Greetwell Quarry, Lincolnshire

[SK 998 727]–[TF 010 719]

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Introduction

Greetwell Quarry, on the eastern outskirts of the city of Lincoln, is one of the most historically significant exposures in the Lincolnshire Limestone Formation, and has yielded many of the limited number of ammonites known from the formation. The extensive quarry lies within an area of old ironstone workings dug for the Northampton Sand Formation. Iron ore extraction at this site has a long history; there were extensive workings in the last century (Ussher *et al.,* 1888) and there is even a suggestion of Roman workings here (Evans, 1952). Extraction took place by means of both underground mines and adits, and by open quarrying. The later operations removed the ore from beneath a considerable overburden of Lincolnshire limestone Formation, but most ironstone extraction ceased in 1938, essentially because of exhaustion; a fault immediately to the east of the site throws the ironstone down to a depth that precluded further economic working and, in any case, the ore thins and degenerates rapidly in this direction (Hollingworth and Taylor, 1951; Evans, 1952). Subsequent operations worked the Lincolnshire Limestone Formation, principally for aggregate; this is currently (1997) continuing on a large scale in the southern part of the site.

Description

The Greetwell Quarry GCR site is close to the Greetwell Road Quarry of Woodward (1894) and the Bowling Green Quarry [SK 995 727] recorded by Richardson (1940), and probably incorporates Grundy's and Greetwell opencast ironstone workings referred to by Hollingworth and Taylor (1951), and the Greetwell Hollow Quarry of Evans (1952). These quarries exposed beds from the top of the Lias Group into the lower part of the Lincolnshire Limestone Formation. A slightly extended section of the Lincolnshire Limestone Formation was recorded by Ashton (1980) (Figure 4.43). By the 1990s, the working face had been extended to expose higher levels of the Lincolnshire Limestone Formation than recorded by Ashton (1980); the highest beds now exposed may be up to 19 m above the base of the formation, but the lowest part of the succession has been largely obscured by tipping. The full Middle Jurassic succession that has been exposed at Greetwell Quarry is Lincolnshire Limestone Formation (*c.* 19 m) overlying Grantham Formation (0-c. 0.6 m) overlying Northampton Sand Formation (2.6–3.1 m).

The Northampton Sand Formation is somewhat variable in thickness. It was 2.9 m thick in the Bowling Green Quarry (Richardson, 1940), and Hollingworth and Taylor (1951) recorded 2.6 m at the entrance to Wilson's Mine [SK 998 724]. The formation is a finely sandy, ooidal ironstone with some more calcareous beds, as well as lenses of sand and silt. Where fresh, the rock is a dark bluish-green colour, with berthierine-rich ooids set in a siderite-berthierine 'mud' matrix. Where weathered, as is generally the case at or near outcrop, the rock is oxidized to a limonitic ironstone with a 'boxy' structure, with occasional cores of less altered material. This oxidation process tends to destroy much of the original structure of the rock, and sedimentary structures and fossils may be hard to discern.

The Grantham Formation is generally absent at Greetwell Quarry, with the Lincolnshire Limestone Formation resting unconformably on the Northampton Sand Formation. However, remnants of the formation remain locally; Evans (1952) recorded lenses of greenish and black laminated clay probably up to 0.3 m thick (Richardson, 1940), and Hollingworth and Taylor (1951) recorded 0.3 m of ferruginous sand succeeded by variegated clays with plant debris. In 1997, some 0.2 m of blue-black to brown sandy clay were seen resting on the topmost few centimetres of the Northampton Sand Formation at one point in the northern part of the site.

The lower part of the Lincolnshire Limestone Formation was recorded by Woodward (1894), Richardson (1940) and Ashton (1977, 1980). Ashton's (1980) Greetwell Member (his beds 1–5; (Figure 4.43)) is dominated by buff, peloidal and ooidal wackestones and packstones, and contains a fauna dominated by bivalves such as *Gervillella* and *Pinna,* with

nerineid gastropods common at some levels. Bed 1, i.e. Richardson's (1940) 'Base Bed' (included in the Blue Beds by most other workers) is a massive, creamy-buff to rust-brown-weathering, coarse-grained, peloidal, ooidal and shell-fragmental packstone to grainstone. It is somewhat conglomeratic at the base, with sporadic pebbles of ironstone (presumably reworked from the underlying Northampton Sand Formation) and phosphatic material. Bed 2 is the so-called 'Wragby Bed' of Ashton (1980). It is a blue-hearted, orange-yellow-weathering, massive, uniform sandy limestone, containing scattered large peloids, and often decalcifying to a loose sand at the base. It forms a valuable marker bed throughout central Lincolnshire.

The succeeding Leadenham Member of Ashton (1980) (beds 6–13) is composed mainly of white, thinly bedded carbonate mudstones (micrites) with marl and clay partings, and forms a distinctive marker that can be traced around the entire pit (Figure 4.44). The basal bed (Bed 14) of his overlying Lincoln Member is a distinctive blue-hearted, ooidal grainstone, which grades up into grey wackestones with *Gresslya* and *Plagiostoma* (beds 15 and 16). At the top of the member, Bed 17 is a grey, ooidal packstone with sporadic *Acanthothiris crossi* (Walker) and other fossils. Bed 18, the Kirton Shale ('Kirton Shale Member' of Ashton, 1980), comprises grey, brown-weathering, marly, shaly clay with some more calcareous bands. It contains poorly preserved bivalves, and forms a conspicuous marker bed in the quarry face. It is up to 2 m thick in the northern and eastern faces of Greetwell Quarry but is absent in the southernmost part, apparently having been cut out by downward channelling of the succeeding beds. A more localized disappearance in the eastern face of the quarry is due to the development of a small reef-knoll, about 75 m in diameter. Composed of white to pale-grey wackestones, locally packed with shells and corals, this reef is up to *c.* 5 m in thickness, and replaces the topmost *c.* 1 m of the Lincoln Member, as well as the Kirton Shale, into which it passes by interdigitation. The succeeding Metheringham Member of Ashton (1980) is draped over the top.

Some 6 m of overlying beds are exposed in the eastern face of the quarry; these are mainly ooidal and peloidal packstones and grainstones. A typical section in the eastern part of the quarry [TF 005 721], recorded by the present author in January 1997, showed the following:

	Thickness (m)
Upper Lincolnshire Limestone	
Limestone, buff, very well-sorted, medium-to coarse-grained, ooidal grainstone, weathering to flaggy rubble in subsoil; large-scale, low-angle cross-bedding; sharp, basal erosion surface	*c.* 3
Lower Lincolnshire Limestone	
Limestone, pale-grey to white, sparsely shell-fragmental and peloidal wackestone; cut out by overlying beds northwards	0–0.80
Limestone, fawn, poorly sorted, peloidal and ooidal packstone to grainstone; massive but with cryptic cross-bedding; sharp, ?erosional base	0.75
Limestone, fawn, poorly sorted, peloidal and ooidal packstone	0.55
Marl and marly limestone, fawn to brown, ferruginous	0.08
Limestone, pinkish-buff and brown, poorly sorted, coarse-grained, shell-fragmental and ooidal grainstone, becoming better-sorted upwards; massive, flat-bedded; sharp, flat or locally loaded basal boundary with Kirton Shale	1.50

Throughout most of Greetwell Quarry, the Metheringham Member rests on the Kirton Shale with little sign of erosion, but in the southernmost part it rests directly on the Lincoln Member, having (presumably) channelled through the Kirton Shale; unfortunately the critical part of the section, which would clarify relationships, is obscured. The succeeding cross-bedded, 'millet-seed' oolites are of typical Upper Lincolnshire Limestone type. These may belong to the Sleaford Member of Ashton (1980), although correlation at this level is uncertain.

Interpretation

The principal interest of Greetwell Quarry is in the sections of the Lincolnshire Limestone Formation. The basal part of the succession (beds 1–5), 4.88 m thick, constitutes the type section of Ashton's (1980) Greetwell Member, which corresponds with the Blue and Silver beds of previous accounts. This part of the Lincolnshire Limestone Formation is much thinner than the corresponding beds farther south (see, for example, Metheringham and Copper Hill GCR site reports, this volume); Ashton (1980) suggested that it may be condensed, and it is likely that the oldest part of the Lincolnshire Limestone Formation is missing beneath the basal non-sequence. The Wragby Bed (Bed 2) corresponds with the Blue Beds *sensu* Richardson (1940); these should not be confused with the Blue Beds of south Lincolnshire, which there equate with the Sproxton Member (see Sprox-ton Quarry GCR site report, this volume), thought to be absent at Greetwell Quarry. The succeeding beds 3–5 equate with the Silver Beds of authors that locally include good freestones much used in the construction of the city of Lincoln, although these are not developed at Greetwell Quarry, where the succession is composed entirely of buff wackestones with scattered peloids. These beds have yielded a number of ammonites over the years (see Kent, 1966); most probably came from the lower part of the unit (Bed 3, or the 'Lower Silver Bed' of Richardson, 1940). As reassessed by Ashton (1977), the taxa recorded are *Darellia polita* S.S. Buckman, *Hyperlioceras* aff. *rudidiscites S.S.* Buckman, *H. subsectum* (*S.S.* Buckman), *H.* cf. *subdiscoideum* S.S. Buckman and *Sonninia aff. marginata* S.S. Buckman, an assemblage that indicates the Lower Bajocian Discites Zone.

Beds 6 to 13 are assigned to the Leadenham Member (Ashton, 1977, 1980), which forms the basal part of the Kirton Cementstones of many previous accounts of the Lincoln district; the latter are essentially equivalent to the Kirton Cementstone Member of north Lincolnshire and Humberside (see Manton Stone Quarry and Cliff Farm Pit GCR site reports, this volume), although Evans (1952) appears to have used the term in a more restricted sense. A loose specimen of *?Darellia* cf. *coela* (previously recorded as *Hyperlioceras aff. discites* (Waagen)) probably came from this unit (Kent, 1966). The topmost *c.* 0.5 m of the member (beds 12 and 13) comprises brownish, argillaceous limestone and shale that characteristically contain scattered buff pisoids, commonly up to 8 mm or more in diameter; these are very similar to those from the Pea Grit of the Cotswolds (see Crickley Hill GCR site report, this volume). This distinctive pisoidal unit is restricted to the Lincoln area but, despite the name, these so-called 'Cathedral Beds' do not yield building stone. They were named by Ashton (1977, 1980) from their development in the Cathedral (or Dean) and Chapter Pit [SK 977 734].

Beds 14 to 17, totalling 1.85 m in thickness, constitute the type section of Ashton's (1977, 1980) Lincoln Member, which forms the upper part of the Kirton Cementstones of most previous accounts. The Lincoln Member (with the succeeding Kirton Shale, Metheringham Member and Blankney Member) was included in the Middle Lincolnshire Limestone by Ashton (1980), although in the bipartite scheme used in the present account, the last-named unit forms the upper part of the Lower Lincolnshire Limestone. The topmost bed (Bed 17) of the Lincoln Member is the so-called 'Lower Crossi Bed' of Kent (1966). Earlier, Evans (1952) appears to have included the whole of the Lincoln Member (together with the succeeding Kirton Shale) in his A. *crossi* Beds, which he took as the basal unit of the Upper Lincolnshire Limestone (see Metheringham GCR site report, this volume).

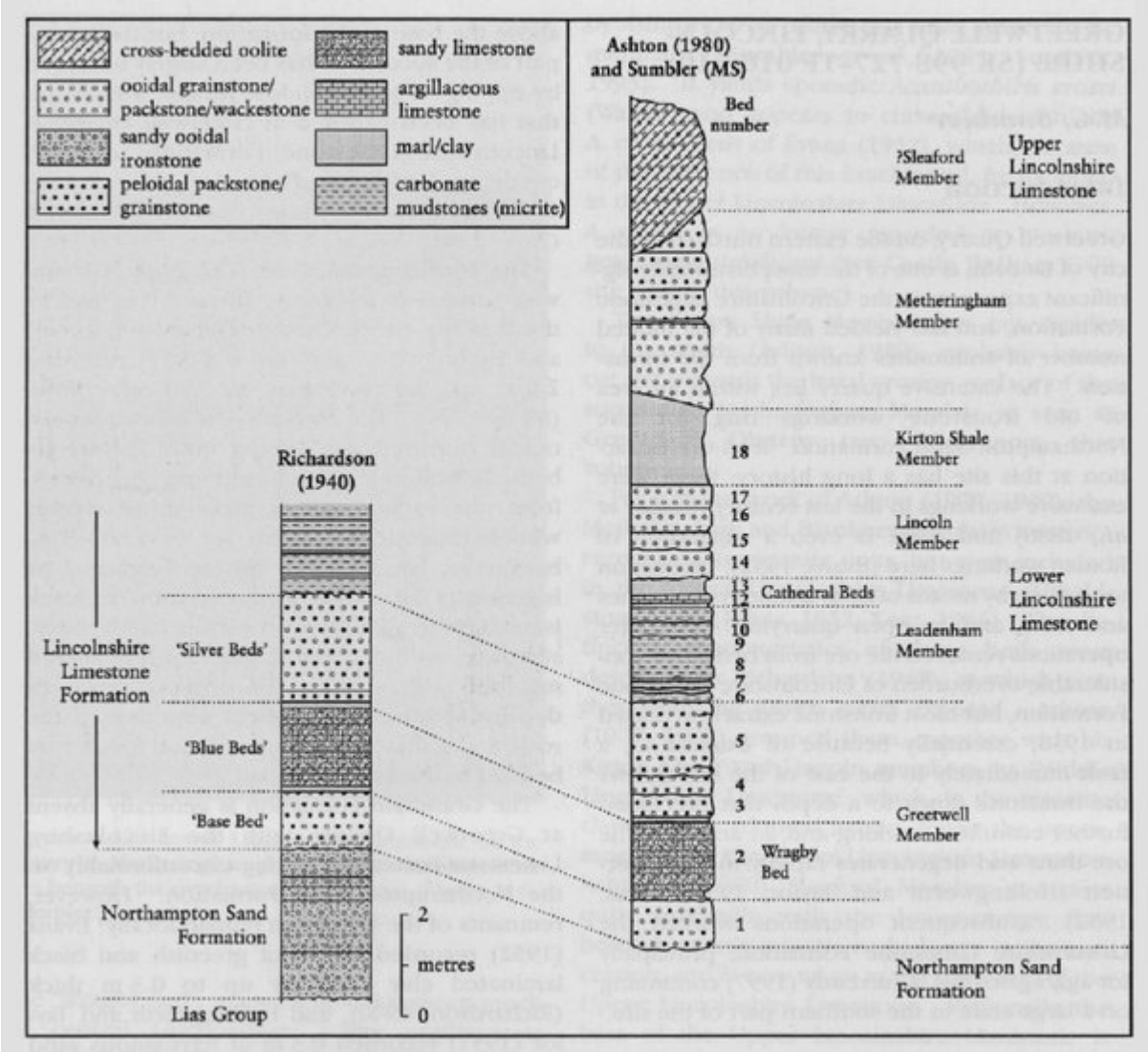
Bed 18, the Kirton Shale (or Kirton Shale Member of Ashton, 1980) is a valuable marker for correlation that can be traced throughout much of north and central Lincolnshire (see Metheringham, Manton Stone Quarry and Cliff Farm Pit GCR site reports, this volume). In north Lincolnshire, it forms the upper part of the Kirton Cementstone Member.

The oolites above the Kirton Shale have been included with the 'Hibaldstow Beds' by most workers. The lower *c.* 3 m are mainly flat-bedded, ooidal packstones to grainstones similar to those of the Metheringham Member at its type locality (see Metheringham GCR site report, this volume), now regarded as the uppermost part of the Lower Lincolnshire Limestone. To the north of Lincoln, recognition of the Metheringham Member becomes difficult and it may be most practical to include all of the strata above the Kirton Shale in the Upper Lincolnshire Limestone (Hibaldstow Member).

Conclusions

Greetwell Quarry formerly exposed the whole Middle Jurassic succession of central Lincolnshire from the Northampton Sand Formation up to the higher part of the Lower Lincolnshire Limestone. The section of the latter here is particularly important as it has yielded many of the relatively rare age-diagnostic Bajocian ammonites known from the formation. The extant sections here show the distinctive Kirton Shale (Kirton Shale Member of Ashton, 1980), a valuable marker for correlations in central and north Lincolnshire, and overlying beds in the topmost part of the Lower, and lowermost part of the Upper, Lincolnshire Limestone.

References



(Figure 4.43) Graphic sections of the Lincolnshire Limestone Formation and underlying beds at Greetwell Quarry. (Based mainly on Richardson, 1940, fig. 29; and Ashton, 1980, fig. 6; with the highest beds as recorded by M.G. Sumbler in 1997.))

(Figure 4.44) Lower Lincolnshire Limestone at Greetwell Quarry. The Wragby Bed in the Greetwell Member is the massive bed on the left of the photograph in the lower part of the face; the paler unit in the upper part of the face is the Leadenham Member and the Kirton Shale (Kirton Shale Member of Ashton, 1980) lies near the top. The fold structure is probably a result of collapse over an ironstone mine in the Northampton Sand Formation, the top of which is visible at bottom left. (Photo: M.G. Sumbler.))