Ketton Quarry, Rutland

[SK 970 060]

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Introduction

The extensive Ketton Quarry GCR site is a complex of quarries in the county of Rutland, 5 km to the west of Stamford, Lincolnshire. Workings here date back many centuries. Initially, the quarries exploited the 'Ketton Stone', fine freestones from the Upper Lincolnshire Limestone, which have been valued for their even texture, 'carveability' and durability since medieval times, and which can be found in buildings throughout the country (Purcell, 1967). More recent working of beds from the lowest part of the Lincolnshire Limestone Formation up to the Blisworth Clay Formation has been principally for cement. Thus, over the years, a major part of the Middle Jurassic succession has been exposed and for this reason the site is included in both the Aalenian–Bajocian and the Bathonian GCR blocks. The site adjoins a vast operational quarry run by Castle Cement Ltd where current sections [SK 980 070] expose the succession up to and including the Cornbrash and Kellaways formations.

The quarries at Ketton were mentioned as early as Ibbetson and Morris (1848), Judd (1875) and Woodward (1894), but the first detailed description is that by Richardson (1939a). Aslin (1965) recorded the 'Upper Estuarine Series', above the Lincolnshire Limestone Formation. This 'Series' was subsequently investigated by Bradshaw (1978) who renamed it the 'Rutland Formation'; the site is its type section. The succeeding Blisworth Limestone Formation was investigated by Cripps (1986). Useful summaries of the succession are given by Sylvester-Bradley *et al.* (1965), Sylvester-Bradley (1968), Ashton and Hudson (1979), and Bradshaw and Cripps (1983). Recently, a small area adjoining the southern part of the site [SK 978 053] has been preserved as the 'Ketton Geological Trail' which shows the succession from the upper part of the Lincolnshire Limestone Formation to the lower part of the Blisworth Clay Formation (Dawn, 1995).

Description

The following composite section is based on several sources. The section of the Lincolnshire Limestone Formation is based on Aslin (in Sylvester-Bradley, 1968), and Ashton (in Ashton and Hudson, 1979) with bed numbers following Ashton (Figure 4.30) and (Figure 4.31); that of the Rutland Formation is based on Aslin (in Sylvester-Bradley, 1968), Bradshaw (1978) and Bradshaw and Cripps (1983) with bed numbers following Aslin (in Sylvester-Bradley, 1968) (Figure 4.32) and (Figure 4.33). The section of the remaining beds is based on Aslin (in Sylvester-Bradley, 1968), with some additional data from Cripps (1986).

	Thickness (m)
Blisworth Clay Formation	
8: Clay passing up into subsoil	seen to 1.52
Blisworth Limestone Formation	
7: Layers of fibrous calcite (tea')	0.02–0.05
6: Limestone, thinly bedded to rubbly, packed with *Praeexogyra hebridica* (Forbes), also *Modiolus imbricatus* J. Sowerby, *Placunopsis socialis* and other fossils	0.71
5: Limestone, hard with *P. hebridica*	0.30–0.38
4: Clay, with *P. hebridica*	0.05–0.08
3: Limestone, hard, with *M. imbricatus, P. hebridica;* very irregular base	0.53
2: Limestone, rubbly, thinly interbedded with clay; common *P. hebridica* and other bivalves; sporadic *Kallirhynchia sharpi* Muir-Wood in lower *c.* 0.4m	1.52

1: Limestone, hard, massive, though decomposing to soft marl in basal *c.* 0.3 m; very fossiliferous with *Bactroptyxis, Natica, M. imbricatus, P. hebridica, Pholadomya, Pleuromya, Protocardia subtrigona* Morris and Lycett, *Epithyris oxonica* Arkell, *Clypeus muelleri* Wright	0.76
Rutland Formation	
9: *Nassington Rhythm:* Mudstone, green to orange-brown, sandy; sporadic rootlets in upper part; thin layers of shell fragments at base	0.90–1.22
8b: *Cranford Rhythm:* Mudstone, green, homogeneous, becoming carbonaceous with rootlets in upper part; interlayered with silt at base	0.30–0.60
8a: *Wellingborough Rhythm:* Mudstone, purple-brown and green, very dark and carbonaceous with rootlets at top, passing down into sandstone to sandy limestone, hard, blue-hearted, cross-bedded, interlayered with mudstone, locally very shelly in lower part	1.90
7: *Casterton Rhythm:* Mudstone, green and black with rootlets passing down into mudstone, dark-green with sandy, shelly layers	1.22
6: *Clipsham Rhythm:* Mudstone, purple-brown and green, black and carbonaceous at top; sandy and with rootlets in upper part; becoming less homogeneous with sandy and shelly seams in lower part	1.3–1.52
5: *Ketton Rhythm:* Mudstone; ironstone concretions and rootlets near top, passing down into mudstone, grey and green, interlayered with shelly sand and silt in lower half; very fossiliferous with fauna including *Lingula* near base	1.83–2.0
Stamford Member	
4: Mudstone, green to black, with rootlets, passing down into siltstone, white, interlaminated with mudstone	0.38–0.46
3: Mudstone, grey-mauve to brown, silty; black and carbonaceous at top; thin, carbonaceous seam at base	2.03–2.23
2: Siltstone, white to buff, with rootlets throughout; limonite nodules (and ?pebbles) in basal *c.* 0.4 m	1.37–1.95
Lincolnshire Limestone Formation	
Upper Lincolnshire Limestone	
13: Limestone, flaggy, cross-bedded, ooidal grain-stone, full of broken shells; *Camptonectes laminatus* (J. *Sowerby*), *Eopecten abjectus* (Phillips), *Gervillella, Catinula ampulla* (d'Archiac), *Oxytoma, Plicatula, P. seudolimea duplicata* (J. de C. Sowerby), *Microrhynchia barnackensis* Muir-Wood, terebratulids, echinoids	1.60
12: Limestone, massive, blue-hearted, pinkish, even-grained ooidal grainstone, cross-bedded in parts; notable hardground at top with annelids and *Lithophaga* borings, and encrusting oysters	3.20–3.60
Lower Lincolnshire Limestone	
11: Limestone, wackestone with large yellow-stained peloids becoming more dominant towards top; *Ctenostreon pectiniforme* (Schlotheim)	0.80–1.04
10: Limestone, packstone with large yellow peloids	0.25

9: Limestone, sparsely peloidal, bioturbated wackestone; sharp, ?channelled base up to 0.90	
8: Limestone, sparsely peloidal wackestone	up to 0.38
7: Limestone, calcilutite, fossiliferous	0.20
6: Limestone, peloidal wackestone to packstone, in two graded beds becoming more grain-rich upwards; fossiliferous, especially at sharp base; nerineid gastropods, *Camptonectes laminatus, Ceratomya bajociana* (d'Orbigny), *Ctenostreon pectiniforme, bellona* d'Orbigny, *Pholadomya lirata* (J. de C. Sowerby), *Plagiostoma semicircularis* (Goldfuss), *Propeamussium pumilum* (Lamarck), *Montlivaltia* and other corals	0.58
5: Limestone, peloidal and ooidal wackestone becoming more grain-rich upwards; fossils scarce	1.12
4: Limestone, peloidal wackestone, fossiliferous ('Second Nerinea Bed'); *Bactroptyxis cotteswoldiae* (Lycett), *Lucina*' *bellona, Protocardia;* notabry sharp base	0.66
3: Limestone, fine grained, slightly sandy with scattered peloids and ooids, thinly bedded with marly seams in lower part	*c.* 1.2
2: Limestone, sandy, fine grained, rubbly; a fossiliferous, ooidal packstone in middle part (Tirst Nerinea Bed'); abundant *Bactroptyxis cotteswoldiae, Gervillella* cf. *acuta* (J. Sowerby), *G. verviformis* Cox, *lucina*' *wrighti* Oppel 0.90	
1: Limestone, fine grained, sandy	0.40

Currently (1997), the succession up to the lower part of the Blisworth Limestone Formation is exposed within the site but much of the Rutland Formation is obscured owing to slumping. The whole succession up to and including the Cornbrash and Kellaways formations can be seen in the north-eastern part of the adjoining working quarry (*c.* [SK 983 070]). Richardson (1939a) reported that a further 3.3 m of Lincolnshire Limestone Formation was proved by a trial shaft in the quarry floor, which, using his measurements, makes the total thickness 17.2 m; this is comparable with the *c.* 16.6 m recorded herein. Beneath the Lincolnshire Limestone Formation, 1.7 m of Grantham Formation (Lower Estuarine Series) and 4.3 m of Northampton Sand Formation were proved.

Interpretation

Lincolnshire Limestone Formation

At the base of the Lincolnshire Limestone Formation, Richardson (1939a) recorded 3.3 m of so-called 'Collyweston Beds'. These strata are blue-hearted, fine-grained, sandy, micaceous, sparsely ooidal limestones with a 0.6 m-thick bed of muddy, iron-stained sandstone at the top. The latter probably corresponds with the fine-grained sandy limestone ('Blue Beds') forming the floor of the quarry as recorded by Aslin (in Sylvester-Bradley, 1968). These sandy strata probably equate with the 'Collyweston facies' of Collyweston (see GCR site report, this volume), which lies only 3 km to the south-east, although the characteristically fissile beds of the Colly-weston Slate seem not to be well developed at Ketton Quarry where the lithologies more resemble the Sproxton Member of Ashton (1980), albeit rather thicker than at the type locality some 22 km to the north-west (see Sproxton Quarry GCR site report, this volume).

Together with the 'Blue Beds', the succeeding *c.* 8 m of strata belong to the Lower Lincolnshire Limestone (beds 1–11). This part of the succession is dominated by peloidal wackestones and packstones, in which individual beds commonly show an upward grading to more grain-rich lithologies. Fossils, notably nerineid gastropods, are common at some levels, particularly in the upper part of Bed 2 and in Bed 4 (i.e. the First and Second Nerinea beds of Aslin, in Sylvester-Bradley, 1968). The succeeding beds of the Lower Lincolnshire Limestone are mainly wackestones, commonly with large,

yellowish peloids; the thinly bedded calcilutites of beds 7 and 8 are particularly fossiliferous. The Lower Lincolnshire Limestone of Ketton Quarry probably corresponds solely with the Greetwell Member of Ashton (1980) at more northerly localities such as Sproxton Quarry (see GCR site report, this volume). A number of apparently mildly erosive non-sequences in the succession, notably at the base of beds 4, 6 and 9 may delimit the four 'rhythms' recognized in the Greetwell Member elsewhere (Ashton, 1980).

The overlying beds 12 and 13, together *c.* 5.3 m thick, belong to the Upper Lincolnshire Limestone, which is dominated by cross-bedded ooidal grainstones. These strata yield the Ketton freestones for which the site is famous. The apparent absence of any representative of Ashton's (1980) Lincoln Member here indicates substantial downcutting by the Upper Lincolnshire Limestone, which is even more marked farther south, where Upper Lincolnshire Limestone locally cuts right through the Lower Lincolnshire Limestone, and into the underlying Grantham Formation as formerly seen at Cowthick Quarry, near Corby, Northamptonshire (Taylor, 1946, 1963). This latter site was originally included in the Aalenian–Bajocian GCR Block but its primary interest has now been excavated away. However, the site, now a RIGS, exposes Lincolnshire Limestone Formation faulted against Rutland Formation, and is often visited by educational parties.

At the base of the Upper Lincolnshire Limestone at Ketton Quarry, well-sorted, even-grained oolites pass upwards into more poorly sorted, shelly limestones, which are capped by a bored and oyster-encrusted hardground, at the top of Bed 12. This is succeeded by brown-weathered, shell-fragmental oolites of Bed 13, with some cross-bedding foresets picked out by strings of mudstone clasts. The two units of the Upper Lincolnshire Limestone correspond with the 'Ketton Beds' and succeeding 'Weldon Beds' of Aslin (in Sylvester-Bradley, 1968). Aslin included the former unit in his Lower Lincolnshire Limestone, because it is capped by a hardground, the most striking stratigraphical break in the Lincolnshire Limestone Formation succession here, although the beds themselves are of markedly different facies to the predominantly micritic rocks below. The two units may conceivably correspond with the Sleaford and Clipsham members of Ashton (1980) that have been recognized farther north, although in the absence of biostratigraphical control or unique marker beds, such correlation is speculative.

The top of the Lincolnshire Limestone Formation is somewhat uneven and altered, with the development of limonite and gypsum, the latter occurring as veins of selenite. This 'Ironstone Junction Band' is probably a result of subaerial weathering prior to deposition of the succeeding Rutland Formation, accentuated by recent weathering at outcrop (see Clipsham Quarry GCR site report, this volume).

Rutland Formation

Ketton Quarry is the type locality of the Rutland Formation (Bradshaw, 1978) which is there about 11.7–12.5 m thick. It rests with marked disconformity on the Lower Bajocian Lincolnshire Limestone Formation; the junction between the two represents a gap of several million years, as the Rutland Formation is inferred to be of early to mid Bathonian age. The Rutland Formation is made up entirely of mudstones, siltstones and sandstones, laid down in deltaic and lacustrine environments on the margins of an extensive land area (the Anglo-Brabant Landmass of authors); hence its former name of 'Upper Estuarine Series'. Within this succession, a number of sedimentary rhythms have been recognized (Aslin, 1965; Bradshaw, 1978) which enable correlation within the formation right across the East Midlands.

The lower part, *c.* 3.8–4.6 m thick, is known as the 'Stamford Member' (Bradshaw, 1978). It is entirely non-marine, and is thought to represent the infilling of a shallow, but extensive, freshwater lake. Clean siltstones at the base, representing the first influx of fluvial sediments, pass upwards into carbonaceous clays with plant remains; these accumulated as shallowing proceeded, and the open lacustrine environment gradually transformed into a swamp. Above the Stamford Member, some six separate sedimentary rhythms have been recognized, and are named in the section above (following Bradshaw, 1978). All are essentially similar; they typically comprise a basal sandy unit, often of interbedded sands and muds with a marine to brackish-water shelly fauna, which passes upwards into more homogeneous, sparsely fossiliferous muds, and thence into plant-rich, carbonaceous muds with rootlets. The topmost rootlet bed is truncated by the sharp base of the next rhythm, and the erosional nature of these contacts accounts for the variability in thickness of the individual rhythms from place to place in the quarry. Such rhythms characterize delta margin situations such as the modern Mississippi (Bradshaw, 1978), in which initially rapid deposition by delta distributary channels may cease abruptly when the distributary pattern changes, to be followed by gradual accumulation of argillaceous sediments and colonization

by plants. Gradual subsidence (or rising sea level), and the local re-establishment of distributaries marks the onset of the next rhythm. The fauna seen within these 'deltaic' beds of the Rutland Formation, is dominated by bivalves tolerant of reduced salinity, such as *Eomiodon angulatus* Morris and Lycett, '*Gervillella ovata*'J. de C. Sowerby, *Placunopsis socialis* Lycett, *Praeexogyra hebridica* (Forbes), and '*Tancredia*' *gibbosa* Lycett; these often occur in almost mono-specific shell beds. Brachiopods occur rarely, although *Lingula,* noted for its salinity tolerance, is fairly abundant in the basal part of the Ketton Rhythm, named from this site. A much more extensive and varied fauna occurs within the lower part of the Wellingborough Rhythm, which is one of the most 'marine' parts of the succession. A development of calcareous sandstone–sandy limestone within the rhythm is better developed farther south (see Finedon Gullet and Irchester Old Lodge Pit GCR site reports, this volume) where it is distinguished as the Wellingborough Member.

Blisworth Limestone Formation

The Blisworth Limestone Formation (the Great Oolite Limestone of Richardson, 1939a), some 3.9–4.2 m thick, represents the deposits of a marine transgression that overwhelmed the deltas of the Rutland Formation. The lower *c.* 1.2 m of the succession (Bed 1 and the lower part of Bed 2) are mainly massive, cream-coloured, peloidal wackestones, often intensely bioturbated. These beds probably represent the Sharpi Beds that are better developed farther south (e.g. Cranford St John, see GCR site report, this volume; Cripps, 1986), although Torrens (1967) considered that this unit was absent at Ketton Quarry. Overlying beds, no longer well exposed at Ketton Quarry, are mainly argillaceous wackestone and packstones with common clay seams and with a fauna that is markedly dominated by oysters (*P. hebridica*), which form lumachelles at some levels. These beds, termed the Longthorpe Member by Cripps (1986), are typical of the Blisworth Limestone Formation in the northern part of the East Midlands region.

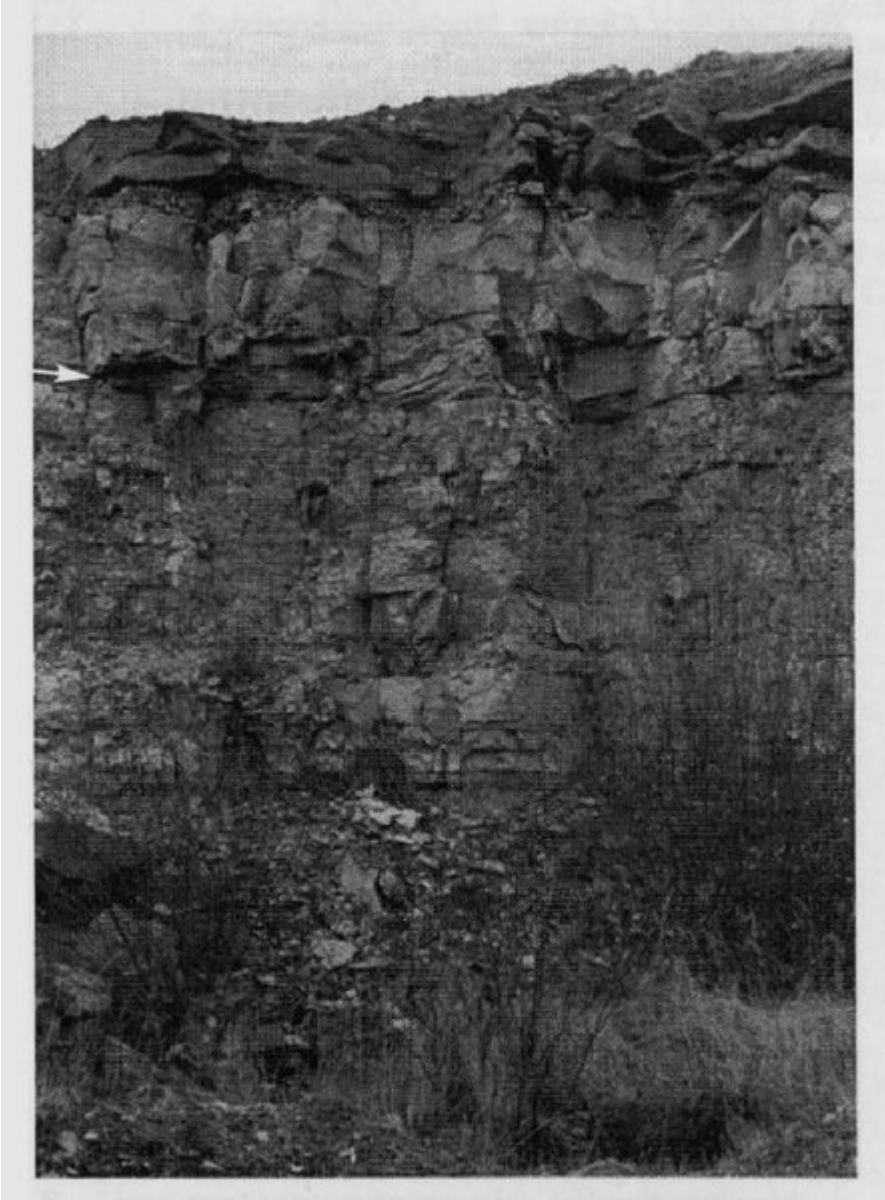
Blisworth Clay Formation

The Blisworth Limestone Formation is succeeded by clays, which are no longer exposed within the GCR site but which are now (1998) exposed very well in the adjoining working part of the quarry complex (Castle Cement Quarry). They are also better seen at localities such as Thrapston and Roade Railway Cutting (see GCR site reports, this volume).

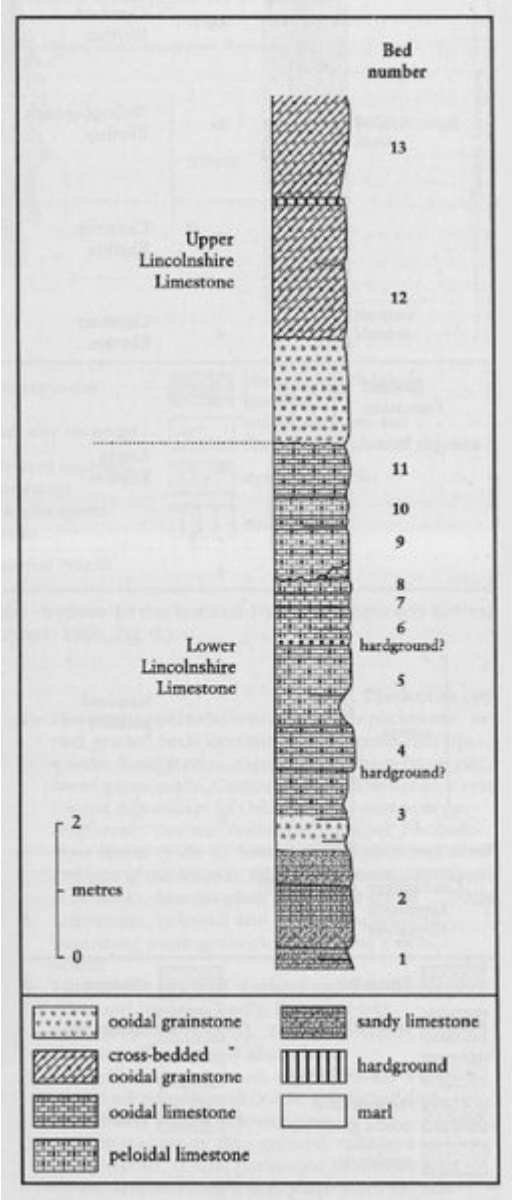
Conclusions

Ketton Quarry has, over the years, exposed a major part of the Middle Jurassic succession, and currently offers good exposures of much of the Lincolnshire Limestone, Rutland and Blisworth Limestone formations. The extent and stratigraphical range of the exposures make the site one of the most important for understanding the stratigraphy and sedimentology of the Bajocian and Bathonian succession in the East Midlands.

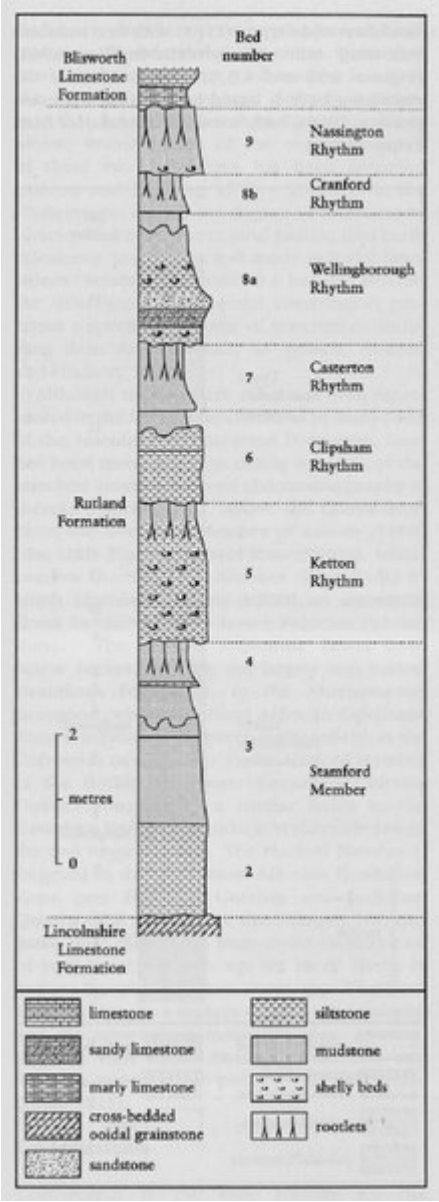
References



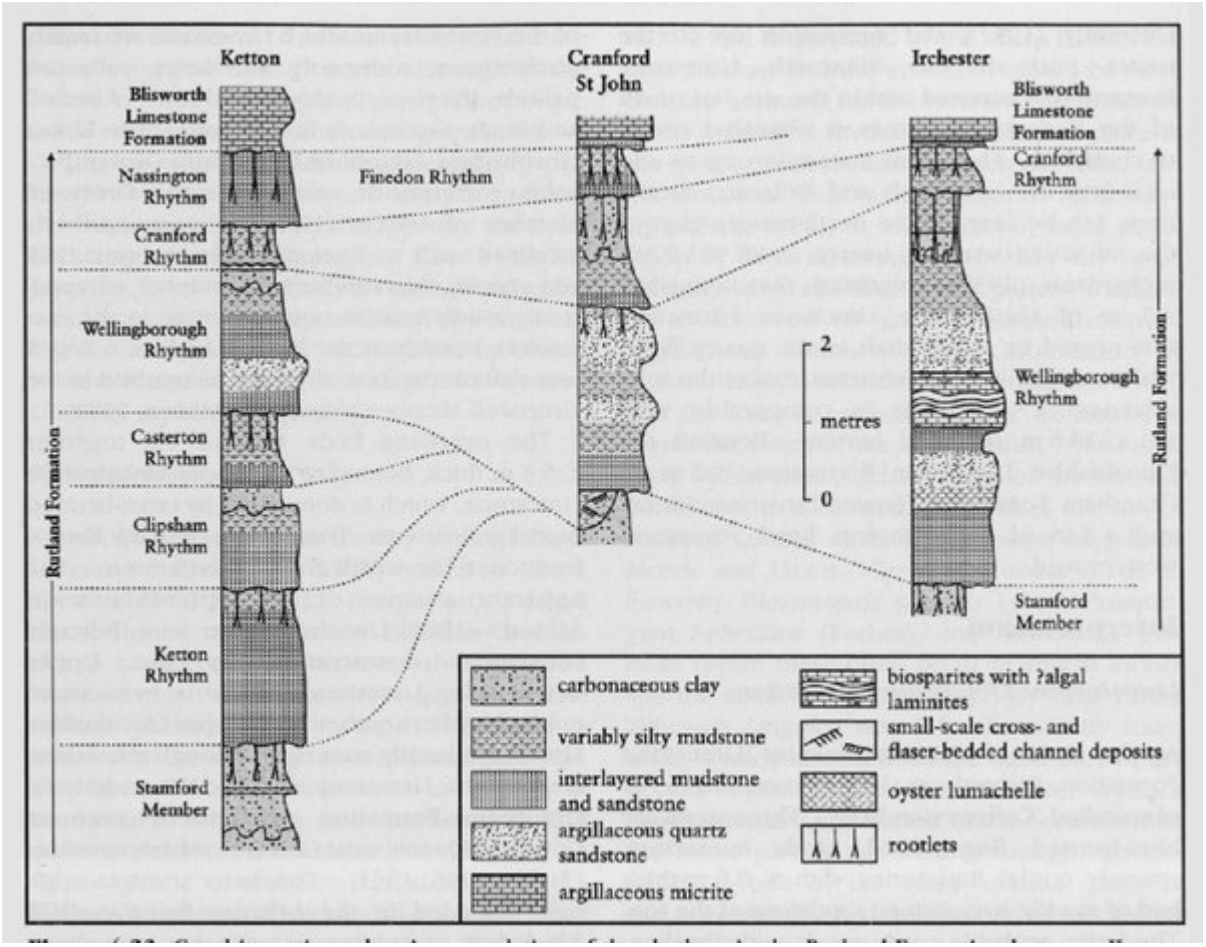
(Figure 4.30) Lincolnshire Limestone Formation at Ketton Quarry. The boundary between the Lower and Upper Lincolnshire Limestone is marked by a white arrow. (Photo: M.G. Sumbler.))



(Figure 4.31) Graphic section of the Lincolnshire Limestone Formation at Ketton Quarry. (After Ashton in Ashton and Hudson, 1979.))



(Figure 4.32) Graphic section of the Rutland Formation at Ketton Quarry (After Bradshaw and Cripps, 1983, fig. 5.))



(Figure 4.33) Graphic sections showing correlation of the rhythms in the Rutland Formation between Ketton, Cranford St John and Irchester. (After Bradshaw and Cripps, 1983, fig. 9.))