Chapter 2 Upper Jurassic stratigraphy from Dorset to Oxford

Introduction

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The region covered in this chapter extends from the English south coast, between Weymouth and Chapman's Pool, east of Kimmeridge, northwards through north Dorset and Wiltshire to Wootton Bassett, and then north-eastwards through Oxfordshire to the M40 motorway east of Oxford (Figure 2.1). Three main units of strata are represented: the Weymouth Member of the Oxford Clay Formation and the Corallian Group, both of Oxfordian age, and the Kimmeridge Clay Formation, of Kimmeridgian age (see (Figure 2.2)). The Corallian Group comprises a series of shallow-water limestones, sandstones and ironstones, with subsidiary clays, and separates the two predominantly clay formations.

Sedimentation in the south of the region took place in a series of basins and troughs separated by 'highs' (Figure 2.1), with maximum thicknesses of Oxfordian strata frequently in excess of 140 m, and minimum thicknesses as low as 90 m. In the north, on the East Midlands Shelf between Swindon and Oxford (Figure 2.1), thicknesses of Oxfordian strata of between 70 and 90 m are common. In between, a large platform area associated with the Mendip High, stretching from Longleat to Wootton Bassett in Wiltshire, subsided more slowly, and the thickness of Oxfordian strata rarely exceeds 50 m. Though in general the Kimmeridge Clay covers the underlying three-dimensional patchwork quilt of sandstones, limestones and clays with a uniform blanket of clay, there is a marked reduction in its thickness northwards, and also incursions of sandy and iron-rich sediments near basin margins.

One of the principal reasons for the variations in thickness is that sedimentation in all areas during the Oxfordian and Kimmeridgian was affected by the operation of reactivated syndepositional faults (De Wet, 1987; Scotchman, 1991a; Bristow *et al.,* 1995; Newell, 2000). Within the Corallian Group in north Dorset, Bristow *et al.* (1995) have demonstrated marked effects of faulting on sedimentation. The consequences of the faulting were (a) to allow thicker sedimentation in hanging wall areas, and (b) by uplift of the footwall, to cause the erosion in the vicinity of the footwall of previously deposited units. Thus, for instance, in the Sturminster dis trict of north Dorset, situated in the horst area known as the Cranbourne–Fordingbridge High, the thickness of Corallian strata is only on average 44 m. Syndepositional faults are situated both to the north and south (Figure 2.3), and so the thickness increases suddenly to 80 m in the Winterbourne Kingston Trough in the south and to 70 m in the Mere Basin in the north (Figure 2.3). The Highworth area north of Swindon was similarly affected, though the details have yet to be worked out. The effect on the ground is that limestone and clay members are often of only local extent, and may pass laterally into sandstones close to the basin margin. This is particularly the case on the Longleat–Wootton Bassett Platform and on the southern part of the East Midlands Shelf to the north-east. Less complicated variations in facies and thicknesses during the Kimmeridgian Age were also caused by differential fault movements (Scotchman, 1991a; Newell, 2000).

In the Early Oxfordian, sedimentation was dominated by the moderately deep-water Oxford Clay facies, which spread across the area with little variation in sediment type, except for an incursion of silts on the Dorset coast. In the late Early Oxfordian, shallow-water sedimentation, represented by the Corallian Group, began abruptly. The principal subdivisions of the Corallian Group are shown in (Figure 2.2). Thus in the southern half of the area, Oxford Clay is overlain by sands (Nothe Grit Formation, Hazelbury Bryan Formation, Lower Calcareous Grit), whereas south and east of Oxford, this interval is represented by the silty muds and fine sands of the lower West Walton Formation and the Temple Cowley and Arngrove Spiculite members.

Middle Oxfordian sediments of the Dorset basins consist predominantly of limestone–clay alternations (Redcliff, Osmington, Stour formations), and these pass northwards into predominantly sandstone–limestone sequences (Kingston and Stanford formations) in Wiltshire and Oxfordshire. In the shallow-water area around Oxford there was a lateral transition into the medium- to coarse-grained sands of the Beckley Sand Member, with its renowned highly fossiliferous shell beds. There is a diminution in quartz sand content upwards, and at the close of the Mid Oxfordian, coralliferous micritic limestone (Coral Rag Member, with its associated bioclastic facies (Wheatley Limestone)) was being laid down

over much of the area. Locally, these limestones pass into clay facies (Littlemore Clay). North-east of Oxford, the shallow-water limestones and sandstones both pass laterally into the silts of the upper West Walton Formation. The silty nature of Middle Oxfordian sedimentation, even in areas nominally of deeper water (East Midlands), is a clear indicator of marine regression, a widespread Early to Mid Oxfordian event.

The Upper Oxfordian sediments are very variable, being predominantly sand–clay (Dorset), ironstone (south Wiltshire) or argillaceous (Swindon). Around Oxford, they are frequently thin or absent, but east of Oxford they occur completely in clay facies (Ampthill Clay) (see Chapter 3). In general, there was a return to deeper-water clay sedimentation, but the Late Oxfordian was a period of tectonic instability in southern England, with frequent uplifts, and localized shallow-water deposits and hiatuses are common.

Early Kimmeridgian times saw continued regional subsidence/sea-level rise, which led to clay facies rocks being deposited over much of the area, though passing locally into sandy ironstone facies (Abbotsbury Ironstone) in the west. Argillaceous conditions continued into the Late Kimmeridgian in south Dorset, leading to a total accumulation of more than 500 m of Kimmeridge Clay in the Kimmeridge area. This thickness is reduced to 250 m only 20 km west, near Weymouth. Northwards, Cretaceous erosion means that the original full thickness of the Kimmeridge Clay is unknown right up to the Wiltshire border, where 265–300 m is reported at Mere. At Westbury, the thickness is reduced to 120 m, increasing to 150 m at Calne, but only 100 m at Swindon. Around Oxford, the thickness is only about 50 m, reducing to 37 m east of Oxford at the M40 (Horton *et al.,* 1995). The total thickness of Kimmeridgian strata around Oxford is thus only a tenth of that reached in the Wessex Basin at Kimmeridge. In the Highworth area and around Oxford, the Upper Kimmeridgian is largely represented by sands containing huge doggers.

The number of workers on the Oxfordian–Kimmeridgian of the area is too many to list individually in this introduction. Only those who have contributed on a broad, regional scale are mentioned below, and reference will be made to more detailed work in the individual site descriptions. The basis for our understanding of the Oxfordian–Kimmeridgian of the area was set by the monumental works of Blake (1875) and Blake and Hudleston (1877). These works are repeatedly referred to today, describing as they do many sections no longer visible. During the 1860s and 1870s, and again in the 1920s, the area was mapped by the Geological Survey. Though much of this was done on a six-inch scale, some areas of Corallian outcrop, particularly in the Shaftesbury Sheet area, were only available until recently in the original one-inch scale mapping. The results of the 19th-century mapping were summarized by Woodward (1895).

During the 1930s, it became apparent to W.J. Arkell that a proper understanding, particularly of the Corallian Group, would only be achieved by detailed mapping on a six-inch scale, and Arkell set himself the task of mapping those areas that included Corallian beds from east of Oxford southwards to north Dorset. The results of this work were published in a series of papers (Arkell, 1939a, 1941b, c, 1942, 1944a, b, 1951). The only areas he did not complete were north Dorset and south Wiltshire. The results of mapping in north Dorset were published by Wright (1981). Arkell (1936a, 1947a) also worked extensively on the Dorset coast. Wright (1980, 1986a, b) revised Arkell's work and formalized the lithostratigraphical nomenclature in line with modern practice.

From the 1960s onwards, the area has been the focus of a considerable amount of work on sedimentology, palaeoenvironmental analysis, and aspects of cyclic sedimentation (Wilson, 1968a, b; Brookfield, 1973a, b, 1978; Talbot, 1973a, 1974; Sun, 1989; Newell, 2000). The realization that Oxfordian sandy beds in Dorset had at one time been oil reservoir rocks, with the discovery nearby of the Wytch Farm Oilfield, led to considerable attention being paid to these rocks by oil companies.

During the 1990s, it was realized that the stratigraphical syntheses of Arkell and Wright suffered both from a lack of borehole information, which was now becoming available, and from a failure to appreciate the extent of fault control of sedimentary basins and the amount of growth faulting taking place during the Oxfordian (Figure 2.3). Arkell's 'axes' affecting sedimentation (Arkell, 1933, chapter 3) were only a preliminary attempt to assess the problem. In general, Arkell explained sudden changes in thickness by folding and crustal flexuring. Only where there was no alternative, i.e. the Peak Fault in north-east Yorkshire (Fox-Strangways, 1892; Rawson and Wright, 2000) were Jurassic fault movements accepted as the explanation for sudden changes in bed thickness. Substantial revision of the successions in north Dorset (Bristow *et al.,* 1995) and the Oxford area (Horton *et al.,* 1995) have now proved necessary.

Problems in the dating and correlation of the beds have been largely solved. In the Lower Oxfordian, ammonites, particularly cardioceratids, are often prolific, and the subdivisions of Arkell (1941a) have stood the test of time. For the Middle and Upper Oxfordian, the situation is not quite as straightforward. The occurrence of specific ammonite groups became dependent on facies during this period. The perisphinctids were largely confined to limestone and sandstone facies. The cardioceratids, though often accompanying the perisphinctids in these shallow-water facies, were often the only group present in clay facies. It has proved necessary in both the Middle and Upper Oxfordian to set up separate zonal and subzonal schemes for perisphinctids and for cardioceratids (see (Figure 1.4)). Precise correlation of the two schemes is still uncertain. For the sake of continuity, the cardioceratid zonal scheme is used throughout in this volume. Prolific perisphinctid faunas have been found in the Middle Oxfordian shell beds of the Oxford area, and in the Upper Oxfordian Clavellata Member and Osmington Mills Ironstone Member of south Dorset. Correlation of these faunas with cardioceratid faunas has proved possible at Dimmock's Cote Quarry (Middle Oxfordian), Leysthorpe Quarry (lower Upper Oxfordian) and Staffin (upper Upper Oxfordian) (see reports in this volume).

The zonation of the Kimmeridgian Stage is more straightforward. The excellence of exposure on the coast (Upper Kimmeridge Clay; Cox and Gallois, 1981) and at Westbury Cement Works, Wiltshire (Lower Kimmeridge Clay; Birkelund *et al.,* 1983), combined with an abundant ammonite fauna in clay facies, means that the ammonite succession is well documented, although there are a few problems of detailed correlation because of homeomorphy in the Upper Kimmeridgian genus *Pectinatites.*

Details of the main lithologies and depositional environments are included in the site descriptions that follow. In the following list (arranged from south to north), (O) indicates that the site belongs to the Oxfordian GCR Block, and (K) the Kimmeridgian GCR Block. The site locations are shown in (Figure 2.4).

Osmington (O)

Black Head (K)

Ringstead (K)

Sandsfoot (O)

East Fleet–Small Mouth (K)

East Fleet (O)

Lynch Cove (O)

Tyneham Cap–Hounstout (K)

Blind Lane (K)

Westbury (O)

Steeple Ashton (O)

Seend Cleeve (O)

Old Town, Swindon (K)

Shellingford Crossroads (O)

Lamb and Flag (O)

Dry Sandford (O)

Cumnor (O)

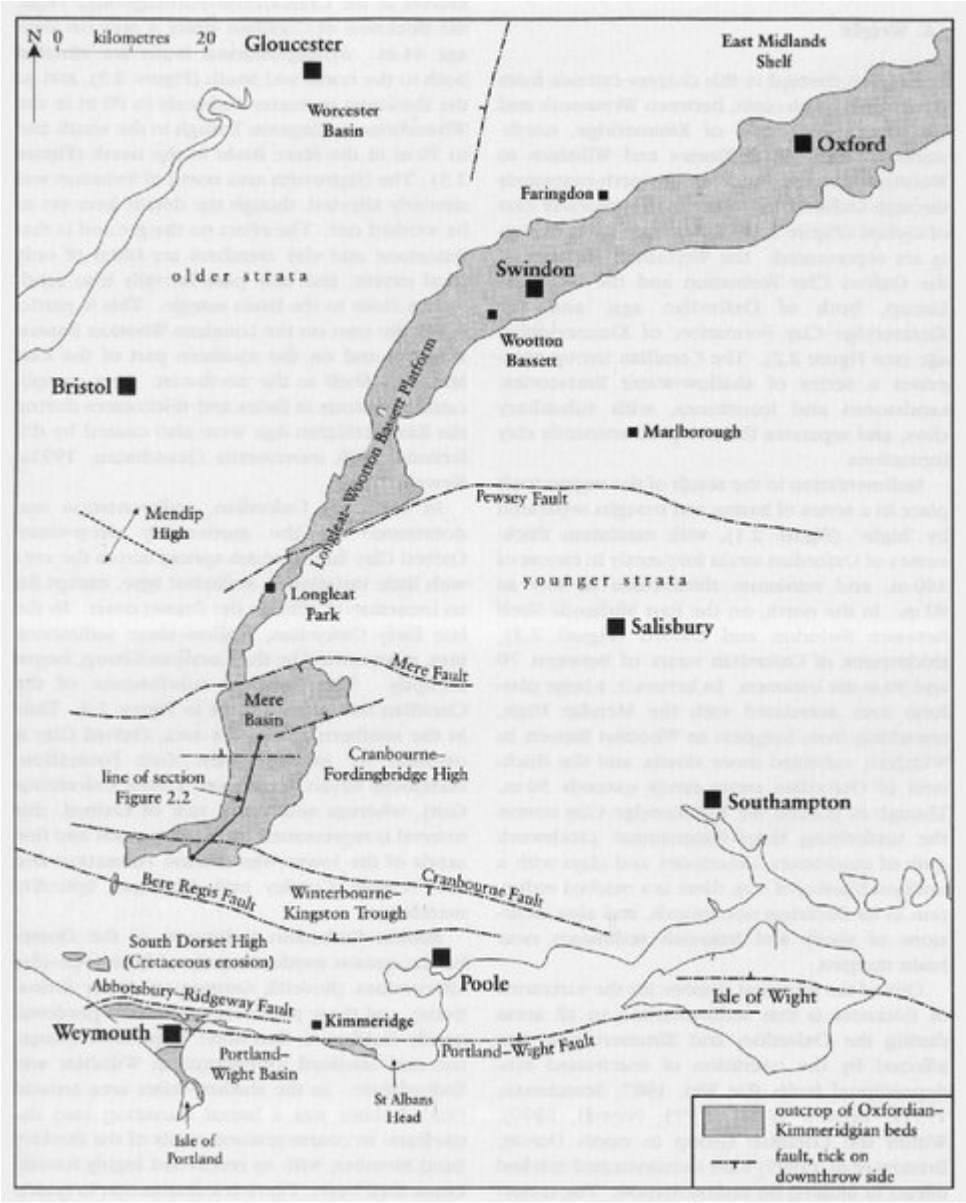
Littlemore Railway Cutting (O)

Cross Roads Quarry (O)

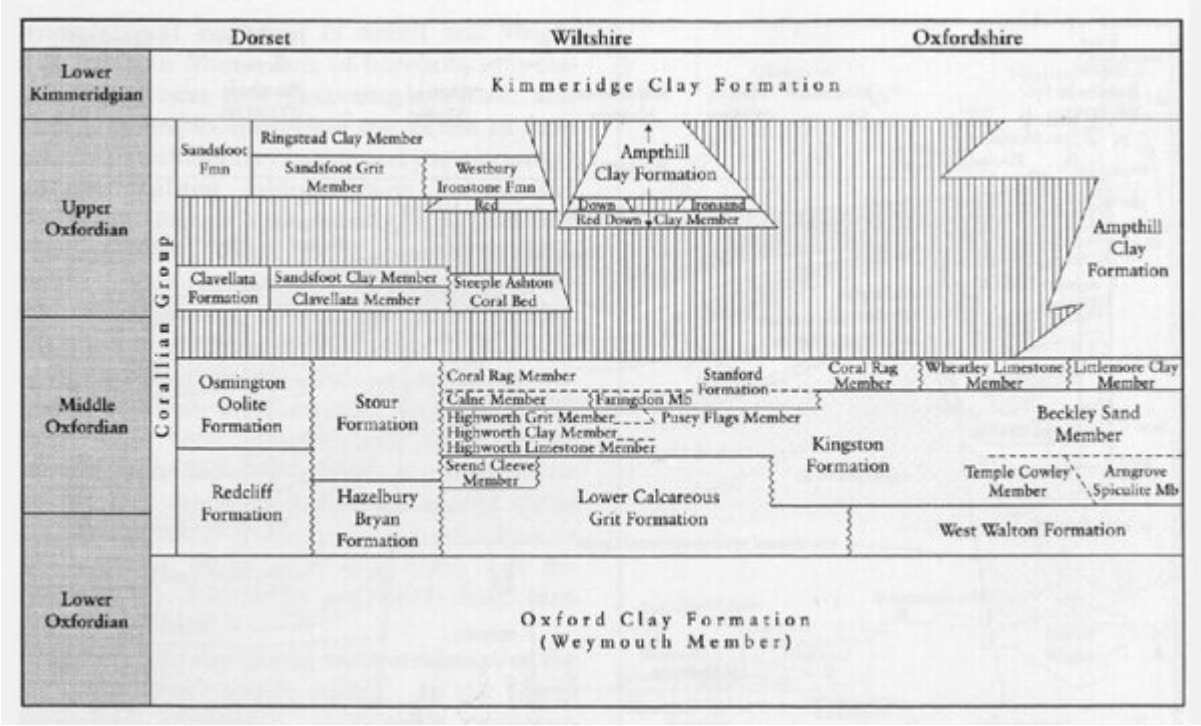
Magdalen Quarry (O)

Lye Hill Quarry (K)

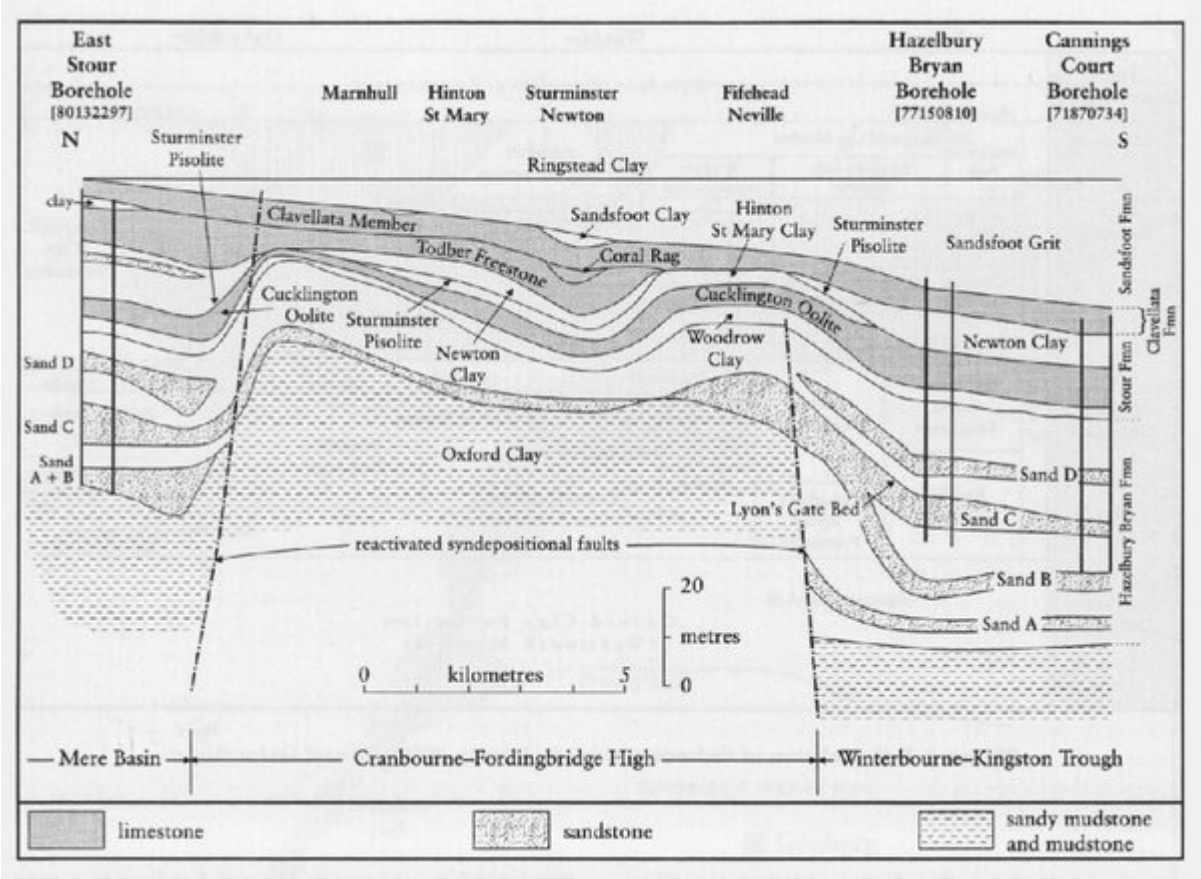
References



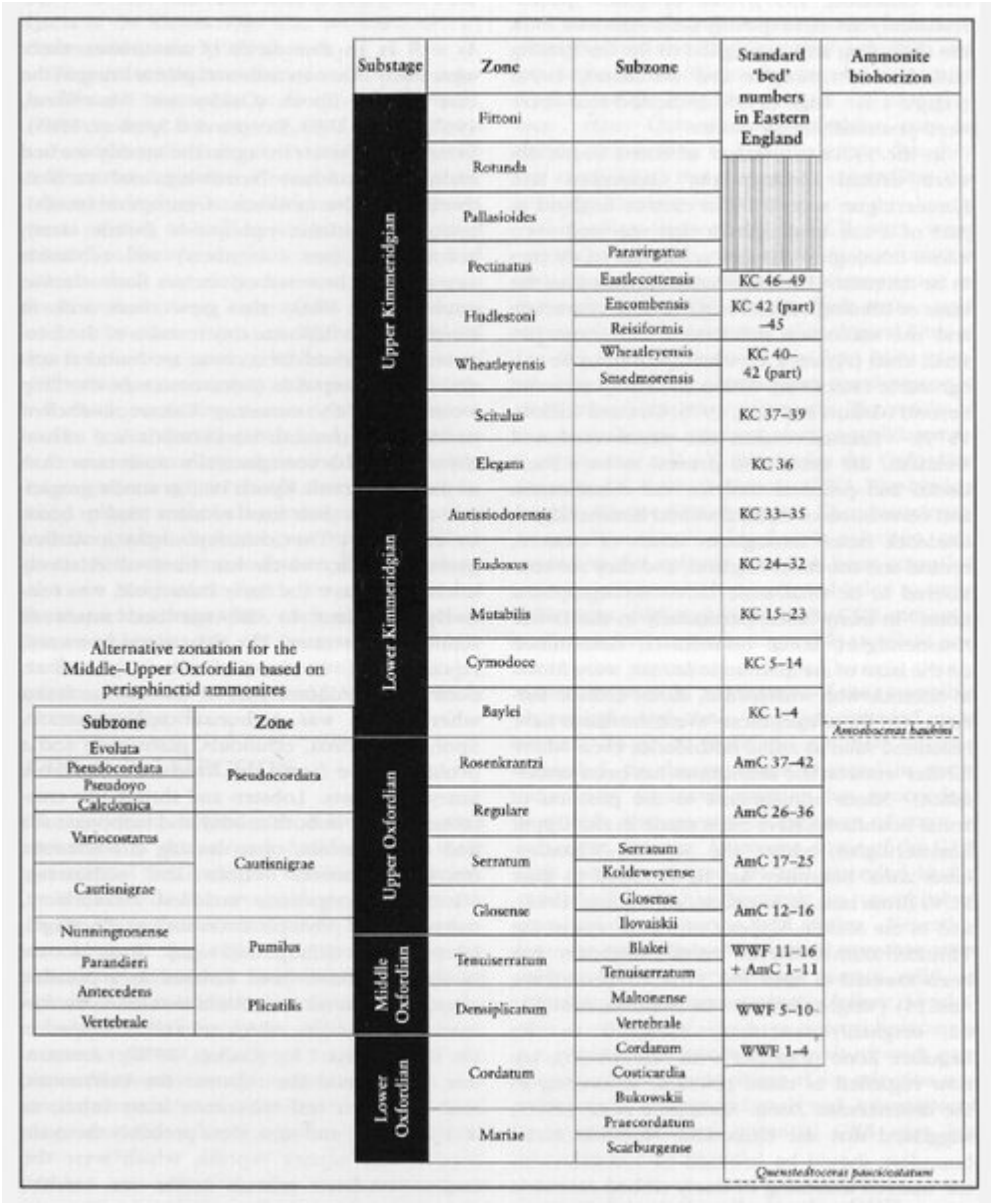
(Figure 2.1) Map of southern England showing the outcrop of the Oxfordian–Kimmeridgian beds, and the principal structural and palaeogeographical features (based on Scotchman, 1991a, fig. 1; Bristow et al., 1995, fig. 6 and Newell, 2000, fig. 6).



(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).

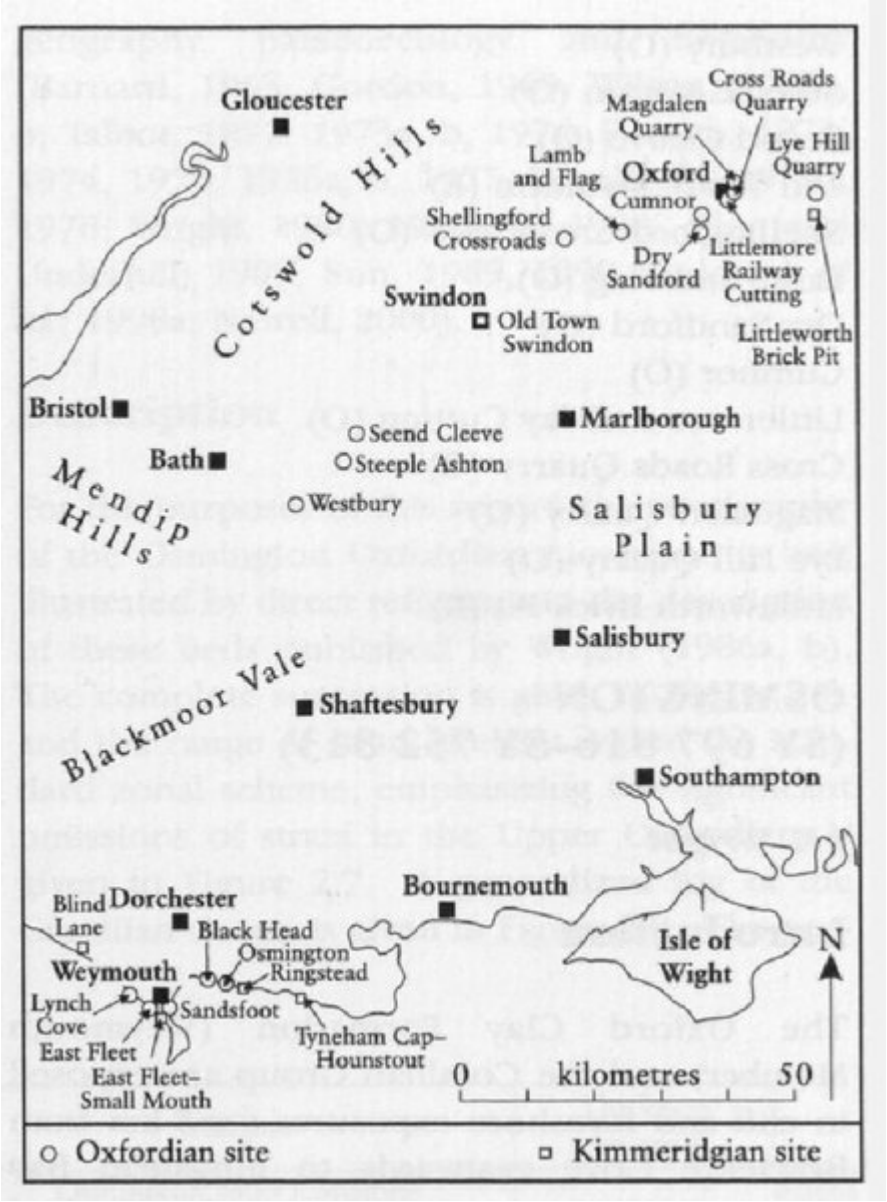


Substage	Zone	Subzone	Standard 'bed' numbers in Eastern England	Ammonite biohorizon
Upper Kimmeridgian	Fittoni			
	Rotunda			
	Pallasioides			
	Pectinatus	Paravirgatus		
		Eastlecottensis	KC 46–49	
	Hudlestoni	Encombensis	KC 42 (part) –45	
		Reisiformis		
	Wheatleyensis	Wheatleyensis	KC 40–42 (part)	
		Smedmorensis		
	Scitulus		KC 37–39	
	Elegans		KC 36	
Lower Kimmeridgian	Autissiodorensis		KC 33–35	
	Eudoxus		KC 24–32	
	Mutabilis		KC 15–23	
	Cymodoce		KC 5–14	
	Baylei		KC 1–4	*Amoeboceras haubrini*
Upper Oxfordian	Rosenkrantzi		AmC 37–42	
	Regulare		AmC 26–36	
	Serratum	Serratum	AmC 17–25	
		Koldeweyense		
	Glosense	Glosense	AmC 12–16	
		Ilovaiskii		
Middle Oxfordian	Tenuiserratum	Blakei	WWF 11–16 + AmC 1–11	
		Tenuiserratum		
	Densiplicatum	Maltonense	WWF 5–10	
		Vertebrale		
Lower Oxfordian	Cordatum	Cordatum	WWF 1–4	
		Costicardia		
		Bukowskii		
	Mariae	Praecordatum		
		Scarburgense		
				Quenstedtoceras paucicostatum

Alternative zonation for the Middle–Upper Oxfordian based on perisphinctid ammonites

Subzone	Zone
Evoluta	Pseudocordata
Pseudocordata	
Pseudoyo	
Calculomica	
Variocostatus	Cautisnigrae
Cautisnigrae	
Nunningtonense	Pumilus
Parandieri	
Antecedens	Plicatilis
Vertebrale	

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