hinton Hill, Wellow; (28) Hinton Charterhouse; (29) Gripwood Quarry)



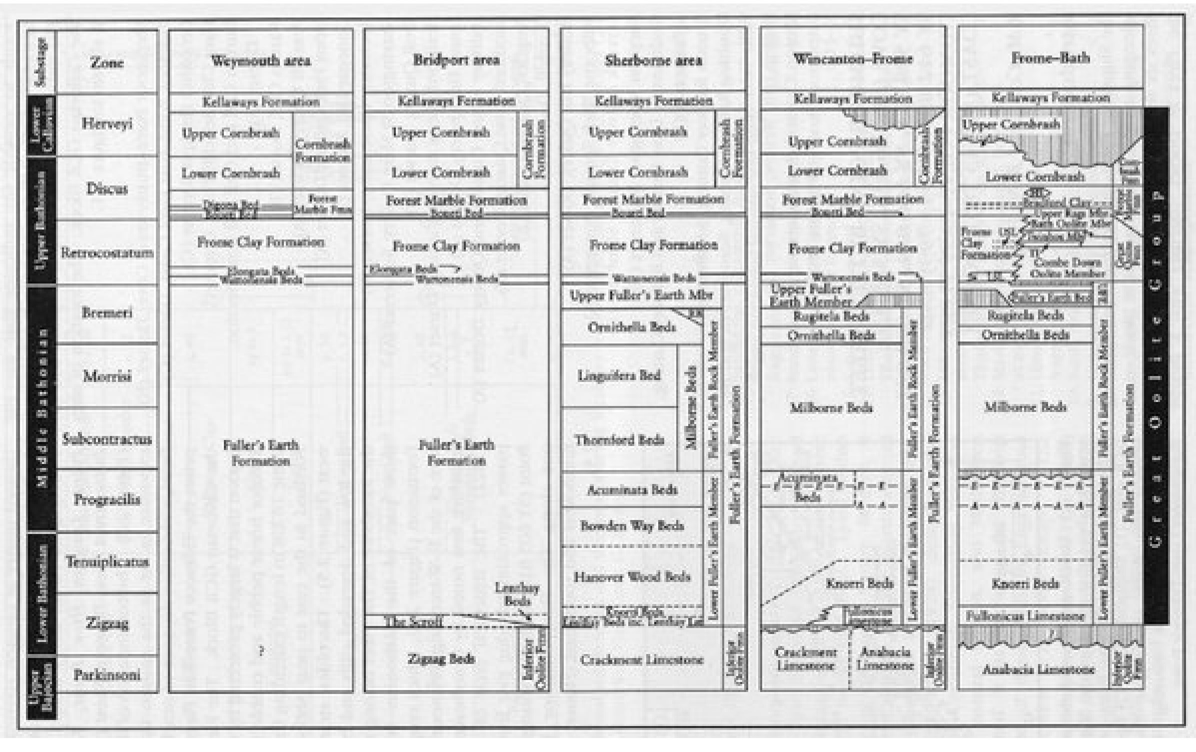
(Figure 1.6) (a–c,e,f) Palaeogeographical reconstructions for the British area during the late Early and Mid Jurassic (slightly modified from Cope, 1995); (d) main structural elements affecting sedimentation in the British area in the Mid Jurassic (terminology as used in this volume). The 'London Platform' 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 2.2) Simplified diagrammatic cross-section through the Bathonian strata of Wessex. (After Bristow et al., 1995, fig. 23.))



(Figure 2.3) Simplified stratal subdivision of the Aalenian–Bajocian succession of the Wessex region. Vertical ruled lines indicate major non-sequences. Not to scale. (Based on data in Bristow et al., 1995, 1999; Callomon and Cope, 1995; and Parsons, 1980a.))



(Figure 2.4) Lithostratigraphical classification of the Great Oolite Group in the Wessex region. Vertical ruled lines indicate non-sequence. (Based on data in Penn and Wyatt, 1979; Torrens, 1980b; Page, 1989, 1996a; Bristow et al., 1995, 1999; and Wyatt, 1998.) (-E-E-E-E- = Echinata Bed; -A-A-A-A- = Acuminata Bed of Penn and Wyatt (1979); HS = Hinton Sand Member; LSL = Lower Smithi Limestone; RB = Rugitela Beds; TI = Twinhoe lronshot; UFE = Upper Fuller's Earth

Member; USL = Upper Smithi Limestone.))

Stage	Zone	Subzone
Aalenian	Concavum	Formosum
		Concavum
	Bradfordensis	Gigantea
		Bradfordensis
	Murchisonae	Murchisonae
		Obtusiformis
		Haugi
	Scissum	
	Opalinum	

Stage	Substage	Zone	Subzone
Bajocian	Upper	Parkinsoni	Bomfordi
			Truellei
		Garantiana	Acris
			Tetragona
			Dichotoma
		Subfurcatum	Baculata
			Polygyralis
			Banksi
	Lower	Humphriesianum	Blagdeni
			Humphriesianum
			Romani
		Sauzei	
		Laeviuscula	Laeviuscula
			Trigonalis
			Sayni
		Ovalis	
		Discites	

Stage	Substage	Zone	Subzone
Bathonian	Upper	Discus	Discus
			Hollandi
		Retrocostatum	Hannoveranus
			Blanazense
			Quercinus
	Middle	Bremeri	Fortecostatum
			Bullatimorphus
		Morrisi	
		Subcontractus	
		Progracilis	Progracilis
			Orbignyi
	Lower	Tenuiplicatus	
		Zigzag	Yeovilensis
			Macrescens
			Convergens

Stage	Substage	Zone	Subzone
Callovian	Upper	Lamberti	Lamberti
			Henrici
		Athleta	Spinosum
			Proniae
			Phaeinum
	Middle	Coronatum	Grossouvrei
			Obductum
		Jason	Jason
			Medea
	Lower	Calloviense	Enodatum
			Calloviense
		Koenigi	Galilaeii
			Curtilobus
			Gowerianus
		Herveyi	Kamptus
			Terebratus
			Keppleri

(Figure 1.3) Chronostratigraphical subdivisions of the Middle Jurassic Series (for sources, see text).)

Stage/Substage	Zone	Subzone	Ammonite biohorizon	
Lower Bajocian	Humphriesianum	Blagdeni	Bj-19	*Teloceras coronatum*
			Bj-18	*Teloceras blagdeni*
		Humphriesianum	Bj-17	*Stephanoceras blagdeniforme*
			Bj-16	*Stephanoceras gibbosum*
			Bj-15	*Stephanoceras humphriesianum*
		Romani	Bj-14b	*Chondroceras wrighti*
			Bj-14a	*Chondroceras delphinum*
			Bj-13	*Stephanoceras umbilicum*
	Sauzei		Bj-12	*Stephanoceras rhytum*
			Bj-11b	*Nannina evoluta*
			Bj-11a	*Otoites sauzei*
	Laeviuscula	Laeviuscula	Bj-10	*Witchellia laeviuscula*
			Bj-9	*Witchellia ruber*
		Trigonalis	Bj-8b	*Shirbuirnia trigonalis*
			Bj-8a	*Witchellia nodatipinguis*
		Sayni	Bj-7b	*Witchellia connata*
			Bj-7a	*Witchellia gelasina*
	Ovalis		Bj-6c	*Witchellia 'pseudoromani'* MS
			Bj-6b	*Fissilobiceras gingense*
			Bj-6a	*Euhoploceras zugophorum*
			Bj-5	*Witchellia romanoides*
			Bj-4	*Bradfordia inclusa*
	Discites		Bj-3	*Hyperlioceras subsectum*
			Bj-2b	*Hyperlioceras rudidiscites*
			Bj-2a	*Hyperlioceras walkeri*
			Bj-1	*Hyperlioceras politum*
Aalenian	Concavum	Formosum	Aa-16	*Euhoploceras acanthodes*
			Aa-15	*Graphoceras formosum*
		Concavum	Aa-14	*Graphoceras concavum*
			Aa-13	*Graphoceras cavatum*
	Bradfordensis	Gigantea	Aa-12	*Brasilia decipiens*
			Aa-11	*Brasilia gigantea*
		Bradfordensis	Aa-10	*Brasilia bradfordensis, similis*
			Aa-9	*Brasilia bradfordensis, baylii*
			Aa-8	*Brasilia bradfordensis, subcornuta*
	Murchisonae	Murchisonae	Aa-7	*Ludwigia murchisonae*
			Aa-6	*Ludwigia patellaria*
		Obtusiformis	Aa-5	*Ludwigia obtusiformis*
		Haugi	Aa-4	*Ancolioceras opalinoides*
	Scissum		Aa-3	*Leioceras bifidatum*
			Aa-2	*Leioceras lineatum*
	Opalinum		Aa-1	*Leioceras opalinum*

Substage	Zone	Subzone	Ammonite biohorizon	
Lower Callovian	Calloviense	Enodatum	XVIII	*Sigaloceras anterior*
			XVIIb	*Sigaloceras enodatum* β
			XVIIa	*Homoeoplanulites difficilis*
			XVI	*Sigaloceras enodatum* α
		Calloviense	XV	*Sigaloceras micans*
			XIV	*Sigaloceras calloviense*
	Koenigi	Galilaeii	XIII	*Kepplerites galilaeii*
		Curtilobus	XII	*Kepplerites trichophorus*
			XIb	*Kepplerites indigestus*
			XIa	*Cadoceras 'gregarium'* MS
			X	*Kepplerites curtilobus*
		Gowerianus	IX	*Kepplerites gowerianus*
			VIII	*Kepplerites metorchus*
	Herveyi	Kamptus	VII	*Macrocephalites polyptychus*
			VI	*Macrocephalites kamptus* β
			V	*Macrocephalites kamptus* α
		Terebratus	IVb	*Macrocephalites terebratus* γ
			IVa	*Macrocephalites terebratus* β
			III	*Macrocephalites terebratus* α
		Keppleri	II	*Macrocephalites verus*
			I	*Kepplerites keppleri*
Upper Bathonian	Discus	Discus	Bt-20	*Clydoniceras hochstetteri*
			Bt-19	*Clydoniceras discus*
		Hollandi	Bt-18	*Clydoniceras hollandi*
	Retrocostatum	Hannoveranus	Bt-17	*Clydoniceras* cf. *schlippei*
			Bt-16	*?Homoeoplanulites* sp.
		Blanazense	Bt-15	*Procerites twinhoensis*
		Quercinus	Bt-14	*Procerites hodsoni*
			Bt-13	*Procerites quercinus*
Middle Bathonian	Bremeri	Fortecostatum	Bt-12	*Wagnericeras bathonicum*
		Bullatimorphus	Bt-11	*Bullatimorphites bullatimorphus*
	Morrisi		Bt-10	*Morrisiceras morrisi*
	Subcontractus		Bt-9	*Tulites modiolaris*
			Bt-8	*Bullatimorphites* ex gr. *ruguifer*
	Progracilis	Progracilis	Bt-7	*Procerites imitator*
			Bt-6	*Procerites progracilis*
		Orbignyi	Bt-5	*Procerites/Prohecticoceras*
Lower Bathonian	Tenuiplicatus		Bt-4	*Asphinctes tenuiplicatus*
	Zigzag	Yeovilensis	Bt-3b	*Procerites fullonicus*
			Bt-3a	*Procerites fowleri*
		Macrescens	Bt-2	*Morphoceras macrescens*
		Convergens	Bt-1	*Parkinsonia convergens*
Upper Bajocian	Parkinsoni	Bomfordi	Bj-28	*Parkinsonia bomfordi*
		Truellei	Bj-27c	*Parkinsonia pseudoferruginea*
			Bj-27b	*Strigoceras truellei*
			Bj-27a	*Parkinsonia parkinsoni* α
	Garantiana	Acris	Bj-26b	*Parkinsonia rarecostata*
		Tetragona	Bj-25	*Garantiana tetragona*
		Dichotoma	Bj-24	*Garantiana dichotoma*
	Subfurcatum	Baculata	Bj-23	*Leptosphinctes davidsoni*
		Polygyralis	Bj-22	*Caumontisphinctes polygyralis*
		Banksi	Bj-21	*Caumontisphinctes aplous*
			Bj-20	*Teloceras banksi*

(Figure 1.4) Ammonite biohorizons recognized in the British Middle Jurassic Series (for sources, see text).)