# Castlechamber to Maw Wyke, North Yorkshire

[NZ 941 082]–[NZ 959 067]

K.N. Page

## Introduction

The cliff and foreshore exposures along the North Yorkshire coast between Castle Chamber and Maw Wyke, near Hawsker Bottoms, provide one of the most complete Pliensbachian–Toarcian boundary sequences in Britain, and a continuous succession through the Staithes Sandstone, Cleveland Ironstone and Whitby Mudstone formations in the Pliensbachian and Toarcian of the North Yorkshire coast. The succession here includes the type sections of the Grey Shale and Mulgrave Shale members of the Whitby Mudstone Formation, while the facies developments in the Staithes Sandstone and Cleveland Ironstone formations below are critical to understanding the sedimentary history of the Cleveland Basin. The site is also the type locality for almost half of the known British species of amaltheid ammonites and has yielded indicator fossils for the basal Toarcian Paltus Subzone.

The strata dip gently west, unbroken by faults or folds, and represent a continuation from the succession exposed in the Normanby Stye Batts–Miller's Nab (Robin Hood's Bay) GCR site to the south (Figure 6.6) and (Figure 6.9). The base of the Upper Pliensbachian succession lies about 2 m above the floor of Castle Chamber and progressively younger strata come down to shore level to the north-west. Highest beds exposed in the site are at Maw Wyke where the upper part of the Bituminous Shales of the Mulgrave Shale Member is exposed on the shore. Still higher levels are exposed farther north but in the cliffs.

This section of coast was well known to early geologists and was described by Phillips (1875) and Tate and Blake (1876). The latter publication formed the basis for many subsequent accounts of the site. Further descriptions can be found in the [British] Geological Survey memoir for Whitby and Scarborough (Fox-Strangways and Barrow, 1882), although with some errors perpetuated in later memoirs (Fox-Strangways, 1892; Fox-Strangways and Barrow, 1915). Herries (1906a,b) provided an account of the succession, including a sketch section of the cliffs and an outcrop map of the shore. Further descriptions included those of Buckman (1915) and Arkell (1933). Tate and Blake's (1876) descriptions were not superseded until the Lias stratigraphy was revised in a series of papers by Howarth (1955, 1962a, 1973). Wilson *et al.* (1934) traced aspects of the variations in thickness of the Upper Pliensbachian sequence, consisting of the Staithes Sandstone Formation and Cleveland Ironstone Formation between Hawsker Bottoms and north-east of Staithes, and Whitehead *et al.* (1952) discussed the petrology of the ironstones. Howard (1985) revised the lithostratigraphy of the Upper Pliensbachian sequence, based in part on the framework of Powell (1984) and using Howarth's (1955) bed numbers, but did not include a bed-by-bed re-description. A graphic log of part of the Pliensbachian succession, published by Phelps (1985), extended up into the base of the succession here, while summary descriptions and logs of the full sequence have been published by Hesselbo and Jenkyns (1995) (Figure 6.10). Powell (1984) proposed that the section near Hawsker Bottoms should be designated as stratotypes for the Grey Shale Member and Jet Rock of the Mulgrave Shale Member, although clearly the latter should now be located at Port Mulgrave. He also proposed that the section from Hawsker Bottoms to Whitby Harbour be considered the stratotype for the Toarcian Whitby Mudstone Formation. The Toarcian sections at Hawsker Bottoms were referred to by Scrutton (1996), who noted that most of the Alum Shale Member is exposed in the cliff. Elements of the fauna from these higher levels are commonly found amongst fallen material on the beach. Reviews of the sedimentology and petrology of the Upper Pliensbachian succession are included in Hallam (1967a), Chowns (1968), Catt*et al.* (1971), Greensmith *et al.* (1980), Young *et al.,* (1990a) and Parkinson (1996).

The site has long been a rich source of fossil material that was described by the early geologists, Including Simpson (1855) and Tate and Blake (1876), and in many other publications since, notably those of Doyle (1990–1992) on the belemnites and Howarth (1958, 1962a, 1973, 1992) on the ammonites. Almost half of the known species of amaltheid ammonite recorded in Britain were described originally from here and the site lends its name to the uppermost

Pliensbachian ammonite *Pleuroceras hawskerense.* The section is also an important source of data contributing towards an understanding of patterns and processes of sedimentation in the Cleveland Basin. It has figured in discussion of the origin of the Cleveland Ironstone Formation (Young *et al.,* 1990a).

## Description

This section of coast exposes a complete sequence through the local Upper Pliensbachian and Toarcian succession, consisting of all or part of the Staithes Sandstone, Cleveland Ironstone and Whitby Mudstone formations. The following section is based on information from Howarth (1955, 1962a, 1973) including faunal records from the Hawsker Bottoms area extracted from his more general records. Belemnite records from Doyle (1990–1992) are incorporated for the Grey Shale Member. Bed thicknesses and faunal details for the higher beds are those for the Whitby to Saltwick GCR site section, although Howarth (1962a) states that there is very little thickness variation between these sites. The graphic log in (Figure 6.10), although compiled independently by Hesselbo and Jenkyns (1995), does not differ substantially from the descriptive log below and the same bed numbers, of Howarth (1955, 1962a, 1973) and Phelps (1985), are used.

Thickness (m)

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| **LOWER TOARCIAN SUBSTAGE** | |
| **Whitby Mudstone Formation** | |
| ***Alum Shale Member*** | |
| ***Main* Alum Shale Beds** (part) | |
| 51: Shale, seen on scar north-west of Maw Wyke Hole, above Bed 50. According to Howarth (1962a) no higher levels are exposed on the foreshore here. | |
| **Hard Shale Beds** [NZ 942 083]–[NZ 940 085] | |
| 49–50: Shale with concretions, capped by a 0.13 m-thick red sideritic mudstone; lower part seen on the eastern side of Maw Wyke Hole and upper part in the scar a short distance north-west of Maw Wyke Hole. Belemnites (including *Acrocoelites*) and ammonites (*Dactylioceras*) present. Includes part of *the commune* Biohorizon. | 6.4 |
| ***Mulgrave Shale Member*** | |
| **Bituminous Shales** ([NZ 942 083]–[NZ 947 081]; partly covered by large boulders, with some levels only visible at low spring tides). | |
| 48: **Ovatum Bed** (or Band): Double row of large sideritic, concretions in grey shale well exposed from the cliff behind Pursglove Stye Batts north-westwards across the scar and into the east side of Maw Wyke Hole; *Ovaticeras ovatum* present and belemnites probably include *Acrocoelites.* Includes part of the *ovatum* Biohorizon. | 0.25 |
| 47 (part): Shale, grey, bituminous, probably with *Parapassaloteuthis, Acrocoelites, Odontobelus* and *Simpsonibelus.* Includes part of the *ovatum* Biohorizon. | 0.75 |
| *Serpentinum Zone, Falciferum Subzone* | |
| 46–47 (part): Shale, grey, bituminous, with a 0.13 m sideritic mudstone at base, exposed on the western side of Pursglove Stye Batts. Belemnites probably include *Parapassaloteuthis, Acrocoelites, Odontobelus* and *Simpsonibelus.* | 5 |

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| 44–45: Shale, grey, bituminous, with row of scattered concretions at base, partly covered by boulders; belemnites probably include *Parapassaloteuthis, Acrocoelites* and *Simpsonibelus.* Probably includes the *falciferum* Biohorizon. | 3.5 |
| 41–43: Shale, grey, bituminous, with a row of scattered pyrite-skinned concretions yielding abundant *Pseudomytiloides* near the middle (seen running north–south across Pursgrove Stye Batts, about 80 m west of the Millstones). *Harpoceras* ex grp. *falciferum, Youngibelus, Parapassalteuthis, Acrocoelites, Odontobelus* and *Simpsonibelus* probably present. Includes the *mulgravium* Biohorizon. | 13.6 |
| **Jet Rock** | |
| *Exaratum Subzone* | |
| 40: **Millstones**: Giant lenticular calcareous concretions, up to 4.5 m in diameter when seen from above, in grey bituminous shale; only poorly exposed here according to Howarth (1962a), with higher levels covered by boulders. Includes part of the *elegans* Biohorizon. | 0.3 |
| 39: **Top Jet Dogger**: Continuous band of argillaceous limestone. *Toarcibelus trisulculosus* probably present. Includes part of the *elegans* Biohorizon. | 0.23 |
| 38: Shale, grey, bituminous, with occasional calcareous concretions, including a band 0.3 m above the base with Curling Stone-like nodules. *Toarcibelus trisulculosus* and *T. ilminsterensis.* Includes part of the *elegans* Biohorizon. | 1.5 |
| 37: **Curling Stones**: Calcareous concretions with pyritic skins and almost perfect spheroidal shapes, up to 45 cm in diameter, in grey bituminous shale. Irregular lines of nodules, or 'pseudo-vertebrae', also occur at this level here. *Cleviceras elegans, Phylloceras heterophyllum* and probably also *Dactylioceras* sp., *Toarcibelus trisulculosus* and *T. ilminsterensis* present. Includes part of the *elegans* Biohorizon. | 0.3 |
| 36: Shale, grey, bituminous. *Toarcibelus trisulculosus* and *T. ilminsterensis.* | 1.1 |
| 35: **Whalestones**: Large ovoid calcareous concretions up to 3 m long and 1 m thick, with many smaller concretions, in grey bituminous shale. *Cleviceras exaratum* common, with less frequent *Harpoceras serpentinum, Hildaites murleyi, H. forte, Phylloceras heterophyllum, Lytoceras nitidum* and probably also *Dactylioceras* sp., *Toarcibelus trisulculosus* and *T. ilminsterensis. Elegantuliceras* cf. *elegantulum* also recorded at Hawsker Bottoms by Howarth (1962a, as *E. rugulatum,* but not in 1992). Corresponds to the *exaratum* Biohorizon. | 0.9 |
| 34: Shale, grey, bituminous, with frequent calcareous concretions. *Elegantuliceras elegantulum* frequent, *Harpoceratoides* sp. (reported by Howarth, 1962a), also *Toarcibelus trisulculosus* and *T. ilminsterensis.* Includes part of the *elegantulum* Biohorizon at Port Mulgrave. | 2.6 |

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| 33: **Cannon Ball Doggers**: Spherical calcareous concretions up to 0.18 m in diameter, with common well-preserved *Elegantuliceras elegantulum* (including macro- and microconch forms) and rare *Harpoceratoides* sp. reported by Howarth (1962a). This horizon is well exposed near Hawsker Bottoms but conspicuous due to round holes in the beach platform, where the actual nodules have been removed by collectors. This includes part of the *elegantulum* Biohorizon. | 0.15 |
| ***Grey Shale Member*** | |
| *Tenuicostatum Zone, Semicelatum Subzone* | |
| 32: Shale, grey, with occasional flat calcareous nodules and some shell beds, including near top, with crushed *Tiltoniceras antiquum* (including the lectotype figured by Howarth, 1992, text-fig. 13). Also *Orthodactylites semicelatum, Passaloteuthis bisulcata* and *Posdonia radiata.* Corresponds to the *antiquum* Biohorizon. | 1.85 |
| 28–31: Shale, grey, with three bands of large calcareous concretions, including a double row at the base, which are often pyritic and contain well-preserved *Orthodactylites semicelatum* and large belemnites (*P. bisulcata*). *Meneghiniceras lariense* in Bed 31 (Howarth, 1976). Probably corresponds to the *semicelatum* Biohorizon. | 3.53 |
| *Tenuicostatum Zone, Tenuicostatum Subzone* | |
| 20–27: Shale, grey, with several bands of small calcareous nodules and a double band of large calcified lenses, weathering red, at the base. Well-preserved *Orthodactylites tenuicostatum* (including the neotype figured by Buckman, 1909–1930, pl. 57; see also Dean *et al.,* 1961, pl. 72, fig. 1) occur in small nodules but generally this level is obscured beneath boulders on the beach at Hawsker Bottoms. *Passaloteuthis bisulcata* probably also present. Corresponds to the *tenuicostatum* Biohorizon. | 2.72 |
| *Tenuicostatum Zone, Clevelandicum Subzone* | |
| 19c: Shale, grey. | 0.8 |
| 19b: Shale, grey, including a band of red-weathering lenticles with *Orthodactylites clevelandicum.* Corresponds to the *clevelandicum* Biohorizon. | 0.05 |
| 19a: Shale, laminated and bituminous (Bed 19 is the probable source of *Passalotheuthis bisulcata, P. milleri* and *Pseudohastites longiformis* in Doyle (1990–1992, text-fig. 3)). | 0.41 |
| 18: Shale, grey with small calcareous concretions. *Orthodactylites crosbeyi* and *Passalotheuthis bisulcata.* Corresponds to the *crosbeyi* Biohorizon. | 0.38 |
| *Tenuicostatum Zone, Paltus Subzone* | |
| 4–17: Shale, grey, with six bands of calcareous and sideritic concretions. Some belemnites and bivalves present, including *Passalotheuthis bisulcata, P. milleri* and *Pseudobastites longiformis.* | 5.42 |

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| 3c: Band of sideritic, calcareous mudstone with rare *Protogrammoceras paltum* (Buckman), *Dactylioceras* sp. and also *P. bisulcata* (= Bed 45, part, of Howarth, 1955). This is the lowest typical Toarcian fauna in the region, corresponding to the *pedtus* Biohorizon. | 0.08 |
| **UPPER PLIENSBACHIAN SUBSTAGE** | |
| 1–2 (= part of Bed 45 of Howarth, 1955): Shale, grey. *Lytoceras* sp. recorded at Kettleness. Doyle (1990–1992) records *Passaloteuthis bisulcata, Pseudohastites longiformis* and *Parapassaloteuthis zieteni* in the district. *c.* | 1.15 |
| 43 (part)–44 (of Howarth, 1955): Limestone, nodular, red-weathering, *with Pseudopecten* and other bivalves in upper part and bituminous shale of the Sulphur Band at the base. | 0. 58 |
| **Cleveland Ironstone Formation** | |
| ***Kettleness Member*** | |
| *Spinatum Zone, Hawskerense Subzone, Hawskerense Zonule* | |
| 43 (part): Shale, grey, with calcareous nodules yielding *Pleuroceras hawskerense.* | 0.3 |
| 42: Ironstone, red, with irregular top and nests of *Tetrarhynchia tetrahedra,* and bivalves, with *Pleuroceras hawskerense.* | *c.* 0.12 |
| 40 (part)–41: Sandstone, calcareous, forming the top of Hawsker High Scar (0.45 m), with shale below, in part sandy. | *c.*1.7 |
| *Elaboratum Zonule* | |
| 39–40 (part): Ironstone (*c.* 0.08 m thick), irregular, with shale and siltstone above (0.15 thick) yielding *Pleuroceras elaboratum* and *Amauroceras ferrugineum.* | 0.23 |
| 38: Shale and siltstone with occasional ferruginous concretions. | 2.1 |
| 37: Ironstone, forming the base of Hawsker High Scar, with *Pleuroceras apyrenum, P. hawskerense, P. elaboratum, Amauroceras ferrugineum, A. lenticulare* and *PseudoAmaltheus engelhargelhardti.* | 0.08 |
| 35–36: Shale with ironstone band (0.1 m thick) below containing *Pleuroceras elaboratum.* | 0.4 |
| 34: Shale with band of scattered calcareous concretions near the middle. | 1.35 |
| 33: Ironstone with abundant bivalves and *Pleuroceras paucicostatum* (the holotype being from here; Howarth, 1958, pl. 6, figs 6–9), *P. apyrenum, P. elaboratum, Amauroceras ferrugineum, A. lenticulare* and *Amaltheus reticularis.* | 0.15 |
| *Apyrenum Subzone, Solare Zonule* | |
| 28–32: Shale and siltstone with two bands of ironstone below and a band of calcareous nodules in the upper part. *Pseudopecten equivalvis* present. *Pleuroceras apyrenum* in Bed 30. | 3.75 |

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| 25–27: Pecten Seam. Ironstone, oolitic, in two bands with shale between. *Pleuroceras* ex grp. *solare* (including the neotype; Howarth, 1958, pl. 5, fig. 1), *P. solare* var. *solitarium, Amaltheus* aff. *margaritatus* and *A. laevigatus* Howarth (holotype from Bed 25; Howarth, 1958, pl. 4, fig. 1). | 0.43 |
| Non sequence — Tr*ansiens* and *Salebrosum zonules* absent | |
| ***Penny Nab Member*** | |
| *Margaritatus Zone, Gibbosus Subzone* | |
| 24: Shale. | 0.5 |
| 23: **Raisdale Seam** (= Two Foot Seam in Howarth, 1955): Ironstone. | 0.1 |
| 21–22: Shale with siltstone above and sandy concretions and sandy streaks in upper 1.5 m. Defined base of subzonq corresponds to base of Bed 21 parastratotype (Howarth, 1992). | 4.95 |
| *Subnodosus Subzone* | |
| 20: **Avicula Seam**: Ironstone with central shale parting. *Amaltheus subnodosus.* | 0.4 |
| 19: Shale and siltstone with scattered calcareous concretions and *Amaltheus subnodosus, A. striatus* and *A. margaritatus* 0.45 m above base. Bed 19 or 20 yielded *Amaltheus gloriosus* (Howarth, 1958, p1. 3, fig. 3). | 5.0 |
| 18: **Osmotherley Seam**: Ironstone. The defined base of the subzone corresponds to the base of the bed parastratotype in Howarth (1992). | 0.15 |
| *Stokesi Subzone, Nitescens* (?part) and *Celebratum zonules* | |
| 17: Shale with scattered calcareous concretions. | 2.1 |
| **Staithes Sandstone Formation** | |
| 14–16: Double band of sandy ironstones with *Amaltheus stokesi* separated by sandy shale and siltstone. Nests of *Protocardla truncata in* upper ironstonc. | 0.8 |
| *Nitescens Zonule,* ?part | |
| 12–13: Ironstone, thin, red (*c.* 0.08 m thick), overlain by thick sandy shale and siltstone with scattered calcareous concretions. *Amaltheus stokesi, A. wertberi* frequent, *A. bifurcus* (holotype from 1.7 m from top of Bed 13; Howarth, 1958, pl. 1, fig. 6) and rare *Protogrammoceras nitescens* (possibly including the holotype from here or near Staithes re-figured by Howarth, 1992, pl. 4, fig. 4, and probably also the holotype of *P. geometricum,* pl. 4, fig. 2 and pl. 5, fig. 2). | 5.6 |
| *Occidentale* and *Monestieri zonules* | |
| 8–11: Sandstone and sandy shale and siltstone, with a basal band of calcareous concretions rich *in Protocardia truncata.* | 1.8 |
| 1–7: Shale, sandy, with sandstone band and red calcareous concretions in lower part, with some bands rich in *Gryphaea* and other bivalves. *Amaltheus stokesi* and *A. bifurcus* in Bed 1. Defined base of Stokesi Subzone corresponds to the base of Bed 1 parastratotype (Howarth, 1992). | 5.2 |
| **LOWER PLIENSBACHIAN SUBSTAGE** | |
| *Davoei Zone, Figulinum Subzone, Figulinum Zonule* | |

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| 62–65 (of Phelps 1985) (= beds ii–v of Howarth, 1955): Two bands of red calcareous concretions separated by sandy shale and siltstone, with *Oistoceras figulinum, O. curvicorne* and a form transitional to *Amaltheus bifurcus* (Phelps, 1985) in the upper band and *O. figulinum in* the lower band. | 0.45 |
| *Angulatum Zonule* | |
| 59–61 (= Bed i): Sandstone, hard, ferruginous, forming the floor of Castle Chamber. | *c.* 2.15 |
| 49–58: Siltstone with concretionary bands in upper part and mudstone with ferruginous concretions near base. *Oistoceras angulatum* (including a form transitional from *Aegoceras crescens*) and *Liparoceras divaricosta* present in beds 49–51, with *Oistoceras ?angulatum* and *O*. sp. in beds 54–55 (thicknesses estimated from Hesselbo and Jenkyns, 1995). | *c.* 6.4 |
| *Capricornus Subzone, Crescens Zonule* | |
| 46–48: Siltstone with some ferruginous concretions, including as a basal band. *Aegoceras crescens* present, including forms transitional from *A. capricornus* below and transitional to *Oistoceras angulatum* above (thickness estimated from Hesselbo and Jenkyns, 1995). | *c.* 1.6 |
| *Capricornus Zonule* | |
| 42–45: Siltstone with a band of ferruginous nodules and concretions. *Aegoceras capricornus* present (thickness estimated from Hesselbo and Jenkyns, 1995). | c. 1.3 |
| 41: Oyster Bed: Ferruginous concretionary band. *Aegoceras ?capricornus.* | 0.2 |

The lower part of the Staithes Sandstone Formation is exposed in and around Castle Chamber (Figure 6.9). The base of the formation is taken at the distinctive ferruginous Shelly sandstone of the Oyster Bed. The formation here is about 25.8 m thick and dominated by siltstones with some mudstone units near the base and fine sandstone around the middle. Small-scale coarsening- and fining-upward cycles are evident. Most units are bioturbated, but some preserve hummocky cross-beds, wave ripples or gutter casts. Ironstone nodules are common at certain levels in the lower part of the formation and were noted by Parkinson (1996) as having anomalously high thorium–potassium ratios. Calcareous nodules occur at several levels towards the top of the formation.

The position of some of the lithostratigraphical boundaries has been the subject of some discussion. Cope *et al.* (1980a) placed the base of the Cleveland Ironstone Formation at the base of Bed 14, but Powell (1984) placed it at the base of Bed 12, and Howard (1985) placed it at the base of Bed 17 (Figure 6.10), a shale with scattered day nodules, which is the position adopted in this account. The formation is 25.4 m thick and dominated by metre-scale coarsening-upward cycles of light to dark mudstones and siltstones with ironstone nodules common at some levels and with several thin (< 0.3 m thick) but continuous ironstone bands at the tops of the cycles. Unlike the ironstone bands at the top of the cycles at Staithes (Myers, 1989), only the Pecten Seam shows a significant increase in thorium–potassium ratios (Parkinson, 1996). Some of the nodules and ironstone beds are richly fossiliferous and this locality has yielded more species types of amaltheid ammonite than any other site. These include *Amaltheus bifurcus* from Bed 13; possibly *A. striatus* from Bed 19; *Amaltheus laevigatus, Pleuroceras solare* and *P. solare* var. *solitarium* from Bed 25; *Amaltheus reticularis* and *Pleuroceras paucicostatum* from Bed 33; *Amouroceras ferrugineum, Pleuroceras birdi* and possibly *Amouroceras lenticulare* from Bed 33 or Bed 37; *Pleuroceras hawskerense* transient *elaboratum* from Bed 40; and *P. hawskerense* from Bed 42 (Howarth, 1958). The silty mudstones of Bed 21 at Far Jetticks yielded the holotype of the crinoid *Balanocrinus solenotis* (*Simms,* 1989). Morgans (1999) examined calcitized and pyritized driftwood from the Penny Nab Member at this site, finding evidence for a seasonally wet and dry climate.

The base of the Whitby Mudstone Formation was placed at the base of Bed 45 by Powell (1984), and around the middle of Bed 43 by Cope *et al.* (1980a) and by Hesselbo and Jenkyns (1995); the latter is the postion adopted in this account. Towards the middle of Bed 43 (Howarth, 1955) is a finely laminated shale, taken to represent the Sulphur Band. The lowest 0.3 m of Bed 43 is a sandy mudstone (Howarth, 1955).

The lower unit of the Whitby Mudstone Formation, the Grey Shale Member, is 13.3 m thick and consists of silty, micaceous, pyritic, mudstone with bands of typically small calcareous concretions, which tend to be more sideritic and weather a red colour in the lower part of the sequence, passing into laminated shales above. Ripple-laminated siltstones are also present in the lower part of the sequence. Howarth (1973) recognized that the general sequence of beds within the member is remarkably constant, in terms of lithology and fauna, throughout the coastal sections from Ravenscar to Port Mulgrave. Consequently he presented only a single composite section for the unit, but identified the individual source localities of the cited faunas. The first definite records of Toarcian style ammonites, namely *Protogrammoceras paltum* and *Dactylioceras* sp., are from Bed 3 of the Grey Shale Member at Hawsker Bottoms (Howarth, 1973, 1992; = Bed 45 of Howarth, 1955) and mark the base of the Toarcian Stage in the Cleveland Basin. The type of *Tiltoniceras antiquum* was obtained from Bed 17 here or at Staithes. A single specimen of *Meneghiniceras lariense* recovered from Bed 31 represents the only known British occurrence of this exclusively Tethyan juraphyllitid genus and is also stratigraphically younger than any other juraphyllitid in Britain (Howarth, 1976; Howarth and Donovan, 1964).

The base of the overlying Mulgrave Shale Member is taken at a prominent bed, the Cannon Ball Doggers (Bed 33) (Powell, 1984). The Mulgrave Shale Member is remarkably consistent in thickness throughout its coastal exposure, with a figure of 32.3 m (105 ft) cited by Howarth (1962a). It is dominated by organic-rich laminated shales with several distinctive bands of often large calcareous nodules. The fauna is dominated by nektonic and planktonic taxa, particularly ammonites and belernnites. Rare remains of teuthids, recorded as *Geoteuthis* by Tate and Blake (1876), also probably are from the Mulgrave Shale Member here. Vertebrate remains have rarely been recorded from here. Benton and Taylor (1984) listed an example of the ichthyosaur *Leptopterygius acutirostris* from an unspecified horizon, although examples of this species from elsewhere have been recorded from the Mulgrave Shale and Alum Shale members.

## Interpretation

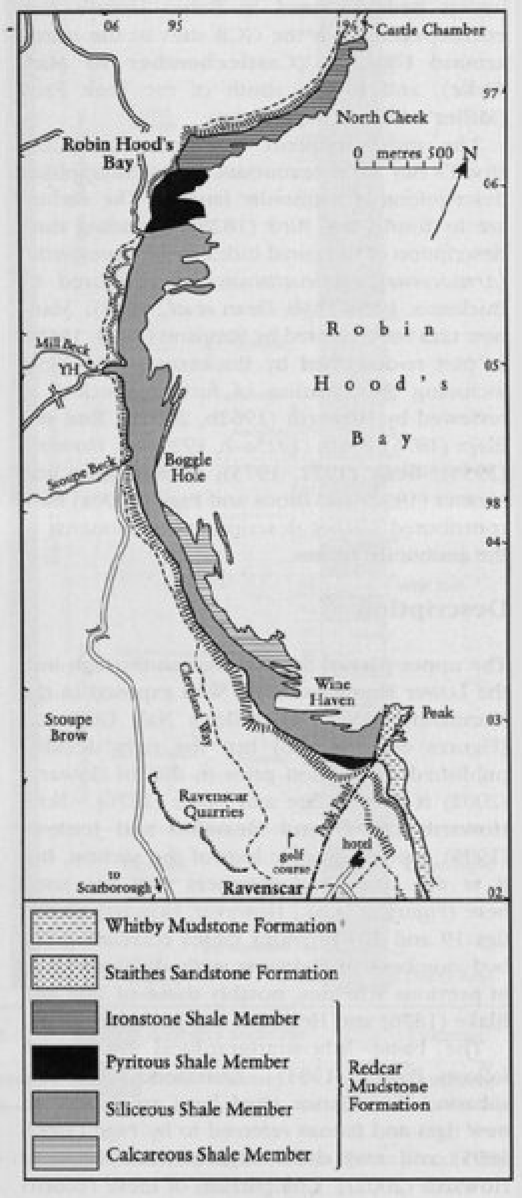
The ammonite faunas of the Upper Pliensbachian part of the succession were described by Howarth (1955, 1958). They include proposed stratotypes, or parastratotypes, for the bases of the Stokesi, Subnodosus, Gibbosus, Apyrenum and Hawskerense subzones and hence the Margaritatus and Spinatum zones themselves. The lectotype of the subzonal index fossil *Pleuroceras hawskerense* (Young and Bird, 1828) came from Hawsker Bottoms (Buckman, 1923). Meister (1988) discussed further the evolution of the Amaltheidae and figured a good selection of specimens from Hawsker. Howarth (1955) proposed that the base of the Hawskerense Subzone should be taken at the base of Bed 38 of the Cleveland Ironstone Formation at Hawsker. However, older faunas with *Pleuroceras elaboratum* were considered by Dommergues *et al.* (1997) to characterize an Elaboratum Zonule in the lower part of this subzone. Hence the base of the Hawskerense Subzone should be drawn lower according to this latter scheme, probably at the base of Bed 33 according to records by Meister (1988). Ammonites characteristic of the Solare Zonule are known from the Pecten Seam at Hawsker Bottoms, while the bed immediately below it near Staithes yields *Amaltheusgibbosus* (see Staithes to Port Mulgrave GCR site report), hence the base of the Apyrenum Sybzone can be drawn at the base of the Pecten Seam, Bed 25. However, information from France and elsewhere indicates that there are earlier *Pleuroceras* faunas, corresponding to the Transiens and Salebrosum zonules of the Apyrenum Subzone (Dommergues *et al.,* 1997), that are not present in Yorkshire. The absence of early *Pleuroceras* faunas in Yorkshire, including *P. transiens* which is known elsewhere in Britain on Raasay (Howarth, 1958), indicates a widespread non-sequence as already predicted on lithological and sedimentological grounds by Howard (1985).

The succession here can be correlated with equivalent sections elsewhere along the Yorkshire coast on the basis of marker beds and ammonite faunas. Although the Toarcian succession remains relatively constant in thickness and facies (Howarth 1962a, 1973), there are marked variations in the Upper Pliensbachian successions. At the Staithes to Port Mulgrave GCR site, the Staithes Sandstone and Cleveland Ironstone formations are coarser than at Hawsker Bottoms, and the ironstone bands, poorly developed at Hawsker, are significantly thicker (Figure 6.11). This north-westerly thickening continues across to the iron workings at Eston, where the ironstone beds in the Kettleness Member form a single bed several metres thick with thin shale partings (Young *et al.*, 1990a). Hesselbo and Jenkyns (1995) suggested that the finer-grained sediments at Hawsker were indicative of a more distal position within the basin. However, in apparent contradiction to this, the non-sequence at the base of the Kettleness Member (see (Figure 6.11)) is more marked at Hawsker than elsewhere, perhaps reflecting opposing directions of sediment progradation during the Penny Nab and Kettleness members. The thin laminated mudstone of the Sulphur Band has been attributed to eustatic sea-level rise. The influence of this becomes even more pervasive in the Mulgrave Shale and Alum Shale members which, except within the Peak Trough, show a remarkable uniformity of thickness and facies development along the entire coast.

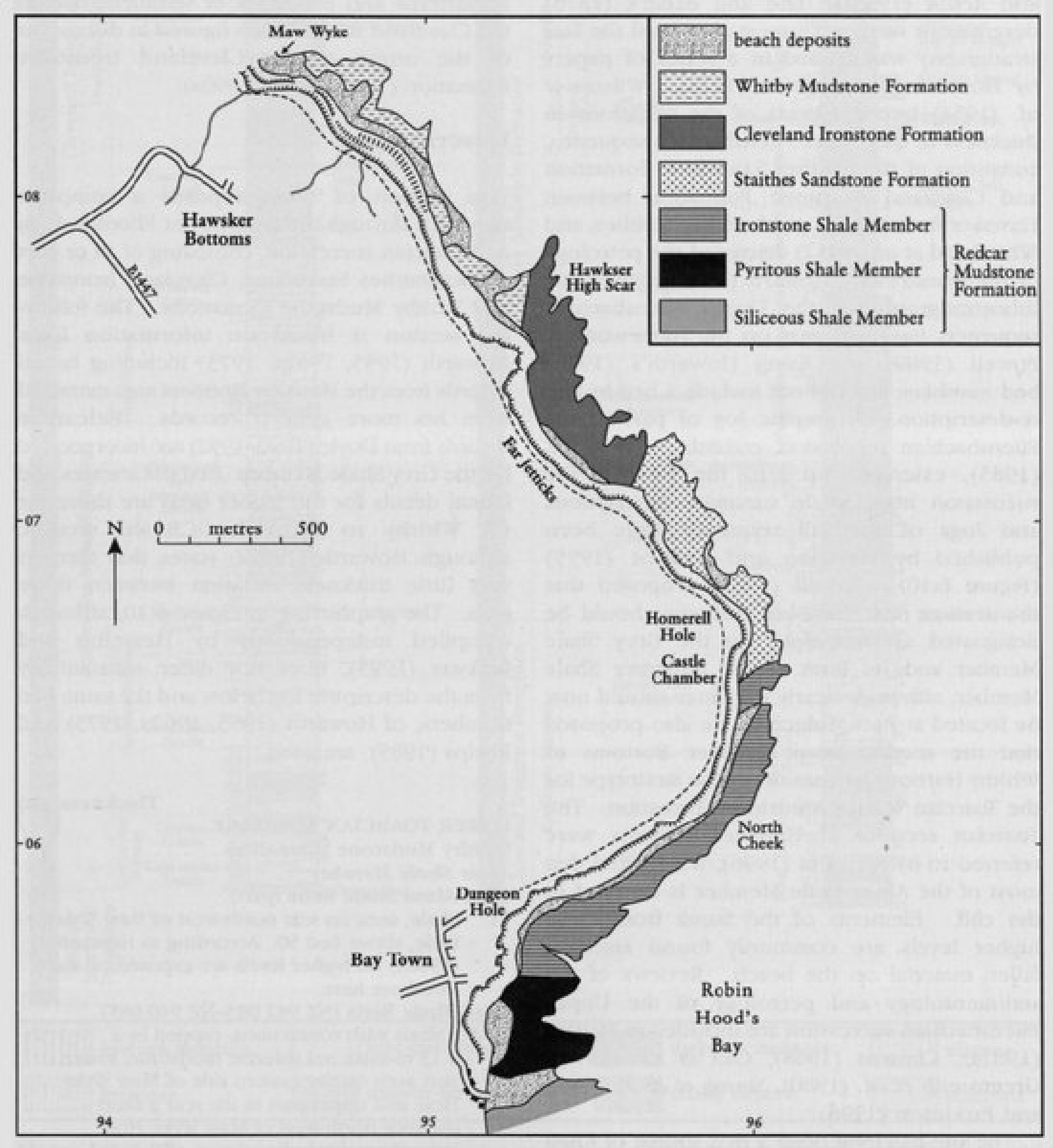
## Conclusions

The coastline between the Castle Chamber and Hawsker Bottoms area exposes a continuous section following on from that on the north side of Robin Hood's Bay (Normanby Stye Batts–Miller's Nab GCR site), extending from the base of the Upper Pliensbachian Substage, through the Pliensbachian–Toarcian boundary, and well into the mid Toarcian, encompassing the Staithes Sandstone Formation, the Cleveland Ironstone Formation and the Whitby Mudstone Formation. Fades developments in the Staithes Sandstone and Cleveland Ironstone formations here are fundamental to understanding the history of sedimentation in the Cleveland Basin. The Toarcian section here complements that nearer Whitby, where the lower part of the Toarcian succession is not exposed. The site is the location for the type populations of almost half of the known species of amaltheid ammonite and hence is of international importance for Upper Pliensbachian biostratigraphy.

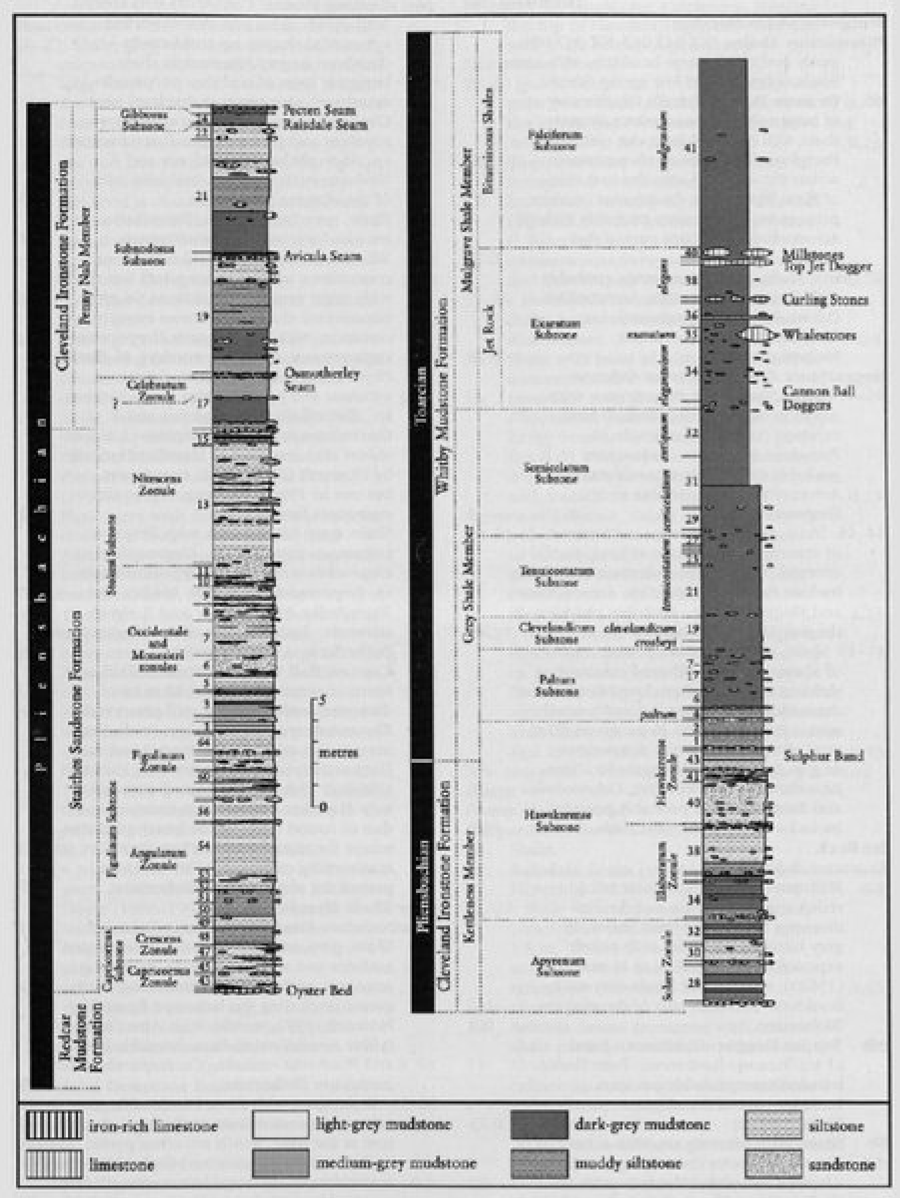
**References**



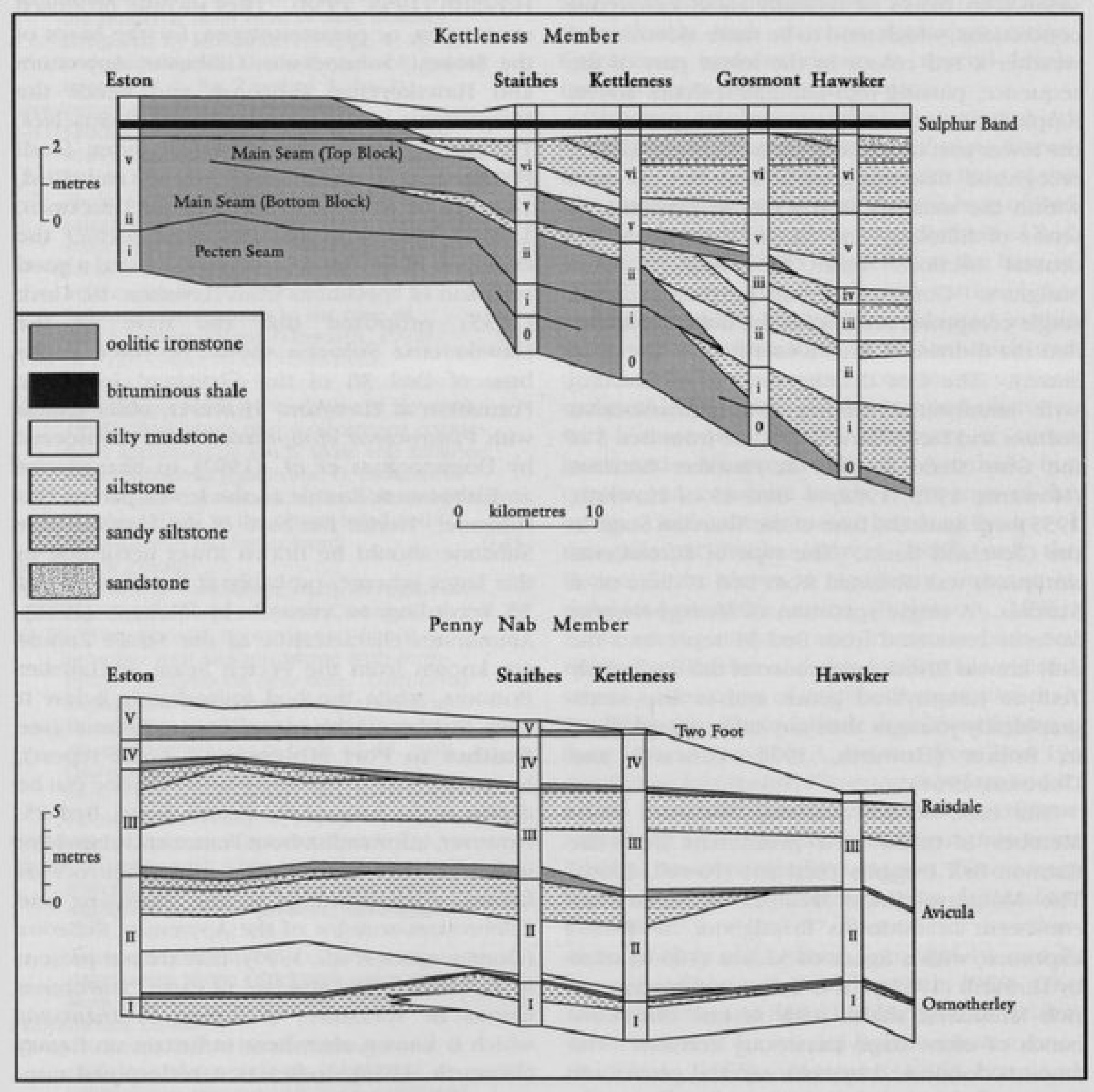

*(Figure 6.6) Outcrop map of Lower Jurassic strata on the foreshore around Robin Hood's Bay. After Rawson and Wright (1992).*




*(Figure 6.9) Outcrop map of the main lithostratigraphical units exposed on the foreshore between Robin Hood's Bay and Hawsker Bottoms. After Knox et al. (1990).*



*(Figure 6.10) The stratigraphy of the Pliensbachian and Toarcian succession between Castle Chamber and Hawsker Bottoms. After Hesselbo and Jenkyns (1995).*




(Figure 6.11) Lateral variation in the Cleveland Ironstone Formation along NW–SE transects between Eston and Hawsker. Datum for the Kettleness Member is the Sulphur Band; datum for the Penny Nab Member is the base of the Two Foot Seam. Roman numerals indicate the cycles of Howard (1985). After Young et al. (1990a).