South Ferriby

[SE 993 204]

B.M. Cox

Introduction

The GCR site at South Ferriby comprises a pit (Middlegate Quarry) worked by Rugby Group plc for the manufacture of cement. There has been a cement factory at South Ferriby since 1938; both chalk and clay, the main raw materials used in cement manufacture, are available here. The pit exposes, in downward succession, the Cretaceous Welton Chalk, Ferriby Chalk, 'Red Chalk' and Carstone, overlying Upper Jurassic clays (Gaunt *et al.,* 1992) (Figure 3.10). The boundary between the Cretaceous and Jurassic beds is unconformable; the conglomeratic base of the Carstone rests on the ?Cymodoce Zone of the Lower Kimmeridgian, younger Jurassic beds having been cut out by the Cretaceous overstep as the Market Weighton High is approached. In the mid-1970s, geologists became aware that the pit exposed the Oxfordian–Kimmeridgian stage boundary in an apparently conformable, ammonitiferous clay succession (Cox in Smart and Wood, 1976); at that time, the section exposed *c.* 7.5 m of each stage. Since then, the pit has been deepened to expose up to a further *c.* 12 m of Oxfordian beds, although the thickness seen varies from year to year with demand from the industry. The section has been investigated and recorded by many geologists from both the UK and abroad (Kelly and Rawson, 1983; Stancliffe, 1984; Whitham, 1984; Birkelund and Callomon, 1985; Ahmed, 1987; Wignall, 1990b; Gaunt *et al.,* 1992; Schweigert and Callomon, 1997) and has featured in the search for a Global Stratotype Section and Point (GSSP) for the base of the Kimmeridgian Stage (Page and Cox, 1995). The importance of the site in this respect has led to its inclusion in both the Oxfordian and Kimmeridgian GCR blocks.

Description

The following section of the Jurassic strata at South Ferriby is based mainly on Birkelund and Callomon (1985) and their graphic section published in Ahmed (1987), but with additional data from the more recent papers listed above together with manuscript notes of Professor Callomon and personal observations. Bed notation follows Birkelund and Callomon (1985) (1–12), as extended by Callomon (pers. comet.) (Y–Z), and relates to sections recorded in 1979 and 1982. Although most subsequent authors have used Birkelund and Callomon's section as the basis of their work, there are discrepancies between the factual details recorded by different authors that make compilation of a definitive, composite section problematic. Although Wignall (1990b) was able to recognize all of Birkelund and Callomon's beds and used their bed numbers, he recorded (in the late 1980s) substantial differences in thickness for some beds, notably Bed 9 where he measured 2.0 m compared with Birkelund and Callomon's *c.* 0.75 m; in 1974, the present author recorded 1.5 m. However, for combined beds 8 and 9, the thicknesses recorded by Wignall and Birkelund and Callomon are comparable (c. 6.5 m and 6.9 m respectively). Ammonite determinations have varied with each iteration of the section as work on contemporaneous faunas from elsewhere progresses, and pending a full account of the South Ferriby ammonites. Those named in the section below follow Schweigert and Callomon (1997), who used the name '*Prorasenia anglica*' for the ammonite previously known as *Microbiplices anglicus.* Wignall (1990b) recorded 60 non-ammonite taxa including bivalves, gastropods, scaphopods, brachiopods, crustaceans, echinoids, a crinoid, an asteroid, an ophiuroid, serpulids and bryozoa but, in the following section, only selected records, mainly the more common of the bivalve genera (i.e. those reported by Wignall (pers. comm. 1998) as common or abundant) are listed; Wignall (1990b, fig. 4) showed a bivalve species distribution table down to Bed 3 of the section given below. The most common bivalve is *Thracia depressa* (J. de C. Sowerby), which is present throughout the succession. Ostracod faunas have been reported by Ahmed (1987) and the palynomorph assemblages by Stancliffe (1984). Wignall (1990b) reported that his investigations of the foraminifera indicated that they were very similar to those described by Medd (in Richardson, 1979) from the nearby Worlaby boreholes.

	Thickness (m)
Kimmeridge Clay Formation	

12. Mudstone, grey, calcareous; fissile and shaly in top 1 m; lower 2 m very shelly, with lenticular, calcareous or phosphatic concretions including persistent horizon of small septaria near base; ammonites with uncrushed body chambers, with phosphatic infillings particularly in lower part of bed; *Amoeboceras* cf. *cricki* (Salfeld), *Prorasenia* sp., *Rasenia* cf. *cymodoce* (d'Orbigny)/berryeri (Dollfus) and *Rasenia* trans. *Pictonia;* bivalves including *Corbulomima, Grammatodon, Isocyprina, Liostrea, Nicaniella, Palaeonucula* and *Thracia;* the gastropod *Dicroloma*	3.0
11. Mudstone, sideritic, mottled brown and grey with pale buff-coloured, phosphatic patches; hard, forming prominent marker in pit face; bivalves including *Grammatodon* and *Isocyprina;* sharp boundary at base	0.05–0.1
10d. Mudstone, grey, massive, calcareous; weakly developed and variable sideritic mudstone at base; very shelly with abundant crushed *Pictonia baylei* Salfeld, *Prorasenia* sp.; bivalves including *Corbulomima, Deltoideum delta* (Wm Smith), *Grammatodon, Isocyprina, Liostrea, Modiolus, Oxytoma* and abundant *Thracia;* serpulids.	2.0
c. Mudstone, grey, more shaly than Bed 10d; sparsely shelly with *Pictonia* sp. and bivalves including *Liostrea, Nanogyra nana* (J. Sowerby), *Oxytoma* and *Palaeonucula*	0.5
b. Mudstone, pale grey, more calcareous and harder than Bed 10c; sparsely shelly with *Pictonia* cf. *normandiana* Tornquist and bivalves including *Liostrea*	0.8
a. Mudstone, pale grey, calcareous, hard, slightly fissile; many pyritized burrows and *Chondrites;* very shelly with *Pictonia densicostata* Salfeld, *Prorasenia* sp.; bivalves including *Corbulomima, Grammatodon, Pleuromya* in growth position, *Protocardia* and *Thracia; Dicroloma;* nest of the brachiopod *Torquirhynchia inconstans* (J. Sowerby) with *Lopha gregarea* (J. Sowerby); uneven base with shell bed including *Amoeboceras bauhini* (Oppel)	*c.* 0.5
9. Mudstone, grey, passing into marl and soft limestone in middle part; layer of prominent, large (*c.* 1 m diameter), weakly septarian cementstone concretions at top; small phosphatic concretions and lenses, especially in lower part; very shelly with fossils commonly partially phosphatized and only partially crushed; *Amoeboceras* aff. *cricki, A.* cf. *lorioli* (Oppenheimer), *Pictonia densicostata, Prorasenia* sp.; bivalves including phosphatic steinkerns of *Pleuromya* in growth position, lumachelles of disarticulated *D. delta* valves, *Corbulomima, Grammatodon, Isocyprina, Liostrea* and *Thracia; Dicroloma* and cidarid echinoids; sharp base marked by Oxytoma Cementstone, a patchily cemented, 0.03–0.20 m thick shell-bed with many broken shells, particularly serpulids and *Oxytoma inequivalve* (J. Sowerby), and phosphatic nodules	*c.* 0.75
Ampthill Clay Formation	

8e. Mudstone, grey, calcareous; very shelly in upper part with ammonites (*Amoeboceras* sp., *Prorasenia* sp., *Ringsteadia/Pictonia* sp.), bivalves including *Grammatodon, Liostrea,* nuculaceans and *Oxytoma; Dicroloma*	2.10
d. Mudstone, grey, hard and tenacious, forming rib in pit face; crowded with serpulids; *Amoeboceras* sp.	0.05
c. Mudstone, grey, calcareous; small limestone concretions; *Prorasenia* sp. and *Ringsteadia evoluta* Salfeld	1.8
b. Mudstone, grey, highly calcareous with layer of scattered limestone concretions or lenses; very shelly with *Prorasenia* sp., *Ringsteadia evoluta* and bivalves including *Corbulomima, Liostrea* and *Oxytoma*; *Dicroloma*	0.2
a. Mudstone, grey, moderately calcareous and shelly with *Prorasenia* sp., *Ringsteadia evoluta* and bivalves including *Corbulomima, Oxytoma, Pinna* and *Thracia*	2.0
7. Mudstone, grey, highly calcareous; layer of reniform concretions at top; many small, uncrushed pyritized ammonites; *Ringsteadia evoluta;* bivalves including *Liostrea* and *Oxytoma;* strongly interburrowed base	0.3
6. Mudstone, grey, very shelly with *Amoeboceras* cf. *marstonense* Spath and *Ringsteadia pseudocordata* (Blake and Hudleston); *Corbulomima, Deltoideum, Liostrea, Oxytoma, Placunopsis* and *Thracia*	2.3
5d. Mudstone, grey, highly calcareous, prominent in pit face; very shelly with *Amoeboceras rosenkrantzi* Spath, *Prorasenia anglica* (Arkell), *Ringsteadia pseudocordata* and bivalves including *Corbulomima, Oxytoma, Protocardia* and *Thracia*	*0.3*
c. Mudstone, grey; *Ringsteadia* cf *evoluta;* clusters of *Pinna* in growth position	0.4
b. Mudstone, grey, more calcareous than Bed 5c; *Prorasenia* sp.	0.3
a. Mudstone, grey, calcareous, rather fissile, less massive than Bed 5b; very shelly with partially crushed fossils preserved in pyrite; *Ringsteadia pseudocordata,* wood fragments and lignite	0.4
4. Mudstone, grey, highly calcareous, locally hardened into soft, marly limestone; layer of large, flat, septarian concretions forming prominent marker; numerous large distinct burrows; sparsely shelly with *Prorasenia* and *Ringsteadia* fragments, occasional bivalves, including *Corbulomima, Modiolus* and *Thracia,* and serpulids	0.25
3. Mudstone, grey, calcareous, very shelly with *Prorasenia* sp. and *Ringsteadia pseudocordata;* belemnites (*Cylindroteuthis, Pachyteuthis*), bivalves including *Corbulomima, Isocyprina, Modiolus, Oxytoma, Protocardia* and *Thracia,* and serpulids	2.2
2. Mudstone, very dark grey, forming marker in pit face; blocky, listric fracture; sparsely shelly	0.3

1d. Mudstone, dark grey, massive; phosphatic lenses in lower part; sparsely shelly with *Prorasenia* sp. and *Ringsteadia pseudoyo Salfeld/pseudocordata;* layer of *D. delta* 1 m below top; *Thracia*	2.45
c. Mudstone, grey, less massive than Bed 1d, with lenticular, partially pyritized and phosphatized, locally cemented lenses of shell debris, particularly *Oxytoma; Ringsteadia pseudoyo, Pachyteuthis, D. delta* and *Thracia;* persistent, 10–30 mm thick, shell-debris-rich bed at base forming marker	1.0
b. Mudstone, grey, calcareous becoming less so below; scattered small concretions; *Prorasenia* sp., *Ringsteadia pseudoyo, Pachyteuthis, Pinna* in growth position, *Thracia*	1.2
a. Mudstone, grey, paler than Bed lb, moderately calcareous, very shelly with partially crushed fossils preserved in buff-coloured phosphate; *Pachyteuthis, Pinna* in growth position and *Thracia*	0.4
Z. Mudstone, grey, highly calcareous with layer of strongly septarian concretions up to 0.6 m diameter at 1 m spacing, forming marker in pit face; *Prorasenia* sp. and *Ringsteadia pseudoyo;* basal 0.1 m intensely bioturbated with *Chondrites*	0.3
Y. Mudstone, dark grey, well bedded; moderately shelly with *Prorasenia* sp., *Ringsteadia pseudoyo* and abundant *Thracia*	to 1.0 seen

The most obvious marker beds in the pit face are the brownish rib formed by the sideritic mudstone of Bed 11, and the concretions in beds 4 and 9.

Interpretation

The phosphatic nodules/concretions that occur throughout the succession above Bed 6 indicate periods of prolonged residence close to the muddy sea-bottom sediment surface (i.e. relatively slow sedimentation), with localized, anoxic, semi-enclosed environments forming nucleation sites in otherwise oxygenated sediments. Similar depositional conditions are indicated by the occurrence of pyrite, which is restricted to specific sites such as the internal cavities of shells, particularly articulated bivalves and the innermost whorls of ammonites (Wignall, 1990b). According to the latter author, the onset of anoxic bottom-water conditions is indicated in the upper part of Bed 12 by the rapid disappearance of a previously diverse benthos, which is replaced by a highly impoverished fauna consisting almost solely of shallow infaunal filter-feeding bivalves. This assemblage is similar to several others in the Kimmeridge Clay of southern England where high environmental stresses, caused by fluctuating but generally low bottom water oxygen levels, reduced the fauna to only a few opportunistic bivalve species. Relatively slow sedimentation rates are also indicated at South Ferriby by the ratio of fragmented to complete specimens of benthos in the mudstones. The longer the residence time near the sediment surface (i.e. the slower the sedimentation), the greater will be the fragmentation of the shelly fauna. Overall, the Ampthill Clay shows lower shell fragmentation values (less than 15%) than the Kimmeridge Clay where values are generally over 20% and nearly 50% in the basal bed (Wignall, 1990b).

Wignall (1990b) identified a number of faunal associations within the benthos that enabled further insights into the depositional environments; these included bottom-water conditions in which the substrate was probably quite firm, substrates with soft surface sediments caused by the activities of deposit feeders, and stable conditions with niche partitioning. He also recognized a number of Boreal forms which appeared to occupy similar ecological niches to more southern species, notably the bivalve *Grammatodon schourovskii* (Rouillier and Vossinsky), replacing *G. longipunctata* of southern England, and the gastropod *Dicroloma trifida* (Phillips), replacing *Quadrinervus ornatus* of southern England, as well as species that had no direct ecological equivalent in southern England, such as the bivalves *Parainoceramus subtilis* (Blake) and *Mesosaccella choroschowensis* (Borissjak). The cause of these differences is uncertain, but it can have had nothing to do with the Market Weighton High, which has been invoked to explain variations in species distribution between the Cleveland Basin and southern England (see site report for Green Lane and Golden Hill Pits, this volume), as this lay well to the north of South Ferriby.

The ammonite faunas in the Ampthill Clay indicate that it belongs entirely to the Upper Oxfordian Pseudocordata Zone. Although both the cardioceratid genus *Amoeboceras* and the perisphinctid genus *Ringsteadia* occur, species of the latter are more recognizable here so that the perisphinctid-based Sub-Boreal zonation (see Chapter 1, (Figure 1.4)) is more readily applied at this level. Successive species of the genus *Ringsteadia* divide the succession into three subzones: Pseudoyo, Pseudocordata and Evoluta (Figure 3.11). The boundary with the overlying Lower Kimmeridgian Baylei Zone is marked at the base of Bed 9 by the Oxytoma Cementstone. When originally recorded by the present author in 1974, this important marker bed was well developed in the pit face but it is only patchily developed and has not always been as obvious elsewhere in the pit; indeed, Birkelund and Callomon (1985) and Callomon (pers. comm.) have never explicitly recorded it. Birkelund and Callomon (1985) suggested that the abundance of shells in this bed was the result of current-winnowing but Wignall (1990b) thought that this was not necessarily so because there was the same ratio (almost twice as many) of the larger, heavily ribbed left valves of *Oxytoma* to the thinner-shelled smaller right valves in both the cementstone and adjacent mudstones; this suggested to him that the conditions leading to the formation of the cementstone were not unique to that bed, and he presumed that the shelly nature of the sediments was controlled by the original abundance of the bivalve itself. The bed has been recognized at a number of localities in north Lincolnshire, including a water-pipeline trench and railway cutting near Elsham and former brickpits at North Kelsey and Moortown Hill (Cox in Gaunt *et al.,* 1992). In the Worlaby G Borehole (Richardson, 1979), *c.* 5 km south-east of South Ferriby, the Oxytoma Cementstone includes a form of *Amoeboceras* comparable with *A. baubini.* The key ammonite for marking the basal Kimmeridgian Baylei Zone is *Pictonia densicostata* but the presence also of *A. baubini* enables correlations with other European sections (Schweigert and Callomon, 1997) (see also site report for Kildorais, this volume). Although small in size (25 mm maximum), Birkelund and Callomon (1985) regarded *A. baubini* as a macroconch, with the even smaller *A. cricki* as the associated microconch. In southern England, the base of the Baylei Zone is marked by the Inconstans Bed characterized by the asymmetrical rhynchonellid brachiopod *Torquirhynchia inconstans* (J. Sowerby). A single cluster of this taxon, together with the bivalve *Lopha gregarea* (J. Sowerby) was reported by Wignall (1990b) in Bed 10a, which he therefore called the Inconstans Bed, implying its correlation with that bed in southern England. However, no other occurrence of this brachiopod has since been reported at South Ferriby, and the validity of this correlation must remain uncertain bearing in mind that asymmetrical rhynchonellids similar to *inconstans* have been reported in Dorset from the younger Black Head Siltstone and Abbotsbury Ironstone (S. Etches, pers. comm. 1995; Blake and Hudleston, 1877; Brookfield, 1973b). If the correlation is correct, a major hiatus must occur beneath the Inconstans Bed in Dorset (Figure 3.11). The section at South Ferriby is considerably more complete although there may still be a break beneath the Oxytoma Cementstone. The phosphatic nodules in that bed show evidence of reworking, which, according to Wignall (1990b), implies that several metres of mudstone have been removed before deposition of Bed 9.

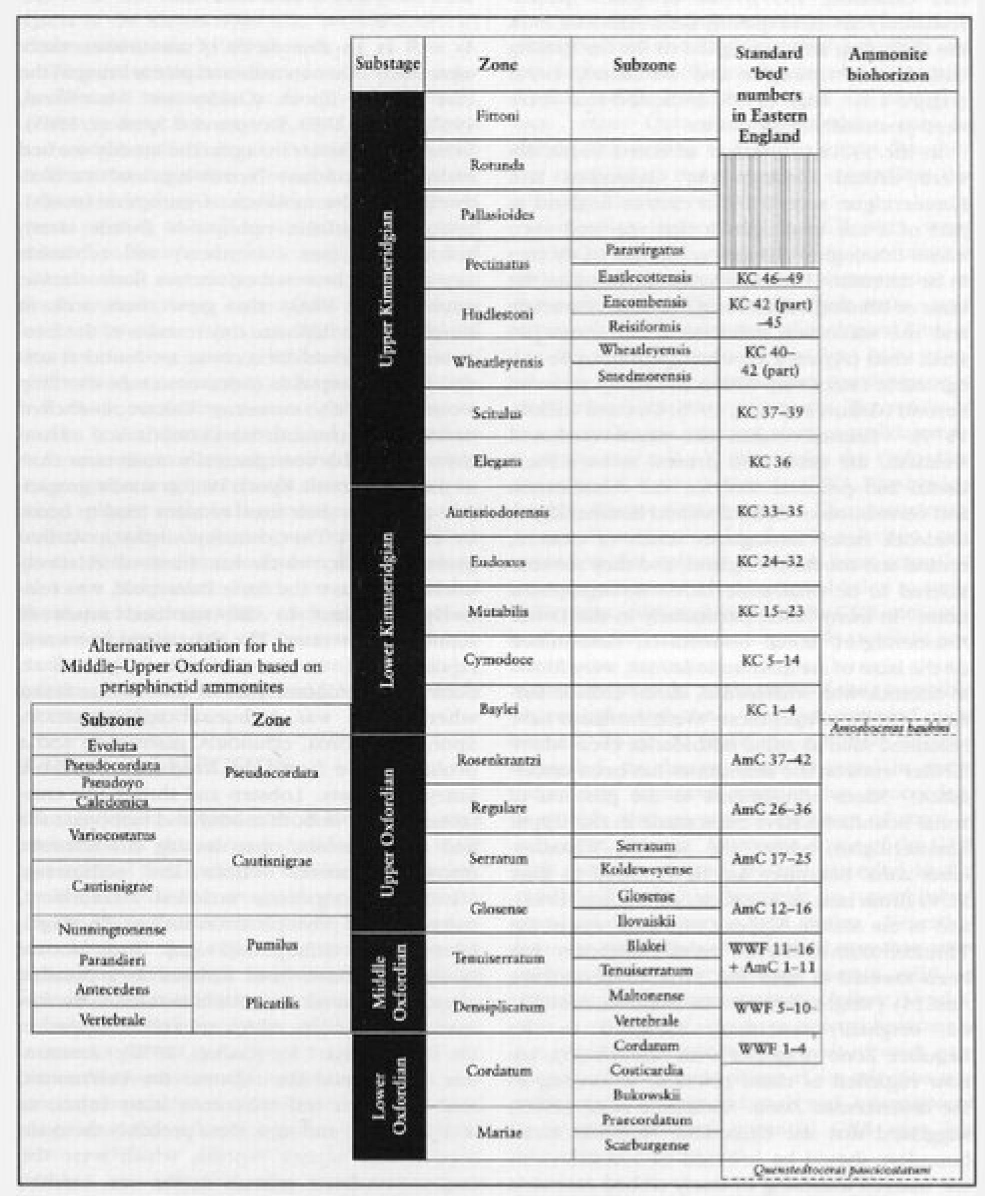
Ammonites in the highest beds include forms transitional between *Pictonia* and *Rasenia,* the latter genus indicating the Cymodoce Zone. Bed 12 is tentatively assigned to that zone, with the sideritic mudstone (Bed 11) marking its basal boundary.

Conclusions

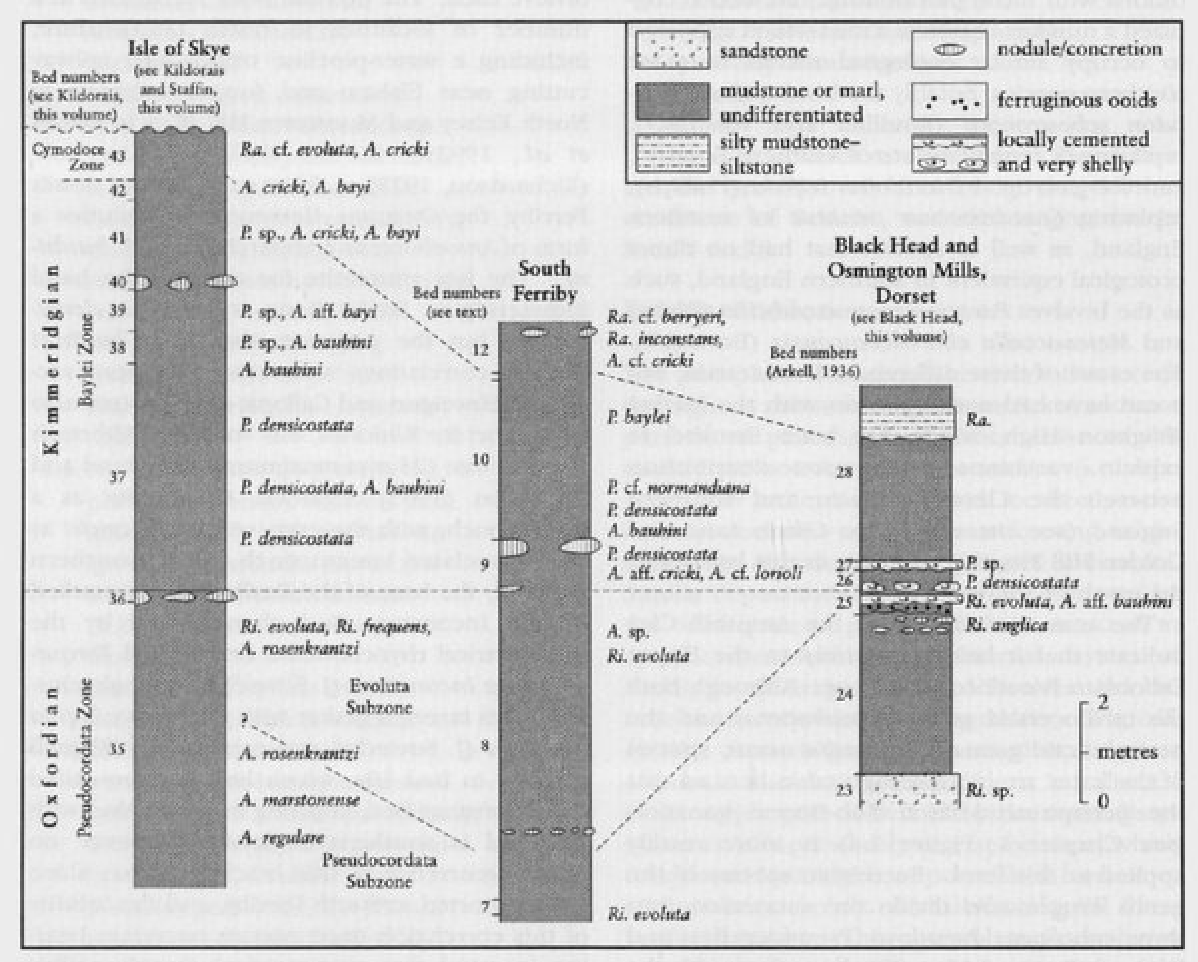
The pit at South Ferriby shows one of the best exposures across the Oxfordian–Kimmeridgian stage boundary in the UK. The structurally uncomplicated mudstone succession there yields a rich ammonite fauna, including an evolutionary succession of *Ringsteadia* species, enabling the subzonation of the youngest beds of the Oxfordian to be documented accurately within the Sub-Boreal zonation. The presence of *Amoeboceras baubini* allows correlation of the stage boundary sequence with other areas of Europe (see also site reports for Kildorais and Staffin, this volume). The site is thus a most important one for stratigraphical studies and both national and international classification and correlation.

References

(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 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 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.