Chapter 3 Upper Jurassic stratigraphy in the East Midlands

Introduction

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The region covered in this chapter extends from Oxfordshire northwards to the East Riding of Yorkshire (Figure 3.1), and broadly coincides with the Late Jurassic depositional area and structural feature known as the 'East Midlands Shelf' (see Chapter 1). For the purposes of this chapter, the southern limit is taken at where the limestones and sandstones of the Corallian Group in the area covered by Chapter 2 pass into clay facies to the east of Oxford (Horton *et al.,* 1995). The northern limit is defined by the Market Weighton High, which, periodically in Jurassic times, acted as a hinge between the rapidly subsiding Cleveland Basin to the north (Chapter 4) and the more gently subsiding East Midlands Shelf to the south. Major uplift, centred on this structure during the Early Cretaceous, led to the erosion of much of the Jurassic succession that had been deposited over and adjacent to it. For this reason, Upper Jurassic strata are discontinuous and largely absent in the Market Weighton area (Kent, 1980a).

The Oxfordian–Kimmeridgian succession in the East Midlands is almost exclusively argillaceous and therefore differs from that elsewhere in England where significant carbonate sediments occur in the Oxfordian (see chapters 2 and 4, this volume). The strata, largely obscured by Quaternary (Drift) deposits, are almost exclusively marine mudstones and calcareous mudstones that weather easily and give rise to a broad belt of low-lying ground. Silty mudstones, siltstones and concretions or thin tabular beds of muddy limestone (cementstone) occur at some levels, and the Kimmeridgian succession also includes kerogen-rich mudstones (oil-shales). In Buckinghamshire, two main are naceous horizons interrupt the otherwise argillaceous Upper Kimmeridgian succession. These silty units, which, further west and south-west (see Chapter 2), become increasingly coarse and sandy, may indicate the proximity of land during Late Kimmeridgian times (Horton *et al.,* 1995). In Cambridgeshire, coralline and ooidal limestones are locally developed in the Oxfordian at Upware, and mudstones with limestones rich in reef debris occur at a similar stratigraphical level at Elsworth. These were probably deposited in shallow, current-agitated water close to the London Landmass, which was fringed by patch reefs. At Elsham, in north Lincolnshire, the lower part of the otherwise argillaceous Kimmeridgian succession is interrupted locally by a wedge of medium- to coarse-grained sandstone. It is uncertain whether this deposit was transported by a flush of fast-flowing water (Swinnerton and Kent,1976), or whether it represents a migrating sublittoral sand bar but, clearly, local shallowing of the sea occurred here during the Early Kimmeridgian (Gaunt *et al.,* 1992).

There are no significant natural exposures of this predominantly mudstone succession, which has never been completely exposed. However, in the past, the region was peppered with small brickpits, some of which, together with other local details, were reported in memoirs and papers of the Geological Survey (Jukes-Browne, 1885, 1887; Ussher *et al.,* 1888; Ussher, 1890; Whitaker *et al.,* 1893; Woodward, 1895; Wedd, 1898, 1901), and by geologists from Cambridge (Seeley, 1861a, b, 1862, 1869; Roberts, 1889, 1892), as well as Blake (1875) and Blake and Hudleston (1877), both of whom had been students at Cambridge. The seat of learning at Cambridge continued to be associated with the Upper Jurassic stratigraphy of the region as field parties and individuals from there explored the local geology (Hancock, 1954; Forbes, 1960); the Sedgwick Museum contains important collections of fossils from the region. W J. Arkell worked there from 1947 and continued to reside in Cambridge until his death. His major monograph on Corallian ammonites (Arkell, 1935–1948) covers the Oxfordian of much of the region. He also contributed some shorter papers (Arkell, 1937a, b, 1938a; Arkell and Callomon, 1963) as well as his earlier regional synthesis (Arkell, 1933). The Oxfordian–Kimmeridgian stratigraphy of the region is covered by the review chapters of Callomon (1968) and Torrens and Callomon (1968), and that of the Huntingdon and Biggleswade, and Cambridge districts by the Survey memoirs published at about this time (Edmonds and Dinham, 1965; Worssam and Taylor, 1969).

Although a few cored boreholes had been drilled in the region in the past (Woodward, 1904; Strahan, 1920; Pringle, 1923), a major advance in knowledge of the detailed stratigraphy came from those drilled in the 1970s in Norfolk (Gallois, 1979b). These became standard reference sections for the Oxfordian–Kimmeridgian of eastern England and further

afield (Gallois and Cox, 1976, 1977; Gallois, 1979b). The internal subdivisions of the various mudstone formations were found to be widespread and enabled detailed correlation of individual borehole sections and temporary exposures to be made with confidence. Even boreholes for which there is no core available can be classified and correlated indirectly by means of geophysical logs (Penn *et al.,* 1986). The detailed classification established in these Norfolk boreholes has been applied to all areas of the East Midlands subsequently mapped by the Geological Survey (Gallois, 1988, 1994; Gaunt *et al.,* 1992; Shephard-Thorn *et al.,* 1994; Horton *et al.,* 1995).

The East Midlands succession is represented by four formations that form the greater part of the thick argillaceous unit known as the Ancholme Group, based on Gaunt *et al.*'s (1992) Ancholme Clay Group (Figure 3.2). The oldest is the Oxford Clay Formation (Buckland in Phillips, 1818), only the upper part of which (the Weymouth Member) is of Oxfordian age (Cox *et al.,* 1992). The term 'West Walton Formation' was introduced by Gallois and Cox (1977) (as 'West Walton Beds') for the overlying unit of generally more silty mudstones, with locally developed more variable silty and calcareous lithologies, between the Oxford Clay and Ampthill Clay. Based on a cored borehole at West Walton, Norfolk, the formation is typically developed in the area of the East Midlands Shelf. Following Gallois and Cox (1977), the locally developed limestones at Upware and Elsworth are recognized as members within it. In the Humber area, beds of this age are slightly more sandy than in areas further south and were differentiated as the Brantingham Formation by Gaunt *et al.* (1992). The Ampthill Clay was named by Seeley (1869), who described its occurrence in Buckinghamshire, Bedfordshire and Cambridgeshire, citing a section on the Bedford–Luton railway near Ampthill, Bedfordshire. The youngest formation is the more widespread Kimmeridge Clay named by Webster (1816) but first recognized as a discrete division (the 'Oaktree Soil') by William Smith on his map of 1815. In the south of the region (Buckinghamshire), silty beds help to divide the Upper Kimmeridge Clay into five members (see (Figure 2.52)) (Oates, 1991; Horton *et al.,* 1995).

Ammonites are well represented amongst the fossil faunas of all four formations, which can therefore be placed within the ammonite-based chronostratigraphical framework with relative ease. Indeed, Market Rasen in Lincolnshire gives its name to the ammonite genus *Rasenia,* which is a zonal index in the Lower Kimmer-idgian (Salfeld, 1913). Uncrushed specimens with beautiful nacreous shells from former pits at Market Rasen are found in many museum collections although the species present have never been properly described (Spath, 1935; Birkelund *et al.,* 1978). In the Oxfordian formations, both cardioceratid and perisphinctid ammonites are present but the former are generally sufficiently abundant to allow the so-called Boreal zonation based on this family to be applied in most cases ((Figure 3.2); see also Chapter 1). In addition to the ammonites, the numbered standard beds in the West Walton, Ampthill Clay and Kimmeridge Clay formations (Gallois and Cox, 1976, 1977; Cox and Gallois, 1979; see above) have proved a valuable means of classification and correlation in the East Midlands where lack of exposure has given particular importance to borehole data. Indeed, it was in this region that the bed-numbering was developed and where the numbered beds, now considered to be small-scale chronostratigraphical units, have been most extensively applied.

Further details of the lithologies, thicknesses and depositional environments are included in the site descriptions that follow. In the following list of sites (arranged south to north), (O) indicates that the site belongs to the Oxfordian GCR Block and (K) indicates the site belongs to the Kimmeridgian GCR Block. The location of sites is shown in (Figure 3.1).

Upware South Pit (O)

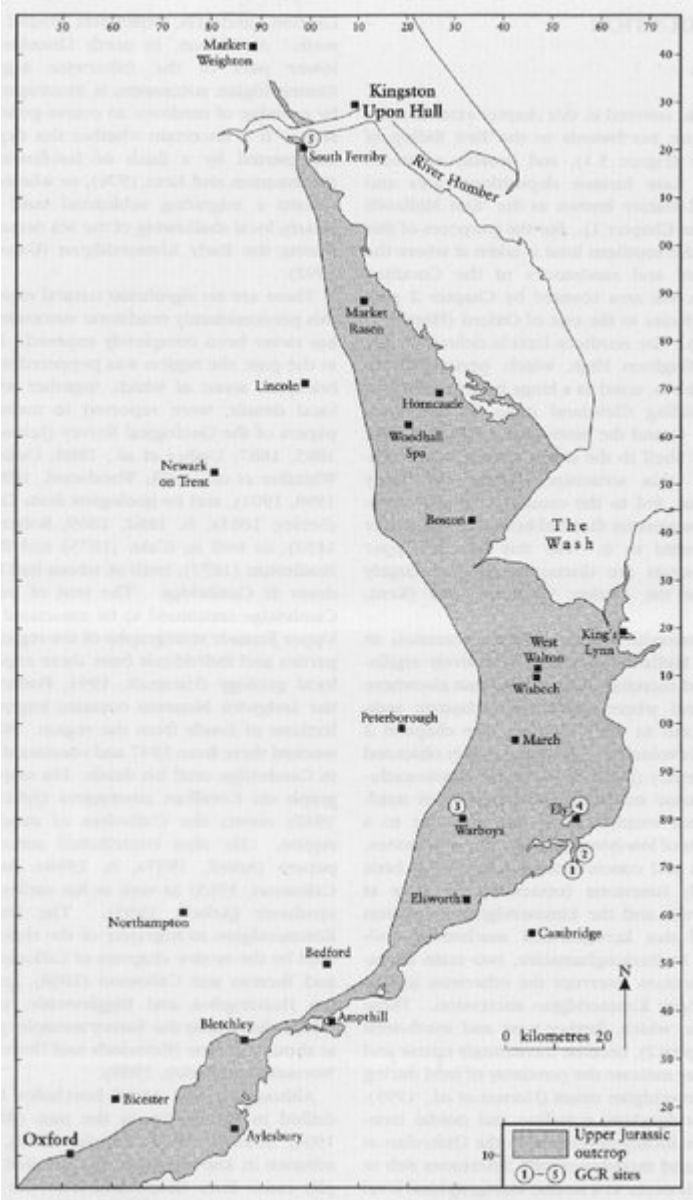
Dimmock's Cote Quarry (O)

Warboys Clay Pit (O)

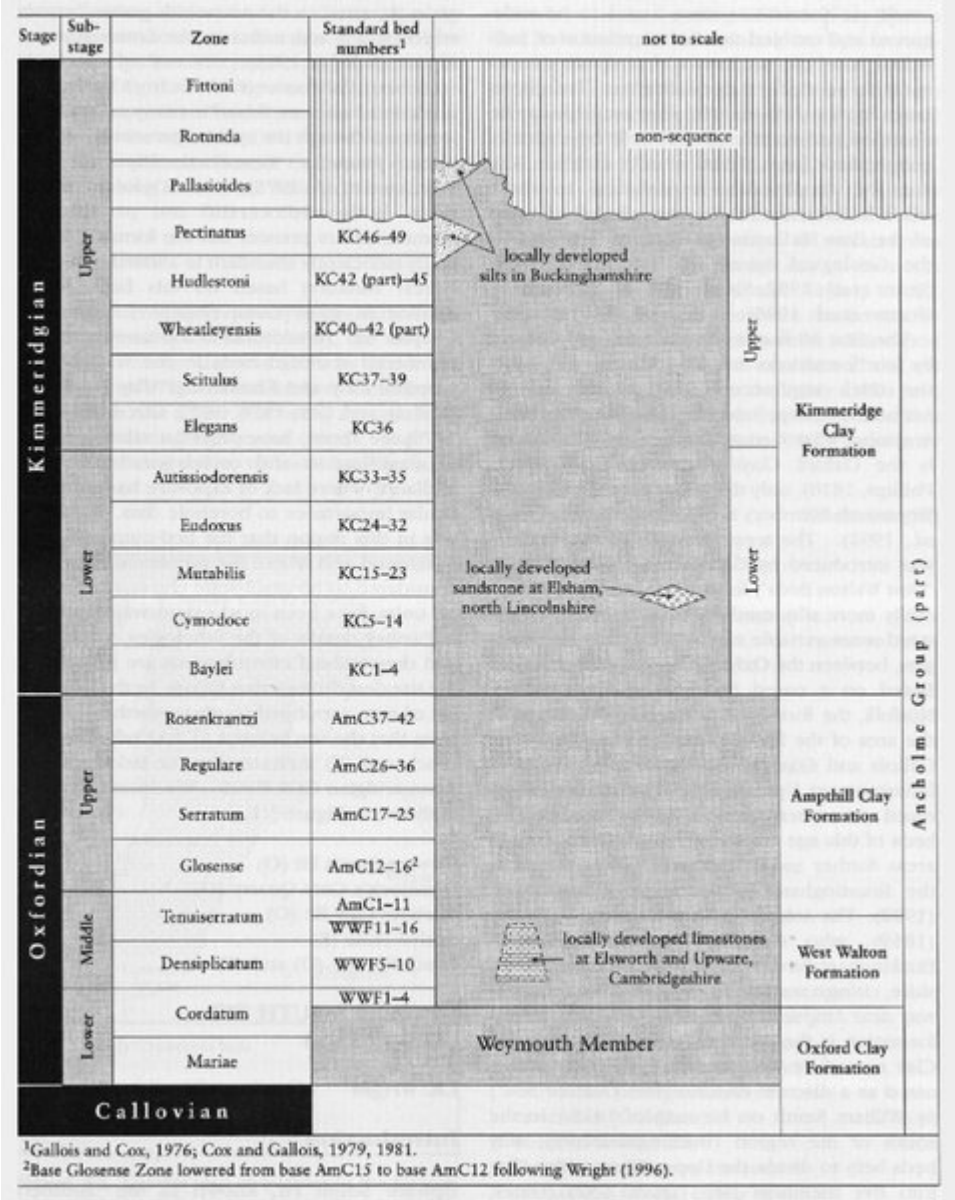
Roslyn Hole (K)

South Ferriby (O) and (K)

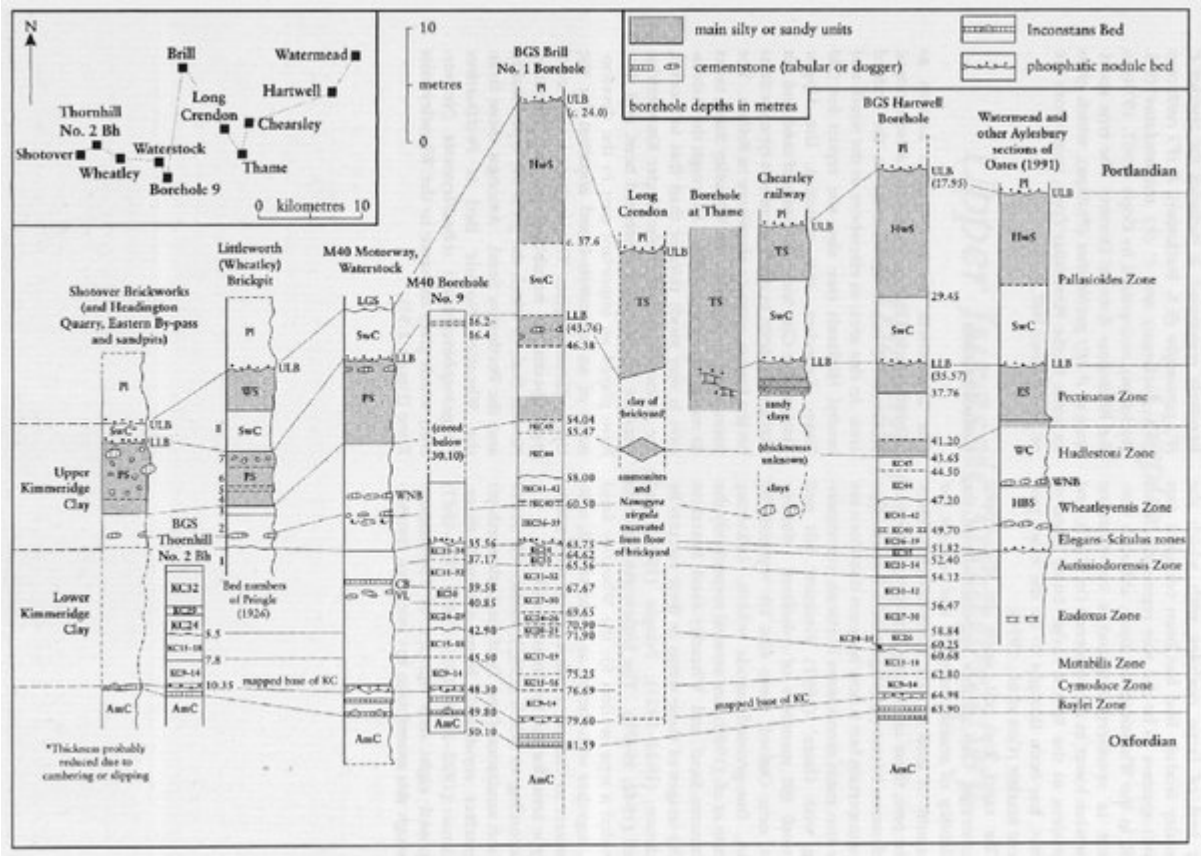
References



(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.



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



(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; Pl, 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.