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A FACIES ANALYSIS OF THE UPPER GREAT OOLITE GROUP IN CENTRAL AND EASTERN ENGLAND

VOLUME II

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Doctor of Philosophy

THE UNIVERSITY OF ASTON IN BIRMINGHAM

October 1986

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APPENDIX 1

LOCALITY DETAILS

1.1 Introduction

To aid the flow of the main text, regional stratigraphic data were left out; this database is, however, reviewed here, in Appendix 1. Localities, both extant and non-extant, are discussed on a county by county basis. Relevant shallow and deep boreholes are also discussed in this appendix.

1.2 Outcrop

1.2.1 Gloucestershire

1. Foss Cross Quarry (SP05550922)

This section was first described by Martin (1958) and later, in more detail, by Torrens (1969c); the adjacent Aldgrove Railway Cutting had previously been described by Harker (1890) and L. Richardson (1911b). Beds 3-11 of Torrens (op. cit.) belong within the Ardley Member; the underlying beds (the Lucina Beds of Richardson) belong within the Shipton Member. The sharp lithostratigraphic junction which separates the two members is seen in Plate 3A.

Lithofacies association B is well developed within the Ardley Member here, as it is further east in the Cherwell Valley and at Wood Eaton. The associated fauna, as elsewhere, includes Digonella digonoides (which accounts for L. Richardson's (1911b) use of the name 'Ornithella Beds' in this area), although in subordinate numbers to Epithyris. Solenopora from the Ardley Member of Foss Cross has been the subject of recent papers by Harland & Torrens (1982) and V. Wright (1985). Specimens of Morrisiceras have been obtained from the top of the Shipton Member at this locality.

2. Wiggold and Stow-Road Railway Cuttings (SP048071 & SP045058)

Both cuttings, described by Harker (1890) and L. Richardson (1911b), are extant, although Wiggold Cutting is very overgrown. At Stow-Road, the uppermost bed of the White Limestone, the 'Gervillia Bed' (probably correlatable with the 'A. bladonensis Bed' often developed at the top of the White Limestone around Burford, and with the Coppice Limestone developed to the south and southwest), and the overlying Forest Marble are still exposed. In April, 1983, the Forest Marble adjacent to the cutting was being worked for roofing tiles by the Circencester Tile Company.

In Wiggold Cutting, approximately 3m of coarse oolitic limestones overlie the 'Gervillia Bed'; reworked pebbles derived from the hardground capping the White Limestone occur locally at the base of this oolite. This unit can be correlated with the thin, lenticular ?Great Oolite mapped by the Survey north of Starveall and Tetbury in the Malmesbury district (Cave, 1977). Northwards within the Wiggold Cutting the ?Great Oolite was seen to attenuate rapidly, with the Forest Marble eventually overstepping onto the White Limestone. Further north still, in Stow-Road Cutting, the 2.13m of limestone and argillaceous limestone which comprise the Bladon Member are locally completely channelled through; the Forest Marble then rests directly on the hardground at the top of the Ardley Member (L. Richardson, 1911b, Plate 15).

1.2.2 Oxfordshire

3. Stonelands Quarry (SP278098)

The following section is adapted from descriptions given by T. Palmer (1974) and Sumbler (in prep.), with additions from notes made in the quarry in September, 1980:

FOREST MARBLE (2.05m+)	Rubbly weathering, heavily bioturbated biopelmicrite	0.20m
	Cross-bedded biopelsparite, locally oolitic, alternating with thin clay bands; abundant oyster debris	1.60m
	Grey-brown, finely interlayered clay and silt; lignite fragments; abundant shell debris at base	0.25m
WHITE LIMESTONE (4.54m+)	Bladon Member (0.59m)	
	Brown weathering, argillaceous, shelly, oolitic limestone with an abundant infauna. Capped by a smooth, oyster-encrusted, Trypanites-bored hardground	0.55m
	Green-grey clay	0.04m
	Ardley Member (3.95m+)	
	Cross-bedded, white to buff, oolitic and shelly limestones. Cross beds dip mainly towards the SSE. Unbroken pectinids and Purpuroidea	2.50m
	Grey-white, bioturbated pelmicrite; bivalves and lignite	0.75m
	Biooosparite, with abundant nerineid gastropods near the top; ?A. cf. langrunensis. The top surface is a hardground, encrusted by 'Liostrea' wiltonensis. Very sandy towards the base, with lignite fragments and bivalves.	0.70m+

In 1975, the quarry manager reported the presence of a 'black clay' beneath the floor of the quarry (Sumbler, in prep.): this was probably developed at the junction of the Ardley and Shipton Members. The junction between the Ardley and Bladon Members is not well developed in this quarry.

4. Whitehill Quarry, Sturt Farm (SP271109)

The section in the old northern quarry, closest to the road, was measured in May, 1984 and is illustrated in Enclosure A-1. Sections from both this and the more recently worked southern quarry (SP269107) have been given by Worssam & Bisson (1961), T. Palmer (1974), Barker (1976) and Sumbler (in prep.).

The section in the southern quarry is slightly different, for in the northern quarry the cross-bedded oolitic limestones have cut down through about 0.7m of basal Ardley Member sediments. Sumbler (in prep.) recorded the following succession, above the 'A. excavata Bed', in the southern quarry:

WHITE LIMESTONE	Ardley Member (2.97m+)	
	White to buff, cross-bedded oosparite	2.30m
	Grey-brown, shelly, oolitic limestone, capped by a planar, bored hardground	0.55m
	Brown, sandy limestone. Abundant lignite and bivalves	0.12m
	Shipton Member (2.77m+)	
	Green-grey to brown clay, sandy at top, 'marly' at base. Lignite fragments and oysters	0.60m
	'A. excavata Bed'	

The hardground developed 0.67m above the base of the Ardley Member is correlatable with the lower hardground in Stonelands Quarry.

5. Eton College Quarry (SP298102)

The section in this quarry is illustrated in Enclosure A-1; it has previously been described by Arkell (1931), Richardson et al. (1946), Worssam & Bisson (1961), T. Palmer (1974), Barker (1976) and Sumbler (in prep.).

The A. cf. langrunensis horizon is well developed in this quarry (Barker, 1976), although the species was identified as 'bladonensis' by Arkell (1931) and 'ardleyensis' by Worssam & Bisson (1961). A laminated, pelletal limestone, belonging to Lithofacies association C, is developed immediately above this horizon and is suggestive of an intra-Ardley Member shallowing event. Sumbler (in prep.) believed that this laminite was capped by a bored hardground, but I can neither confirm the presence of this 'hardground' nor the 'hardgrounds' which Sumbler recorded 0.63m and 3.76m higher in the section. However, a hardground is present at the top of the Ardley Member: it is sharp, burrowed, and is encrusted by a black, ferruginous coating.

The horizon within the Shipton Member which, in 1924, probably yielded a specimen of Tulites glabretus (Arkell, 1931; Torrens, 1980b) is no longer exposed. The horizon could either have been in the upper part of Rhythm A or in the lower part of Rhythm B.

6. Asthall (Worsham) Quarry (SP300118)

The section in this large, extant quarry has not been remeasured, but it has been previously described by Worssam & Bisson (1961), T. Palmer (1974) and Sumbler (in prep.). The Forest Marble directly overlies the harground-capped White Limestone. The Bladon Member

(=Rhythm D) is about 0.6m thick, the Ardley Member is about 6.4m thick and the Shipton Member is over 3.7m thick. The section appears to be similar to that seen in Eton College Quarry.

7. Minster Lovell War Memorial Quarry (SP318109)

Enclosure A-2 illustrates the section seen in this quarry in November, 1982. The section has been described previously by Arkell (1931), Richardson et al. (1946), T. Palmer (1974) and Barker (1976). Palmer's section is a modified version of Arkell's description whereas Barker remeasured the section.

It is not easy to place the junction between the Ardley and Bladon Members at Minster Lovell. It is tentatively placed at the base of Barker's and Arkell's 'Bed 4', with the Bladon Member thus consisting of a single, 0.75m thick, fining-upwards unit. The underlying cross-bedded, oolitic limestones (Barker, op. cit.) are placed within the Ardley Member.

A 0.15m thick unit of bioturbated oobiopackstone, containing plant debris, oysters, coral and Epithyris, is here assigned to the ?Great Oolite; it probably passes northwards into the upper part of the Bladon Member.

A very similar section was described from the now infilled Walker's Quarry (SP283101) by Richardson et al. (1946). The ?Great Oolite was there 0.48m thick and capped by an irregular, bored hardground. The top of the underlying 'A. bladonensis Bed' (at the top of the White Limestone) may also have been a hardground (Sumbler, in prep.).

8. Crawley Road Quarry, Witney (SP354108)

This site has been incorporated in a housing development and very little exposure now remains. The locality was described by Arkell (1931, 1947) and Richardson et al. (1946), and briefly discussed by McKerrow (1955). The 'Bradford Fossil Bed' was developed here, about 5.9m above the base of the Forest Marble (Arkell, 1931), and contained Cladophyllia, Cidaris, small rhynchonellids and Digonella digona. The same horizon was formerly exposed south of Witney, at Ducklington Lane Quarry (SP349092; Arkell, op. cit.), about 3m below the base of the Lower Cornbrash (implying that the Forest Marble in this district is about 9m thick).

9. Fisher's Gate Quarry, North Leigh (SP390141)

Fisher's Gate has been the site of considerable quarrying within the White Limestone. The site most frequently mentioned in the literature was at SP390141 (Pringle, 1926; Arkell, 1931; T. Palmer, 1974; Barker, 1976). Richardson et al. (1946) also gave a section from this quarry, calling it 'Breakspear's Quarry, Fisher's Gate, North Leigh'; this should not be confused with 'Breakspear's Quarry, East End' of Arkell (1947), the 'New East End Quarry' of Richardson et al. (1946). Richardson et al. (op. cit.) also mentioned a quarry west of the brook at Fisher's Gate, worked by J. Werrell and Sons; this was at c.SP388141 and was probably later worked westwards to c.SP385144. By May, 1984 the quarries on both sides of the stream had been completely infilled with refuse.

Barker's (1976) and T. Palmer's (1974) sections are similar; their descriptions can be combined, briefly summarised and interpreted as follows:

FOREST MARBLE	Flaggy, shelly limestone	c.1.11m
	erosive base/top of Rhythm E	
?GREAT OOLITE	'Marl' and 'marly' limestone with *P. hebridica*, *P. socialis* and *B. waltoni*	c.2.40m
	erosive base/top of Rhythm D	
WHITE LIMESTONE (9.75-12.0+ m)	*Bladon Member* (0.70-2.95m)	
	Unfossiliferous micrite with birdseyes and cryptalgal laminae. Nerineid gastropods at base	0.45m
	Clay parting	0.05m
	Massive, fining-upwards limestone	1.60m
	'Marl' with *A. bladonensis*	0.10m
	Micrite with *A. bladonensis*, *E. angulatus*, *A. loweana* and *B. waltoni*	0.25m
	Well-sorted, coarse, oolitic limestone; *A. bladonensis* at base	0.35m
	Lignitic clay	0.10-0.15m
	top of Rhythm C	
	Ardley Member (5.65m)	
	Well-sorted, coarse, oolitic limestone; *A. ardleyensis* in shelly basal deposit	0.85m

Micrite with A. ardleyensis	0.15m
Cross-bedded and bioturbated, oolitic, intraclastic and bioclastic grainstones with occasional thin clay partings; transported B. implicata; E. arduennensis and A. cf. langrunensis in sandy limestone c.0.9m above base	4.65m
Shipton Member (3.40m+)	
Laminated, muddy sand with P. hebridica	0.30m

----------top of Rhythm B----------

Burrowed limestone	0.25m
Biograinstone	0.20m
Burrowed 'marl' and 'marly' limestone	0.15m
Oolitic and shelly limestones with indet. gastropods and bivalves; R. varicosa at top	1.90m
Oobiowackestone/packstone with 'Isastraea' and associated coral bed fauna	0.60+ m

In some parts of the quarry, the uppermost 2.25m of the Bladon Member has been removed by pre-Great Oolite erosion. Sumbler (1984) here included only the uppermost beds of the Bladon Member within his own 'Bladon Member'; the lower beds he wrongly assigned to the Ardley Member. The ?Great Oolite was included in the Forest Marble by Sumbler; in fact, these micritic and argillaceous limestones correlate with similar beds found to the south and southwest which Sumbler there placed within his 'Bladon Member'.

10. Breakspear's Quarry, East End (SP390153)

The section in this small quarry (opened 1934), first described by Richardson et al. (1946) and subsequently by Arkell (1947) and T. Palmer (1974), was still extant in 1982. The most notable feature of the section is a 0.6m thick bed of oobiowackestone containing bored Convexastraea waltoni, small rhynchonellids, Plagiostoma and cidarid spines. This is the 'Bradford Fossil Bed' of Arkell (1947), although it lacks the most diagnostic elements of the 'Bradfordian' fauna (Digonella, Eudesia, Dictyothyris). The whole of the Forest Marble Formation in this area is about 4.7-5.1m thick (T. Palmer, 1974).

The section can be follwed beneath the base of the Forest Marble in the adjacent, Whitehill Wood Quarry (SP388153), where a pre-Forest Marble 'Rhythm' channel, 0.45m deep and with an apparent width of 12m,

cut into the uppermost bed of the White Limestone. The channel was passively infilled by black, carbonaceous, terrigenous mudstone (Palmer, op. cit.). The uppermost bed of limestone here could belong to either Rhythm D or Rhythm E. I have not personally examined the Whitehill Wood section, which was described initially by Woodward (1894).

11. Layshill Wood Quarry (SP418147)

The most complete descriptions of this section have been given by Richardson et al. (1946) and T. Palmer (1974). About 1.75m of Forest Marble, comprising interbedded clay and characteristic cross-bedded oobiograinstones is present at the top of the section, overlying the burrowed top of the White Limestone (T. Palmer, op. cit.). The Bladon Member appears to be 3m thick here and may comprise both Rhythm D (1.3m?) and Rhythm E (1.7m?). The section appears to extend down into the upper part of Rhythm A, for Palmer's bed 19, a "greenish grey clay, black at the top, with abundant lignite, 30cm", may be the uppermost bed of that rhythm. If so, Rhythm B would here be about 3.5m thick (cf. 4.5m at Shipton). Rhythm C at Layshill Wood comprises predominantly biopelpackstones and wackestones (Lithofacies 5) developed above bioturbated bio- and intra- oograinstones and packstones (Lithofacies 2 and 3), and is about 5.8m thick (beds 5-11 of Palmer).

12. Long Hanborough Station Quarry (SP436142)

Although still extant, this is another section I have yet to examine. It has been described by Woodward (1894), Pocock (1908), Odling (1913), Pringle (1926), Arkell (1931, 1947), Richardson et al. (1946) and T. Palmer (1974).

The Forest Marble is here about 5.25m thick. Typical Forest Marble cross-bedded oobiograinstones dominate the formation in the quarry, but in the nearby railway cutting (SP426146), they are replaced by terrigenous mudstones (Arkell, 1931). Comparison with sections at Shipton suggests that the edge of a lime sand bar occurs within the cutting.

The top of the White Limestone is capped by an oyster-encrusted hardground with Trypanites. In the southwest face of the quarry, the uppermost bed of limestone is cut by a small channel containing lignite-rich black clay (T. Palmer, 1974).

13. Bladon

A number of quarries which exist, or formerly existed, at Bladon were described by Arkell (1931, 1933b, 1947). These include the Old White House Quarry (SP448150), designated as the type section of the Bladon Member by T. Palmer (1974, 1979). The Bladon Member appears to be about 2m thick in the Bladon area and probably comprises only Rhythm D sediments. A channel, infilled by a green and brown clay containing Cetiosaurus bones, appears to have been cut into the uppermost bed of the Bladon Member at Tolley's New Quarry (SP450150), assuming that I have interpreted Arkell's (1933b) section correctly.

The Forest Marble in the Bladon quarries is typical for the area. The edge of an oolitic-bioclastic sand bar may formerly have been exposed in Tolley's New Quarry (see Arkell, 1931 and 1933b).

14. Woodstock Railway Cutting (SP460172)

A section from the top of the Forest Marble up to the lower part of the Kellaways Sand, formerly exposed in this cutting, was described by Woodward (1894). The Lower Cornbrash was 2.4m thick here and the overlying Upper Cornbrash was 1.1m thick. The latter is significantly thinner at both Enslow Bridge (Loc. 18) to the northeast or at Long Hanborough (Loc. 11) to the southwest (Douglas & Arkell, 1928, 1935).

15. Slape Hill (SP425196)

This quarry was first mentioned by Arkell (1931), but more complete descriptions of the succession have been given by T. Palmer (1973, 1974) and Barker (1976). The section is still extant and has been examined on several occasions. The following description is based on those of Palmer and Barker, with my own observations on, and interpretations of, the succession:

FOREST MARBLE	Cross bedded biooograinstone	3.00m
WHITE LIMESTONE	Bladon Member Porcellaneous, cryptalgally-laminated lime mudstone with shrinkage cracks, passing down into a biopelmudstone/ wackestone containing A. bladonensis, A. (A.) loweana, Corbulomima, Eomiodon, Bakevellia and Protocardia	2.10m

Ardley Member (5.40m)	
Biopelpackstone, argillaceous, bioturbated; A. ardleyensis, Anisocardia, Bakevellia, Pleuromya	0.20m
Interlayered mud and bioclastic sand	0.20m
Pelpackstone; A. ardleyensis, B. implicata	1.30m
Oopelpackstone/grainstone; Eu. arduennensis, Globularia	0.80m
Oopelgrainstone; Nerinella cf. acicula, 'Isastraea', Chomatoseris, trigoniids	0.80m
Biointragrainstone; Eu. arduennensis, N. cf. acicula, A. compressa, Protocardia, Vaugonia, Trigonia, Parallelodon, Eocallista, Pleuromya, Chomatoseris	0.20m
Shipton Member (5.25m+)	
Interlayered lime and siliciclastic sand and terrigenous mud; plant debris	0.40m

----------base of Rhythm C----------

Sandy, argillaceous pelpackstone; Anisocardia, Pholadomya	0.40m
Biopelgrainstone/packstone; A. excavata, Eu. arduennensis, E. munieri, R. varicosa, Protocardia, Modiolus, Trigonia, Nucleolites, Clypeus, Acrosalenia	0.80m
Sand pelpackstone/wackestone; ?corals	0.55m
Biopelgrainstone/packstone; Trigonia	0.50m

----------base of Rhythm B----------

Olive green clay; rootlets	0.50m
Pale green, indurated clay; Protocardia, Cuspidaria, Modiolus, P. hebridica	0.30m
Argillaceous biopelwackestone	0.70m

Rhythm B is about 3.35m thick. Rootlets are not as common here, at the top of Rhythm A, as they are at Shipton (Loc. 16). The sharp base of the Ardley Member is illustrated in Plate 3B & C. The Bladon Member here comprises only Rhythm D sediments.

16. Shipton (SP475178-SP476172)

Blue Circle's large quarry at Shipton exposes a section from the top of Rhythm A up to the Lower Cornbrash; this is illustrated in Enclosure A-2. The quarry, which incorporated the 'Gibraltar Quarry' of Allorge & Bayzand (1911) and Odling (1913), has been described by Arkell (1931, 1947), Richardson et al. (1946), Allen & Kaye (1973), T. Palmer (1974, 1979) and Barker (1976). It is the type section of the Shipton

Member and a possible type section for the Forest Marble Formation. The base of the Forest Marble 'Rhythm' is clearly erosive here, for Rhythm E (including the 'Upper Epithyris Bed') is cut out northwards, and is absent at SP475178. Barker (op. cit.) recorded the occurrence of A. bladonensis in a micritic limestone, 1.05m above the top of the 'Upper Epithyris Bed' (and, therefore, in the upper part of Rhythm E), only locally preserved beneath the base of the Forest Marble 'Rhythm'. Earlier, Arkell (1931) had recorded A. bladonensis here in Rhythm D.

17. Whitehill Quarry, Gibraltar (SP477186)

This quarry, called 'Gibraltar Quarry' by both Arkell (1947) and McKerrow & Kennedy (1973), is not the Gibraltar Quarry of Allorge & Bayzand (1911). Although still well exposed and visited on several occasions, I have yet to measure this section. It has been described in some detail by both T. Palmer (1974) and Barker (1976). Cross-bedded Lithofacies association B sediments are well-developed within the hardground-capped Ardley Member here; these are illustrated in Plate 8B. Although Klein (1965) believed that the cross-bedding was produced by meandering tidal channels, I would rather interpret it as marking the edge of an elongate sand bar. A typical Biofacies 4 fauna is associated with these Lithofacies association B sediments. Beneath them, in the lower part of the Ardley Member, lime sands of Lithofacies 2 and 3 occur. These overlie about 3.6m of less resistant Shipton Member limestones, exposed since both Palmer and Barker measured the section. These are very similar to those exposed at Shipton (Loc. 16).

18. Greenhill Quarries (SP483179 & SP485177)

The section in the Lower Greenhill Quarry (SP483179) is now largely obscured, but that in the upper quarry was still extant in 1984. The quarries have been described by Woodward (1894), Odling (1913), Pringle (1926), Arkell (1931, 1947), Richardson et al. (1946) and T. Palmer (1974). The Cornbrash in the upper quarry, including 0.46m of Upper Cornbrash, was described by Douglas & Arkell (1928, 1932, 1935). Odling's (1913) 'Fossiliferous Cream Cheese' (=coral bed) in the lower quarry was developed at the base of Rhythm E. As the quarry was worked back the face moved into an area where this bed had been removed by pre-Forest Marble 'Rhythm' erosion. Thus, when Arkell (1931) measured

the section, this bed was no longer present; instead, the Forest Marble rested directly on rootletted Rhythm D sediments. A pebble bed is developed at the base of Rhythm D here (Arkell, op. cit.).

Islip/Noke Inlier

Islip and Noke Hills are domes of Cornbrash, Forest Marble and White Limestone sited at the point of intersection of the Wheatley Fault Zone with a line of periclines that occur between Blackthorn Hill and Noke (Arkell, 1947). In the past, the Upper Bathonian limestones of the inlier provided a local source for stone in an area otherwise lacking good building materials; thus small quarries were once plentiful in the area, and Arkell (1944, 1947) was able to remark that there were at least 28 quarries in the Forest Marble and Cornbrash of Noke Hill, alongside the Islip-Wheatley road; today, most of those small quarries have been infilled.

The few remaining extant sections, together with published descriptions of former sections, suggest that variable amounts of pre-Forest Marble erosion took place in the area, and that locally the Forest Marble directly overlies the Ardley Member. This reflects the positive tectonic setting of the Islip/Noke Inlier, situated as it is at the junction of the Islip-Riseley and Wheatley structural belts. The Forest Marble at Islip is considerably thinner than at Shipton, only 5.5km to the northwest, an illustration of the rapid attenuation of the formation towards, and southeast of the Islip-Riseley Line.

19. Quarry c. 1/4 mile NW of Islip Church (c.SP522148)

A section measured in this quarry by W. Whitaker, showing Forest Marble resting on 1.98m of White Limestone (? all Ardley Member), was reproduced by A. Green (1864). According to Arkell (1944), this quarry had formerly shown 'Fimbriata-waltoni clays', but this is not indicated by Whitaker's section.

20. Islip Railway Cutting (SP52641435)

The Cornbrash is still visible at the top of this cutting, described by A. Green (1864) and Odling (1913). Green's section can be interpreted as follows:

L. CORNBRASH	Rubbly Cornbrash Limestone	1.17m
FOREST MARBLE (c.4.42m)	Laminated white and blue clay	2.44m
	Hard, grey oolitic limestone	1.22m
	Clay	c.0.76m
WHITE LIMESTONE	Bladon Member	
	White limestone with nerineid gastropods	seen

The clay at the base of the Forest Marble could belong to the Bladon Member, but no bakevellids or Eomiodon were recorded, and these bivalves are characteristic of Bladon Member clays. The nerineid gastropods recorded at the top of the White Limestone were probably A. bladonensis, which Arkell (1944) also found at sites on the north side of Noke Hill (c.SP534131).

21. Grange Quarry, Islip (SP52401398)

This section, the upper part of which is still in existence in the paddock of 'The Grange', has been described many times (Woodward, 1894; Pocock, 1908; Odling, 1913; Engleheart, c.1925; Pringle, 1926; Arkell, 1931, 1947; Richardson et al., 1946; T. Palmer, 1974). Arkell's (1931) account shows that the Forest Marble here is apparently only 3.65m thick, beneath a minimum of 1.15m of Lower Cornbrash. Underlying the Forest Marble is a blue and green lignitic clay, containing B. waltoni, Eomiodon and Protocardia, which can be tentatively assigned to the Bladon Member.

'Bradfordian' faunas (T. Palmer, 1974) were obtained from an argillaceous limestone about 2.6m above the base of the Forest Marble, and only 1.2m beneath the base of the Cornbrash; such an unusual, relatively high position within the Forest Marble supports the hypothesis that the Cornbrash oversteps onto lower parts of the formation southeastwards towards the Islip-Riseley Line. Engleheart (c.1925) recorded the presence of a central 'marly' band within the lowermost, 2.45m thick, unit of the Forest Marble (a cross-bedded oobiograinstone) which apparently contained transported elements of the 'Bradfordian' fauna.

22. Quarry south of Islip (SP52851376)

In A. Green's (1864) section from this quarry, either the lowermost unit of the Forest Marble in Grange Quarry has here been wrongly classified as White Limestone on account of the presence of Plagiostoma, or otherwise the 'Bradford Fossil Bed' has been called Cornbrash; that only 0.91m of Forest Marble is developed here does not seem credible. Arkell's (1944) map suggests that the quarry worked an outcrop of Forest Marble, thus favouring the second interpretation.

23. Noke Hill Quarries

Arkell (1944) showed that three of the quarries on the crest of the Noke Hill formerly worked small outcrops of White Limestone: 1. SP53721279; 2. SP53811287; 3. SP53831265. A composite section from the first two of these quarries, measured by Engleheart (c.1925), is given in modified form below:

WHITE LIMESTONE (4.44m+)	Bladon Member	
	White-weathering, 'marly' limestone, comparable to 'cream cheese', yielding Isastraea, Epithyris, Plagiostoma, Modiolus, Praeexogyra, etc.	1.22m
	Ardley Member (3.2m+)	
	Coarse, oolitic, shelly limestone	1.37m
	Impersistent 'marly' clay with limestone	1.22m
	Massive limestone with ?B. waltoni, ?Nerinella and trigoniids	0.61m

Arkell (1944) notes that in the third quarry, the coral bed of the above description was overlain by "8 feet (2.44m) of false-bedded Kemble Beds", these undoubtedly being cross-bedded Forest Marble limestones. At Noke Quarry (SP541131), 1.83m of Cornbrash was formerly visible (Arkell, op. cit.).

24. Grove Quarry, Wood Eaton (SP53401225)

Forest Marble was formerly quarried both in Grove Quarry and Home Farm Quarry (SP531122) in the parish of Wood Eaton (Arkell, 1944). Grove Quarry was reopened in 1970 to provide stone for the reconstruction of the Oxford northern by-pass (McKerrow & Kennedy, 1973) and more recently it has been expanded by J. Barney Plant Hire. Enclosure A-3 illustrates a composite section measured within the enlarged quarry. As a result of the increased overlap now available between different faces, this

composite section is more accurate than those of either T. Palmer (1973, 1974) or Bradshaw (1978).

The Grove Quarry White Limestone/Forest Marble section, as a result of the positive tectonic setting of the Islip/Noke Inlier, is more closely comparable to the typical S.W. Northamptonshire succession than with the usual Oxfordshire successions to the west; Bradshaw (1978) noted that the same was true of the underlying beds. Within the Shipton Member here, both Rhythms A and B can be recognised, each with episodes of rootletting preserved at the top. By comparison with Shipton (B4; Rh.A = 2.0m, Rh.B = 4.47m) and Ardley (Loc. 28; Rh.A = 2.48m; Rh.B = 3.97m), Rhythm A (0.54m) and Rhythm B (1.56m) are here considerably reduced in thickness, thus anticipating the eventual overstep of Rhythm C over both lower rhythms southeast of the Islip-Riseley Line, as is seen in the Bedford-Newport Pagnell area.

The section has been interpreted as showing typical Forest Marble resting sharply upon the Ardley Member, with the Bladon Member coral bed of Noke Hill here removed by pre-Forest Marble erosion. A hardground, which passed laterally into a pebble bed, was formerly (1980) seen within the Ardley Member (T. Palmer, 1974), but this has not been located since the expansion of the quarry.

The Ardley Member at Wood Eaton, as in Northamptonshire, is dominated by sediments of Lithofacies association B. Epithyris dominates the fauna found with this association, but Digonella digonoides also occurs locally within the Ardley Member.* It should be noted that the Solenopora at Wood Eaton, contrary to *T. Palmer (1979), is found* in the Ardley Member, not in the Shipton Member (cf. Foss Cross, Loc. 1).

25. Charlton-on-Otmoor (?SP560156)

A section exposing the Lower Cornbrash here was described by Douglas & Arkell (1932). The section was as follows:

LOWER CORNBRASH (1.60m+)	Hard, flaggy limestone; M. echinata, R. vagans, P. duplicata	0.30m
	'Marl' and 'marly' rubble, highly fossiliferous. O. obovata, M. echinata, P. duplicata, R. vagans, Homomya, Pleuromya, Pygurus	0.69m

* The occurrence of 'ornithellids' within the White Limestone of Noke Hill was first noted by Arkell (1944).

Soft limestone, with abundant *C. intermedia*; *Clydoniceras*, *R. vagans*, *Limatula*, *Ceratomya*, *Pleuromya* 0.61m

The lithologies and faunas are typical for the Lower Cornbrash in the area.

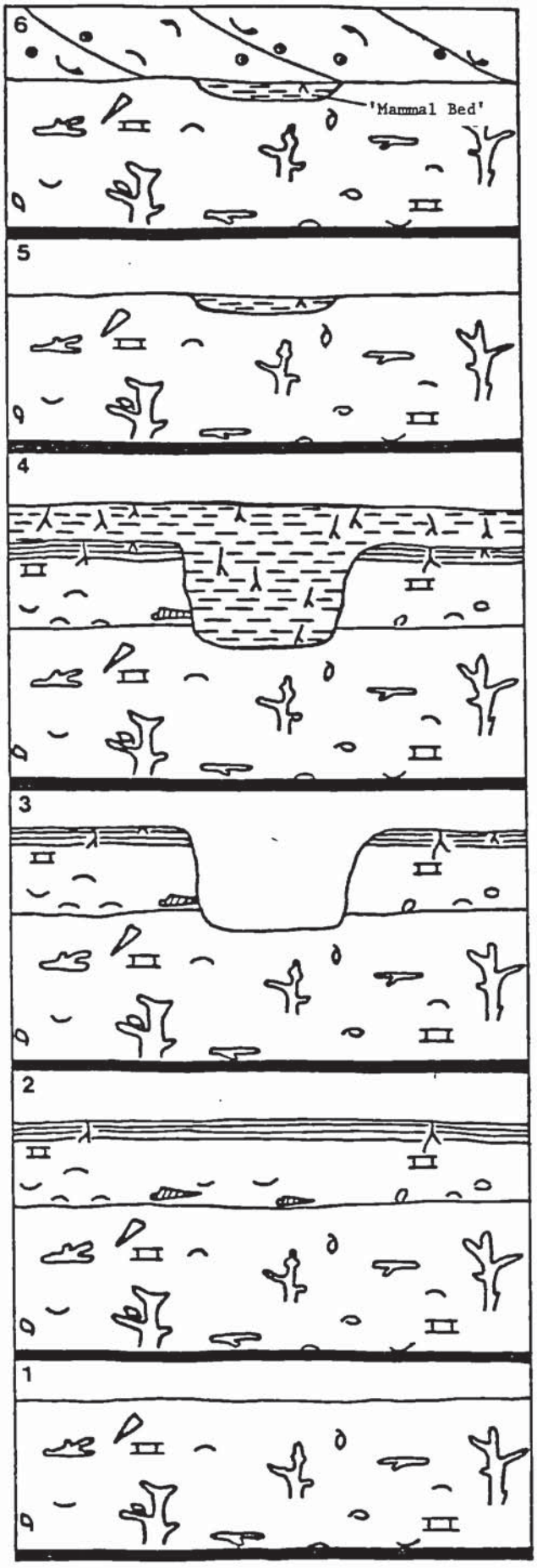
26. *Kirtlington* (SP49471998)

The much described Kirtlington Old Cement Works Quarry (Odling, 1913; Bayzand (in Sollas, 1926); Arkell, 1931; Douglas & Arkell, 1932; McKerrow et al., 1969; T. Palmer, 1974; Barker, 1976), now owned but not worked by Blue Circle, was cleaned up for the Nature Conservancy Council in 1982. A section measured in the northwest corner of the quarry (cf. section 3 of McKerrow *et al.*, 1969) is illustrated in Enclosure A-3.

Lithofacies association B is well developed in the Ardley Member at Kirtlington, and is characterised by considerable lateral lithological variation. The type specimens of '*Epithyris oxonica*' were obtained from this facies association here (=Biofacies 4; Arkell, 1931). A 0.38m thick unit of pelletal and oolitic biograinstone, exhibiting possible hummocky cross-stratification, is developed at the top of the Ardley Member (Plate 9E); this may belong within Lithofacies association C.

Mammal teeth have been obtained from a thin, locally developed bed above the 'coral-*Epithyris* Bed' and directly beneath the Forest Marble (E. Freeman, 1979). This bed may be the basal part of a passive infill of a channel cut into the uppermost sediments of the White Limestone, but subsequently truncated by pre-Forest Marble erosion. A model for the formation of the Kirtlington 'Mammal Bed', based on data from locations in the Cherwell Valley and elsewhere, is presented in Figure A-1. The essentially non-marine/terrestrial micropalaeontology of the bed, here believed to be of Rhythm E (*hodsoni* Zone) age, has been studied in detail by Ware (1978). Non-marine and brackish water ostracods (particularly *Timiriasevia mackerrowi*), charophytes, and lignite are present in the bed, together with crocodile, dinosaur and rare mammal remains.

The Forest Marble at Kirtlington, as elsewhere in the region, comprises cross-bedded oobio- and biooograinstones and subordinate



6. A further relative rise in sea level. Deposition of the basal Forest Marble 'Rhythm' lime sands. Preservation of the 'Mammal Bed'.

5. Pre-Forest Marble erosion. Removal of the uppermost sediments of Rhythm E.

4. A terrigenous-mud dominated coastal plain prograded across the area. The channel was passively infilled. Terrestrial and non-marine material was deposited in the channel. Further Equisetites colonisation.

3. A channel cut its way across the supratidal marsh. The marsh was colonised by Equisetites.

2. Pelletal muds were subsequently deposited in a lower energy environment. Following coastal progradation, cryptalgally laminated lime muds were deposited on a supratidal marsh.

1. A relative rise in sea level initiated Rhythm E. The 'Coral-Epithyris Bed' was deposited in a shallow subtidal setting.

FIGURE A-1 Deposition of the 'Kirtlington Mammal Bed'.

packstones interbedded with units of predominantly terrigenous mudstone. These sediments are characteristic of Lithofacies association A. Bate (1965) obtained freshwater-brackish ostracods from terrigenous mudstones developed within the Forest Marble here.

27. Northbrook Quarry (SP499223. Not SP497222 as given in T. Palmer, 1974, 1979)

This section, measured by T. Palmer (1974), is no longer extant. Although small, this Ardley Member exposure formerly exhibited a characteristic example of Biofacies 4, associated with bioturbated sediments of Lithofacies association B. Palmer's section is as follows:

WHITE LIMESTONE	Ardley Member (3.52m+)	
	Flaggy weathering, coarse oobiosparite	0.30m
	'Marl' with biopelmicrite pebbles	0.40m
	Biopelmicrite with M. imbricatus and Epithyris; common Favreina	1.70m
	Biopelmicrite; M. imbricatus, Epithyris, D. digonoides	0.40m
	'Marl' with abundant Acrosalenia	0.02m
	Oobiosparite, locally micritic; Favreina abundant at top	0.70m

Palmer's 'biopelmicrite' was probably a biointrawackestone/packstone. The Northbrook section is notable for being one of the few Oxfordshire exposures to have yielded Digonella digonoides. Also of note was the abundance of Acrosalenia (c. 1000 m^{-2}) in the thin 'marl' in the lower part of the section (T. Palmer, 1974).

28. Ardley-Fritwell Railway Cutting (SP51852865)

A section from just below the base of the White Limestone up to the lower part of the Ardley Member was measured in this cutting in 1981, courtesy of British Rail; this is depicted in Enclosure A-4. I have followed T. Palmer (1979) by placing the base of the White Limestone at the base of bed 20 of Arkell et al. (1933); however, the base of Rhythm A occurs 1.15m lower, at the top of a green, rootletted, calcitic sandstone (Bed d of Odling, 1913; the Prominent Bed of Arkell et al., 1933); Bradshaw (1978) believed this to be the uppermost unit of the Cranford Rhythm.

Both Rhythm A (2.48m) and Rhythm B (3.97m) are still fully exposed in this cutting, but rootlets occur only at the top of Rhythm A. Two specimens of Tulites appear to have been collected from the lower part of Rhythm B here (Odling, 1913; Arkell et al., 1933), but one is not extant and the other was not collected in situ.

29. Ardley Station Quarry (SP539271)

Ardley Station Quarry is now heavily overgrown and partially infilled. However, in 1981 I was still able to study most of the section. Descriptions of the whole section have been given by Odling (1913), Arkell et al. (1933) and Bradshaw (1978). The top of Rhythm A is not rootletted here (Bradshaw, 1978). The overlying Rhythm B is about 3.9m thick and consists of bioturbated intrabiograinstones and packstones, colonised by a typical Biofacies 3 fauna, overlain by bioturbated oo-, intra- and biopackstones (with subordinate grainstones and wackestones) containing a coral bed fauna (Biofacies 5).

30. Ardley Fields Farm Quarry (SP541265)

This quarry, the type section of the Ardley Member, was described by both T. Palmer (1973, 1974) and Barker (1976). Although expanded in recent years, the base of the quarry has been maintained at the level seen by earlier workers (at the top of the Shipton Member). The present section is illustrated in Enclosure A-4. The Trypanites-bored, oyster-encrusted hardground capping the Ardley Member/Rhythm C is well developed at this location; bryozoans locally encrust the insides of burrows within this hardground.

The Bladon Member in the Ardley district appears to consist only of Rhythm D sediments. Supratidal lime muds are developed in the upper part of the rhythm (the 'Cream-Cheese Bed' of Odling, 1913) and are apparently overlain locally by at least 1m of rootletted terrigenous muds (seen in the railway cutting near SP551257; T. Palmer, 1973 & pers. comm.) which also belong within Rhythm D. Elsewhere, the uppermost Rhythm D sediments of the Ardley area have been removed by pre-Forest Marble erosion (Odling, 1913).

31. Dane Hill Road Cutting (SP46852935)

Following Bradshaw (1978), the uppermost 2.6-2.9m of Torrens's (1968) section can be assigned to the Shipton Member. The base of Rhythm A is likely to have been in the upper part of Torrens's bed 9 (within the Hampen Marly Formation); the uppermost bed (bed 13 of Torrens) may have been similar to the rootletted calcareous mudstone (bed ?20 of Palmer, 1974) developed at the top of Rhythm A at Slape Hill (Loc. 15).

32. Whiteways Quarry (SP420246)

The section here has been described previously by T. Palmer (1974) and Horton et al. (in prep.). The present section, measured in 1982, is illustrated in Enclosure A-5. Lower beds, apparently no longer exposed, were recorded by Palmer (op. cit.).

33. Great Rollright (SP32303035)

This small quarry, now totally infilled, was described by Arkell (MS.), T. Palmer (1974) and Barker (1976). The section I measured in July, 1982 is illustrated in Enclosure A-5. Higher beds within the Bladon Member were formerly exposed in another small quarry, east of the road (SP32503025), also described by Arkell (MS.). At least 4.1m of Bladon Member limestones appear to have been exposed in the latter pit, with A. bladonensis present at several horizons within this thick succession, together with Bakevellia and Eomiodon. Corals were present at the base of the Bladon Member, which, at both locations, possibly includes sediments of both Rhythm D and Rhythm E. Palmer (op. cit.) noted that the top of the Ardley Member at SP32303035 is a hardground, encrusted by Liostrea wiltonensis.

34. Pest House Railway Cutting (SP315300 to SP342308)

The geology of this cutting, on the disused 'Banbury and Cheltenham Direct Railway', was described by Beesley (1877), Hudleston (1878) and Woodward (1894). The section in the cutting formerly extended from the Bladon Member up to the Lower Cornbrash, the latter originally being called 'Great Oolite Limestone' by Beesley. The Forest Marble is at least 4.7m thick here. T. Palmer (1974) interpreted Woodward's description to show that the White Limestone in this cutting and in

cuttings further east comprises about 2.5m of Bladon Member, 3m of Ardley Member and 7m of Shipton Member.

Arkell (1947) noted that Hudleston's (op. cit.) 'angulata Bed' (a bed of limestone within the Bladon Member, containing abundant Bakevellia and Eomiodon, A. bladonensis, Corbulomima, Protocardia and Amberleya) was then still well exposed in Pest House Cutting; this bed is clearly a development of Lithofacies 5/Biofacies 6. The bed is overlain by a birdseye lime mudstone, of Lithofacies 6, developed at the top of the White Limestone (T. Palmer, 1974).

35. Temple Mills (SP34703615)

Two quarries within the White Limestone and Forest Marble of the faulted Sibford Ferris outlier remain at Temple Mills; Enclosure A-5 shows the section in the northern quarry. Details of the succession in both quarries were given by Whitehead & Arkell (1946), McKerrow & Kennedy (1973) and T. Palmer (1974); all of these descriptions can be correlated with my own observations.

T. Palmer (1974) recorded the presence of a locally developed hardground at the top of the White Limestone, capping a burrowed biowackestone/mudstone containing A. bladonensis. Reworked pebbles of the same lithology were encountered at the base of the Forest Marble. The Bladon Member is here only 1.4m thick and, unlike at Great Rollright (Loc. 33), comprises only a single rhythm, Rhythm D. Temple Mills may have been just outside the area reflooded by the Rhythm E transgression or, alternatively, the sediments of that rhythm may have been removed by pre-Forest Marble erosion.

Whitehead & Arkell (1946) correlated clays infilling a 15m wide channel developed at the top of the Ardley Member (their Bed 4) with similar Cetiosaurus-bearing clays found within the Bladon Member of the Cherwell Valley. However, as is possibly not the case there, this channel fill predates the Rhythm D transgression. Channelling here, as at Stratton Audley (Loc. 44), occurred at the close of Rhythm C times. The abandoned channel was passively infilled during the final phase of the Rhythm C regression by brackish and freshwater terrigenous muds of Lithofacies association E. Cetiosaurus bones and logs form a basal lag to this channel fill. The overlying oyster-rich muds were deposited immediately after the initial Rhythm D relative rise in sea level.

Arkell (in Whitehead & Arkell, 1946; 1947) apparently misidentified A. ardleyensis from Temple Mills as A. bladonensis.

36. Belleisle Farm Quarry (SP35573579)

Horton et al. (in prep.) recorded a section here prior to the total infilling of the quarry. Their section can be summarised and interpreted as follows:

FOREST MARBLE	Interbedded mudstone and limestone with a 0.15m thick 'marl' at the base containing nodular limestone masses	1.67m
WHITE LIMESTONE	Bladon Member White porcellaneous, shelly limestone with echinoid spines, bryozoans, B. waltoni, Protocardia, ?Eomiodon, Modiolus, corbulids, ?Mactromya, ?Nanogyra, nerineid gastropods and fish fragments	No thickness given
	Brown, sandy, shelly limestone, roughly cross stratified; Placunopsis, ?Tancredia and indet. echinoid	0.30-0.33m
	Brown clay and oyster-rich mudstone	0.24m
	Ardley Member (1.63m+) Grey, shelly, sparsely oolitic limestone, locally with nerineid gastropods	0.41m
	Pale grey, oolitic, shelly limestone, nerineid gastropods	1.22m

The section appears to have been similar to that at Temple Mills. The 'nodular limestone masses' in the basal Forest Marble were probably reworked pebbles of White Limestone.

37. Wallace's Pit, Stourswell (SP376362)

The section here is illustrated in Enclosure A-5. No published section exists for this location although it was described by Geological Survey workers during the mapping of the Chipping Norton Sheet (MS., Keyworth).

38. Broughton Fulling Mill Quarry (unlocated)

A total of 4.06m of White Limestone, comprising three units of 'oolite' (up to 1.83m thick) split by two 0.15m thick beds of 'sandy shale', were formerly visible here (Beesley, 1874); this exposure was in the upper part of the formation, with the overlying Forest Marble exposed near the top of the quarry. Corals were obtained from the White Limestone.

39. Tadmarton 'Forest Marble Pit' (unlocated)

The section in this quarry, recorded by Beesley (1873, 1874), can be interpreted as follows:

FOREST MARBLE (1.51m+)	Slaty 'Forest Marble' (?oobiograinstone)	0.38m
	Limestone	0.30m
	Shale	0.30m
	Grey clay	0.28m
	Black clay, thinning northwards	c.0.30m
WHITE LIMESTONE	Oolite	3.05m

Bones of Teleosaurus and other vertebrates were obtained from the White Limestone here, while oysters and ?Bakevellia were apparently obtained from the Forest Marble.

40. Blenheim Farm Quarry (SP369391)

As noted by Bradshaw (1978), the 3.54m of limestone, clay and 'marl' recorded here by Edmonds et al. (1965) could belong to either the Hampen Marley or Sharp's Hill Formations; the associated fauna suggests that these beds could also be White Limestone.

41. Broomhill Farm Quarries (SP345411 & SP347411)

Sections in both the main quarries (Cornbrash and Forest Marble) and a small quarry at SP347411 (White Limestone) were still exposed in 1982. Enclosure A-6 shows a composite section measured in both the main and small quarries. Edmonds et al.'s (1965) interpretation of the succession at SP347411 is clearly wrong. The uppermost bed of the White Limestone here contained rare carbonaceous rootlets.

Edmonds et al. recorded the presence of at least 3.8m of Forest Marble at Broomhill, although they were uncertain whether the relevant

beds should be placed in the 'Forest Marble' or in the 'Great Oolite Clay'.

42. Blackthorn Hill Road Cutting (SP609205)

The exposure of Forest Marble and Lower Cornbrash in this recently made cutting was measured in 1982 and is illustrated in Enclosure A-6. The section is similar to that once exposed in the nearby brickpit (A. Green, 1864; Woodward, 1894; Douglas & Arkell, 1932). Green's account suggests that the top of the White Limestone lies not far beneath the base of the present section.

43. Blackthorn Hill Railway Cutting (SP616211)

The section in this cutting has not yet been investigated; it has been discussed previously by Barrow (1908, 1909), Odling (1913), Arkell (1931) and T. Palmer (1974). Arkell's section, based on Barrow's description, can be interpreted as follows:

L. CORNBRASH		1.52m
FOREST MARBLE (3.05m)	Sandy clay with one pale 'marl' band	1.07m
	Hard, grey, oolitic limestone	0.30m
	Dark, tenacious clay, passing down into lighter clay with thin, pale 'marl' bands (crowded with Placunopsis)	2.13m
----------top of Rhythm E----------		
WHITE LIMESTONE	Bladon Member (2.97m+) Pale grey, blotchy limestone, pale clay parting and hard clay-limestone locally forming a single thick unit of 'Cream Cheese' limestone. Modiolus imbricatus and P. socialis.	1.75m
	Pale grey clay; B. waltoni, E. angulatus, Protocardia, Corbulomima, M. imbricatus	0.15m
----------top of Rhythm D----------		
	Bright bluish-green clay, passing down into grey clay	1.07m
	White limestone	No thickness recorded

T. Palmer's (1974) section, contrary to Palmer's own opinion, can be closely matched with Arkell's; however, Palmer appears to have omitted

the 1.07m of 'sandy clay with one pale marl band', which directly underlies the Cornbrash, from his own account.

44. Elm Farm Quarry, Stratton Audley (SP601255)

The lower part of the section in this quarry, recorded by T. Palmer (1973, 1974), is now obscured by flooding. The upper part of the section is illustrated in Enclosure A-6. Palmer (1973) placed the top of the White Limestone at the top of a 'hard micrite with shrinkage cracks and algal laminae', here developed in the upper part of Rhythm D. However, Barker (1976) has subsequently found A. bladonensis in Bed 10 of Palmer's Forest Marble, indicating that this bed also belongs within the White Limestone. It is developed at the top of Rhythm E. The basal bed of the Forest Marble at Stratton Audley appears to be an oyster-rich clay which contains lignite and vertebrate remains (crocodile and fish teeth). The highest bed of the White Limestone (following Barker) contains pyritised rootlets and possible birdseyes; Thalassinoides burrows developed at the top (Plate 5A) are infilled with Forest Marble 'Rhythm' sediment. Locally this limestone bed has been channelled and the channel has been infilled with green, rootletted, silty mudstone.

The Ardley Member/Rhythm C is not now exposed. It is capped by an oyster-encrusted hardground with Trypanites, and is at least 3.8m thick (T. Palmer, 1973).

1.2.3 Buckinghamshire

45. Buckingham (SP689339?).

A. Green's (1864) section from a clay pit at Buckingham can be interpreted as follows:

L. CORNBRASH (1.11m+)	Hard blue limestone, full of fossils	0.61-0.91m
	Sandy oyster bed	0.10m
	Dark blue laminated clay	0.10m
FOREST MARBLE (4.41m+)	White, 'marly', chalk-like limestone; ?Eomiodon, ?Mactromya	0.30m
	Hard, yellowish, sandy limestone	0.30m
	Stiff blue clay, with bioclastic debris and lignite	1.68m
	Very stiff, dark black clay	1.22m
	Blue and yellow mottled clay	0.91m

White Limestone occurred a little below the base of this section (Green, op. cit.). The Forest Marble clays were mistakenly included within the Cornbrash by Green.

46. Thornborough (SP733326 & SP735325)

An important section formerly exposed in large quarries south of Thornborough was described by A. Green (1864) and requoted by Woodward (1894). By comparison with the sections at Blackthorn Hill (Loc. 42 & 43), the following interpretation can be made:

L. CORNBRASH	Cornbrash rubble	0.61m
FOREST MARBLE (3.96m)	White 'marly' limestone	0.15m
	Brown clay	0.76m
	White 'marl'	0.91m
	Stiff blue clay	1.22m
	Hard, grey, evenly-bedded limestone	0.46m
	Clay	0.46m
WHITE LIMESTONE (5.42m+)	Hard, grey, evenly-bedded limestone	0.46m
	Rubbly 'marl' with shells	0.61m
	Hard, whitish limestone	1.07m
	White sand	0.23m
	White sandstone	0.61m
	Sandy clay	0.23m
	Hard, brown limestone	0.15m
	Clay	0.23m
	Hard, cream-coloured limestone	0.61m
	Cream-coloured, rubbly 'marl' with Plagiostoma cardiiformis	1.22m

I am uncertain where the boundary between the Ardley and Bladon Members should be placed in this section.

47. Thornton (SP754355?)

A. Green's (1864) section from road cuttings and a large quarry at Thornton can be tentatively interpreted as follows:

L. CORNBRASH	Rubbly Cornbrash	seen
FOREST MARBLE (?3.66m)	Alternations of white, bluish and brown clay with beds of smooth, evenly jointed white 'marl'	3.05m
	Thin, flaggy, sandy limestone with oysters	0.61m

?WHITE LIMESTONE (?3.80m+)	Thick-bedded, white, shelly limestone	0.91m
	Thick-bedded, brownish limestone	0.91m
	Thin-bedded, brown sandstone	0.76m
	Thick-bedded, brownish limestone	1.22m

48. Akeley Brickyard (SP715382)

This quarry once showed the following succession (Woodward, 1894; Douglas & Arkell, 1932):

KELLAWAYS BEDS (4.27m+)	Yellow, sandy loam	1.22m
	Blue clay with oysters at the base	3.05m
LOWER CORNBRASH (2.44m)	Hard, grey, poorly fossiliferous limestone; O. obovata, M. echinata, R. vagans, Pleuromya, nerineid gastropods	1.83m
	Hard, cream weathering limestone; C. intermedia	0.61m
FOREST MARBLE	Grey and black clay with a few thin limestone beds and a 'marl' with P. hebridica at the top	c.2.44m
WHITE LIMESTONE	Brown and white compact limestone) 'Marly' beds, etc.)	3.66m+

The Upper Cornbrash is noticeably absent here.

49. Quarry between Akeley and Lillingstone Lovell (SP71483900)

The following section was measured during the mapping of the Towcester Sheet (BGS, MS.):

L. CORNBRASH	Soil with Cornbrash fragments	seen
FOREST MARBLE (1.85m)	Blue, green and variegated clays	1.37m
	Pale cream, rubbly, shelly, 'marly', oolitic limestone; weathered to mottled yellow-brown, soft 'marl' in the top 0.15m; increasingly massive downwards. Highly fossiliferous, with trigoniids, oysters and gastropods	0.48m
?WHITE LIMESTONE	Pale cream, massive, tabular, sparitic limestone with scattered shells and oolitic laminae	2.13m+

50. Lillingstone Lovell (SP71484040)

Taken together, A. Green's (1864) and Woodward's (1894) descriptions of the village quarry at Lillingstone Lovell suggest that, contrary to their classifications of the section, only White Limestone was ever exposed here; the succession was probably comparable to that at Pury End (Loc. 96). The following interpretation is proposed for Woodward's section, which is more complete than that recorded by Green:

WHITE LIMESTONE (3.22m+)	?Bladon Member	
	Rubble and white 'marl')	
	Clay)	
	?Ardley Member)	0.91m
	Cross-bedded, calcareous sandstone)	
	Thin shale with gritty laminae)	
	Blue, shelly and oolitic limestones	1.83m
	Pale, compact and shelly, locally oolitic limestone with ?Anisocardia, ?Gervillia and Epithyris	0.48m
	Greenish-grey clay	0.10m
	Brown oolite	seen

Correlation between Green's and Woodward's sections is difficult.

51. Calverton (SP78583916)

According to Woodward (1894), A. Green (MS.) had earlier noted that thick-bedded white limestones had been extensively quarried between Calverton and Stony Stratford. The section in Enclosure A-6 was recorded from the remaining exposure in a large stone-pit between Calverton and Passenham. The same section was described by Horton, Shephard-Thorn & Thurrell (1974).

52. Castlethorpe (SP79624543)

The section still exposed in this quarry in 1984 is illustrated in Enclosure A-7. A 3.46m thick section was described here by the Geological Survey (BGS, MS.) during the mapping of the Towcester Sheet. The present exposure comprises Lithofacies association C sediments developed within the upper part of Rhythm C/Irchester Member.

53. Park House Quarry, Hanslope (SP82414520)

Approximately 1.7m of limestone and 'marl' exposed in this quarry was described by Geological Survey workers (BGS, MS.), but I am unable to satisfactorily interpret their description; it was probably all White Limestone.

54. Hill Farm Quarry, Haversham (SP83394349)

Only the uppermost 0.5m of the 2.8m thick section recorded here by Horton, Shephard-Thorn & Thurrell (1974) is still visible. This comprises well-sorted, fine-grained pelletal biooograinstone with pelwackestone laminae; Diplocraterion is present locally. These are sediments of Lithofacies association C, once again developed in the upper part of the Irchester Member.

55. Canal bank exposure, Wolverton (SP82424085)

This section was described during the Survey's mapping of the Towcester Sheet (BGS, MS.). The following is a tentative interpretation of the Survey's description:

FOREST MARBLE (0.7m+)	Dark green clay	seen
	Rubbly weathering, shelly limestone with occasional ooids and scattered oysters	0.23m
	Oolitic limestone with minor shell debris; possibly cross-bedded; occasional argillaceous partings	0.35m
	Obscured	c.0.30m
WHITE LIMESTONE	Oolitic ''marl' with dark green, argillaceous pockets passing laterally into an argillaceous limestone	0.61m+

Alternatively, the entire succession may belong within the White Limestone. I have not yet located the section.

56. Loughton Valley (SP82754027)

Bradshaw (1978) measured several sections through the upper Great Oolite Group, temporarily exposed in October, 1975 in trial pits and pipe tunnels excavated for the Loughton Valley Foul Sewer. The following composite section is based on Bradshaw's field notes:

LOWER CORNBRASH	Hard limestone; M. echinata, P. duplicata	seen
	Irregularly bedded bioclastic sand	0.50m
FOREST MARBLE (3.09m+)	Blue-grey lignitic, fossiliferous clay	0.40m
	Porcellaneous, micritic limestone	0.16m
	Biograinstone, becoming a biopackstone upwards; ?Sphaeriola	0.70m
	Blue-grey and black, fossiliferous clay	1.20m+
	GAP	
	Black, very carbonaceous, very slightly silty clay; abundant wood debris	seen
----------erosive base of Forest Marble 'Rhythm'----------		
	Bright green, unfossiliferous, silty clay with abundant rootlets	0.22m
	Silty micrite; Eomiodon; rootlets; loaded base	0.18m
	Bright green, unfossiliferous, silty clay; rootlets	0.25m
WHITE LIMESTONE	Irchester Member (7.48m+)	
	Massive limestone; rootlets	0.50m
	Grey, irregularly laminated, bioclastic, sandy clay; P. hebridica, M. imbricatus; rootlets	0.11m
	Massive limestone, with abundant bivalves at base; rootlets	1.13m
	Black, bioclastic, sandy clay; coral, ?Camptonectes, Plagiostoma, ?Pteroperna	0.08m
	Oobiopackstone/wackestone; 'Isastraea', Plagiostoma, ?Pteroperna	0.65m
	Bioclastic, sandy clay; P. hebridica, ?Pteroperna, Plagiostoma	0.11m
	Biooograinstone; ?cross-bedded; oyster debris and echinoid spines	0.73m
	Argillaceous oopackstone	0.13m
	Biooograinstone, but locally a packstone; very abundant P. hebridica; high-spired gastropods; abundant corals	0.30m
	Biooopackstone/wackestone; Pholadomya, Plagiostoma, P. hebridica, corals	0.32m
	Finely laminated sandy and bioclastic clay; Plagiostoma, Pholadomya, P. hebridica	0.05m
	Massive peloopackstone/wackestone; Clypeus, Globularia, P. hebridica, Plagiostoma, Anisocardia, serpulids, echinoid spines	0.25m

	Silty, calcareous clay with shelly laminae; in places an argillaceous biomudstone; P. hebridica, ?Eocallista	0.49m
	Bioturbated, argillaceous biopackstone/ grainstone; M. imbricatus, P. hebridica	1.12m
	Bioturbated biowackestone/packstone; P. hebridica	0.30m
	Bioturbated, argillaceous oobiopackstone/ grainstone; Pholadomya, trigoniids, P. hebridica, M. imbricatus, ?P. duplicata, ?Isognomon	0.52m
	Biograinstone/packstone; P. hebridica	0.10m
	Cross-bedded biooograinstones; fish teeth	0.29m
	Shelly oograinstone	0.30m

Without examining the sections, it is difficult to assess which rhythms were developed at Loughton. Rhythms C and D are both thought to be present within the Irchester Member and basal Forest Marble Formation. Sediments belonging to Rhythm E may also have been developed. The Forest Marble 'Rhythm' is certainly developed beneath the Lower Cornbrash.

57. Bradwell Mill Railway Cutting (SP83114112)

A small section of White Limestone still visible in this cutting (now used for the Wolverton-Newport Pagnell 'Redway') comprises the following:

WHITE LIMESTONE (1.11m+)	Very hard bed of fine-grained biopelgrainstone	0.15m
	Massive bed of medium to very coarse-grained biograinstone containing micrite clasts	0.38m
	Massive bed of medium-grained oobiograinstone	0.58m

Woodward's (1894) account of the more complete succession once exposed, and Horton, Shephard-Thorn & Thurrell's (1974) recent redescription of the uppermost part of the section can be combined and interpreted as follows:

L. CORNBRASH (1.40m+)	Shelly, slightly oolitic limestone with P. hebridica and C. intermedia	1.22m
	Sandy 'marl' with shells and shell debris	0.02-0.05m
	Fine, sandy, bioclastic limestone with C. intermedia	0.13m

FOREST MARBLE (4.05m)	Micritic limestone with scattered bivalves and echinoids	0.31m
	Limestone, becoming an oyster lumachelle in lower part	c.0.18m
	Impersistent bluish-green clay	0.01m
	Sandy and argillaceous 'marl' with scattered oysters	0.48m
	Sandy clay	0.13m
	Dark blue-grey clay with interlayered silt laminae; many crushed shells	0.36m
	Soft grey-green clay	0.15m
	Sand	0.15m
	Bluish-grey clay	1.83m
	Irregular earthy band with oysters	0.45m
WHITE LIMESTONE	Irchester Member (4.92m+)	
	Massive bed of banded, 'earthy' limestone	1.52m
	'Marly' limestone with P. hebridica and M. imbricatus	0.91m
	Pale, 'earthy', oolitic limestone	0.36m
	Pale, 'earthy', oolitic and shelly limestone	0.36m
	'Marly' bed crowded with oysters	0.61m
	Cross-bedded, shelly, oolitic limestone	1.22m

The exposure of White Limestone described above may correspond with the shelly oolite developed at the base of Woodward's section.

58. Stantonbury Farm (SP84224161)

Horton, Shephard-Thorn & Thurrell (1974) reported that temporary exposures at Stantonbury Farm, north of Bradwell, showed Kellaways Clay, with a basal 0.3m thick bed of shell debris 'marl' (?=U. Cornbrash) overlying a bioclastic limestone in which O. obovata and C. intermedia were present (=L. Cornbrash). West of this locality, Lower Cornbrash is developed only sporadically.

59. Great Linford (SP84864224)

The succession in this disused canal-side quarry (near the Black Horse Pub) was described by Horton, Shephard-Thorn & Thurrell (1974) and is illustrated in Enclosure A-7. The Forest Marble is still developed here, as it also is in the nearby MK30 borehole (B20). However, unlike in the borehole core, terrigenous mudstone laterally-equivalent to the Thrapston Clay is not seen in this exposure. The lowermost limestone developed within the Forest Marble here was included in the White

('Blisworth') Limestone by Horton et al. (op. cit.), who recorded it as only 0.15m (cf. 0.58m) thick.

60. Linford Wharf (SP85414263)

Horton, Shephard-Thorn & Thurrell (1974) noted the presence of a 3.7m thick section of White Limestone at Linford Wharf. In 1984 I measured the following section:

WHITE LIMESTONE	Irchester Member (2.3m+)	
	Even-parallel laminated, very fine grained biograinstone and biopel-grainstone/packstone with layers of pelpackstone/wackestone. Platy weathering.	0.50m
	Even-parallel laminated biopel-grainstone/packstone and pelpackstone/ wackestone. Local hummocky cross stratification. Rare Diplocraterion	0.13m
	Massive unit of biograinstone/packstone containing subordinate ooids, pellets and intraclasts. ?Bioturbation at base. Fines upwards, becoming even-parallel laminated at the top. Sharp base.	0.27m
	Silty, bioclastic, indurated clay	0.03m
	Massive to locally laminated oobiograinstone and pelpackstone/ wackestone, admixed by bioturbation. Lime mud-filled burrows. Rare ?nerineid gastropods. Sharp base.	0.15m
	Interlayered clay and bioclastic, terrigenous mud. Sharp base.	0.05m
	Cross laminated biograinstone, containing fish teeth and echinoid spines, becoming even-parallel laminated upwards	0.13m
	Massive unit of interlayered oobiograinstone (0.10-0.20m thick layers) and thinner laminae of pelpackstone/wackestone. Local hummocky cross stratification.	0.28m
	Exposure gap	
	Massive unit of bioturbated oobio- and pelbiopackstone; carbonaceous debris; fish debris and coarse shell debris in places.	0.40m
	Thinly bedded biograinstone.	0.36m

All of these sediments are characteristic of Lithofacies association C, developed here in the upper part of Rhythm C.

61. M1 Cutting, Newport Pagnell (SP856438)

An important temporary section from the top of the Rutland Formation up to the Upper Cornbrash was recorded in 1956, during excavation of the M1 motorway cutting near Portfields Farm (Horton, Shephard-Thorn & Thurrell, 1974). The succession recorded in this cutting suggests that it is in an area where the upper Great Oolite Group is markedly attenuated: sediments belonging to either the Lower Cornbrash or Forest Marble 'Rhythms' are not present beneath the Upper Cornbrash; the section is not far from the erosional margin of the Thrapston Clay, and it is probably beyond the erosional margin of the K. sharpi Beds. The following section is adapted and reinterpreted from that of Horton et al. (op. cit.), with additional details taken from both their text and figure 7:

UPPER CORNBRASH (0.87-1.25m)	Blue hearted, massive, sandy limestone with Upper Cornbrash brachiopods and bivalves; Macrocephalites (Dolikephalites) typicus, M. (Kamptokephalites) cf. bedfordensis, M. (K.) kamptus and M. (M.) cf. canizzoroi.	0.84-1.22m
	Layer of serpulid-encrusted limestone pebbles which contained Upper Cornbrash brachiopods and bivalves and macrocephalitid ammonite fragments	0.03m
	----------erosive base----------	
THRAPSTON CLAY (1.78-1.85m)	Pale green, purplish and variegated blue-black to green mudstone with greyish-green limestone doggers at the top; rootlets near the top; uppermost 0.46m yielded Viviparus, Tornus praecursor, corbulids, Neomiodon, Euestheria and 'Chara'	1.30m
	Green-tinted, white, 'marly' limestone	0.10-0.15m
	Greyish-brown mudstone	0.10-0.15m
	Green-tinted, white, 'marly' limestone with Praeexogyra hebridica, Placunopsis socialis and Modiolus imbricatus.	0.23-0.30m
WHITE LIMESTONE	Irchester Member (3.06-3.08m) Shelly, 'marly' limestone passing laterally into greyish-brown shelly 'marl'	0.46m

	Interbedded thin, grey, tabular limestones and greyish-brown 'marl'	0.26-0.28m
	Buff, well-laminated 'siltstone'	0.71m
	White, massive, oolitic limestone with shell debris	0.41m
	Not exposed	c.0.61m
	Brown 'marl' with thin lamination of grey clay	0.15m
	White, 'marly' limestone; Epithyris in upper part	1.02m
	Blue-hearted, brown-weathering, sandy limestone	0.46m
RUTLAND FORMATION	(?Cranford Rhythm)	
	Dark bluish-green, sandy clay	seen 0.30m

The flora and fauna collected from the very top of the Thrapston Clay here are essentially non-marine in character and the uppermost 0.46m of clay may have been deposited in a small brackish to freshwater lake within a coastal swamp environment. The Lower Cornbrash is totally absent from this immediate area; the limestone pebbles at the base of the Cornbrash were instead derived from a bored, intra-Upper Cornbrash hardground, seen in situ by the Survey in a temporary exposure at Portfields Farm (SP85694418).

100m further north, the Thrapston Clay apparently thickens to 3.28m (measured by Casey & Owen; Horton et al., op. cit.), but details from this more northerly section have not been published. The White Limestone in this area can all be assigned to the Irchester Member. The absence of the Kallirhynchia sharpi Beds, or any lateral equivalent, results from the southeastward overstep of Rhythm C onto Rutland Formation rhythms (cf. Bromham, Loc. 74, only 19km distant).

62. Weston Underwood (SP861514)

An old quarry near Cowper's Alcove was reopened in the early 70's to supply hardcore to Milton Keynes. Only the uppermost 2.5m of the Irchester Member was exposed in April, 1982 when the section in Fig. A-7 was measured. A lenticular bed up to 0.6m thick, packed with Digonella digonoides, was formerly exposed at a lower level within the Irchester Member (G. Osborn, pers. comm.).

63. Court Farm Railway Cutting, Olney (SP877528)

The section once exposed here was as follows (from Woodward, 1894):

L. CORNBRASH	'Marly' and shelly limestones, not very fossiliferous; M. echinata, R. vagans, O. obovata, etc.	c.1.83m
THRAPSTON CLAY	'Great Oolite Clay'	c.3.05m
WHITE LIMESTONE	Rubbly and 'marly' beds; 'stone-beds'	thickness not given

The Lower Cornbrash is well developed in the Olney area, although absent at Newport Pagnell to the south and in much of the Bedford area to the east.

64. Warrington

Woodward's (1894) section from the former Warrington Stone Pit (SP895534) can be abstracted and interpreted as follows:

THRAPSTON CLAY (0.91m+)	Brown clay	0.30-0.61m
	'Marly' clay	0.30m
WHITE LIMESTONE (6.98m+)	Irchester Member (4.86m)	
	Pale, fissile limestone	0.30m
	Pale, rubbly 'earthy' limestone and clay	1.52m
	Banded, 'marly' limestone Fissile, limestone with scattered ooids Hard, oolitic limestone with 'marly galls'	1.52m
	Cross-bedded oolitic and bioclastic limestone	1.37-1.52m
	Kallirhynchia sharpi Beds (2.12m+)	
	Calcareous, sandy beds	0.61m
	Hard limestone	0.30m
	Calcareous sandstone	0.30m
	'Poor stone'	0.91m

Within the Irchester Member, Lithofacies association C appears to have been developed above cross-bedded limestones of Lithofacies association B. The sandy beds in the lower part of the section probably belong within the K. sharpi Beds, although the index species was not collected here (Woodward, op. cit.).

In the 1970's, alterations to the A509 (SP897537) exposed temporary sections from the White Limestone up to the Cornbrash. Gordon Osborn has kindly allowed me to study his fieldnotes and the samples he collected at the time. The following composite section is the result (my additions in brackets):

LOWER CORNBRASH (1.25m+)	Limestone	0.50m
	Brown clay	0.30m
	Limestone	0.45m
THRAPSTON CLAY	Green and purple, unfossiliferous clay	c.3.24m
WHITE LIMESTONE	Irchester Member (2.81m+)	
	Rubbly limestone, locally iron-stained; Epithyris and ?Eomiodon (rootletted, faintly laminated, argillaceous, biowackestone/mudstone)	0.74m
	Dark clay with fossil wood and much carbonaceous matter	0.33m
	Cross-bedded, unfossiliferous limestone	0.36m
	Brown, clayey bed with Epithyris and R. vagans	0.15m
	Hard limestone with pockets of calcite and Epithyris (bioturbated, very fine to medium oobiowackestone/packstone with ?Cyathopora, Plagiostoma, Epithyris, Modiolus and Praeexogyra)	0.30m
	Clay parting	0.05m
	Hard limestone with Epithyris	0.28m
	Clay	0.10m
	Hard limestone	0.50m

65. Newton Blossomville

Arkell (1933a) noted that 'a large, modern quarry' at Newton Blossomville exposed at that time, about 4m of massive Forest Marble limestones. There are now no remaining exposures in this area. The quarry may have been at SP934511, although this is recorded only as 'old clay pits' on the 1:25000 O.S. Sheet SP95; G. Osborn (pers. comm.) has suggested that Arkell referred to a former quarry at SP899516 which yielded several imperfect Cetiosaurus vertebrae now housed in the Cowper & Newton Museum, Olney. Wherever Arkell's quarry was located, it was in the White Limestone, not the Forest Marble, for the latter is not developed in this area. The Irchester Member between Olney and Bedford, on the other hand, contains a high proportion of cross-bedded oobiograinstones, lithologically similar to the Oxfordshire Forest Marble that Arkell knew so well.

66. Lavendon (SP91625368)

A temporary excavation in the White Limestone at Lavendon yielded abundant digonellids (G. Osborn, pers. comm.). Such occurrences of Digonella digonoides indicate the presence of the Irchester Member.

1.2.4 Bedfordshire

67. Temporary exposure, Turvey (SP94105227)

The following small section, exposed during the construction of a garage, was measured in 1984:

WHITE LIMESTONE	Irchester Member (1.58m+)	
	Fine-grained oopackstone	0.16m
	Trough cross-laminated, fine-grained oograinstone/packstone	0.29m
	Interlayered mud and fine to medium-grained bioclastic sand; P. hebridica, echinoid spines	0.09m
	Bioturbated intraoopackstone; P. hebridica, Globularia	0.20m
	Interlayered bioclastic, sandy mud and mud; P. hebridica, echinoid spines	0.29m
	Oowackestone with biooograinstone laminae	0.19m
	Interlayered bioclastic, terrigenous mudstone and biopelpackstone	0.26m
	Bioturbated, very fine-grained biopelpackstone/wackestone	0.10m

68. Sander's Pit, Turvey (SP94755380)

An old quarry near Northey Farm, between Turvey and Carlton, was re-opened in the early 1970's to supply hardcore to Milton Keynes (G. Osborn, pers. comm.). About 3-4m of White Limestone is said to have been exposed beneath 0.9-1.2m of Thrapston Clay; the overlying Lower and Upper Cornbrash were visible at one end of the quarry. Subsequently the pit was largely back-filled, but the following small section, low in the Irchester Member, has been preserved:

WHITE LIMESTONE	Irchester Member (1.84m+)	
	Trough cross-laminated oobio- and biooograinstone with micrite clasts present locally; in places a slightly bioturbated oobiopackstone	0.80m

	Bioturbated oobiopackstone and wackestone; P. hebridica, D. digonoides, echinoid spines	0.46m
	Rubbly weathering, bioturbated biooopackstone; P. hebridica, Epithyris	0.58m

Gordon Osborn informed me that higher beds, no longer exposed, contained Diplocraterion.

69. Stagsden Quarry (Unlocated; c.SP995502?)

Woodward (1894) gave a section from here which illustrates the thinning of the Thrapston Clay in the Bedford area.

KELLAWAYS BEDS	Clay	thickness not given
CORNBRASH	Tough, grey limestone	thickness not given
THRAPSTON CLAY	Brown, blue and green clay, locally calcareous; ironstone nodules at base	1.22m
WHITE LIMESTONE	Irchester Member (1.87m+)	
	Pale, 'marly', rubbly bed	0.76m
	Pale, 'earthy', shelly, cross-bedded limestone	0.38m
	Irregular band of 'earthy', cross-bedded limestone crowded with oysters	0.23m
	'Earthy, marly' clay	0.25m
	Pale, oolitic limestone; P. hebridica	0.25m
	Mottled, green-grey, clayey 'marl'	thickness not given

The Cornbrash here is thinner than at Franklin's Pit (Loc. 70). Lopha marshii, Ctenostreon rugosum and Microthyridina lagenalis indicate the presence of the Upper Cornbrash; the Lower Cornbrash may have been absent, as it is in the Newport Pagnell area. Woodward's (1905) later account suggests that the top of the White Limestone may have been channelled.

70. Franklin's Pit, Bedford (c.TL037515?)

The following section is based on Woodward's (1894, 1905) descriptions:

KELLAWAYS BEDS	Sands and clays, with calcareous sandstone 'doggers'	thickness not given
	Clay	3.05m
CORNBRASH	Dark blue-grey stone ('Pendle')	0.61-0.91m
THRAPSTON CLAY	Mottled yellow-green, red, grey and purple clay)	
	Dark, carbonaceous clay with concretionary ferruginous horizon)	2.74-3.05m
WHITE LIMESTONE	Tough, grey limestones and shaley beds	3.66m

The Thrapston Clay and Cornbrash are both thicker here than they are at Stagsden Quarry (Loc. 69). The section was probably similar to that more recently exposed at Bromham (Loc. 74), although there too the Thrapston Clay is thinner. A specimen of Clydoniceras collected here (Douglas & Arkell, 1932) proves that the Lower Cornbrash was once exposed.

71. Cox's Pit, Bedford (Unlocated)

Up to 5.64m of White Limestone, overlain by drift, was once exposed here (Woodward, 1894); this was probably all Irchester Member, with the Rutland Formation possibly encountered at the base of the quarry (clay was noted beneath the limestones). Cross-bedding was recorded in some of the limestones and Procymatoceras, Modiolus, Pleuromya, Praeexogyra and ?Vaugonia were collected here.

72. Clapham Gravel Pit (TL023531)

The section Woodward (1904a) measured in this pit can be classified as follows:

CORNBRASH	'Marly' and flaggy limestone; Lopha marshii	0.61m
THRAPTSON CLAY	Dark blue clay	0.91m
WHITE LIMESTONE	Grey limestones	1.52-1.83m
	'Marly' clay with P. hebridica	thickness not given
	'Marls' and limestones	thickness not given

These beds were folded into a small anticline, the axis of which was aligned NNW-SSE.

73. Temporary exposure, Clapham (c.TL030525?)

A trench near Clapham Working Men's Club temporarily exposed the following section (after Smart, 1959a):

DRIFT	Subsoil with fragments of limestone at base	1.83m
WHITE LIMESTONE (3.96m)	Whitish limestone	0.91m
	Blue limestone	3.05m
?RUTLAND FORMATION	Dark blue clay	0.30m

The fauna collected by Smart (op. cit.), which included Epithyris, Pseudolimea, Modiolus, Vaugonia and Globularia, is typical of the Irchester Member in this area. Smart's 'ammonite' (collected from the 3.05m thick unit of blue limestone; the enclosing matrix is a medium to coarse oobiograinstone) was actually a nautiloid (H.S. Torrens, pers. comm.).

74. Bromham

A section from the top of the Rutland Formation up to the Cornbrash was formerly exposed in a large quarry (TL027515) between Bromham and Clapham (Bradshaw, 1978). The group of gravel-pits in this vicinity includes the now overgrown 'Oakley Junction Pit' (TL027520) discussed by Smart (1959b, 1961a, 1961b) and formerly scheduled as a S.S.S.I. by the Nature Conservancy Council for its supposed exposure of fossiliferous Cornbrash. As Torrens (1980b) correctly noted, this exposure was of White Limestone (Irchester Member) and not Cornbrash. Abundant Epithyris were mistaken by Smart for Cererithyris intermedia and Digonella digonoides for Obovothyris obovata. The quarry at TL027515 is now flooded and access to it is prevented by a high fence. Fortunately, the White Limestone to Cornbrash section was recorded in some detail by Bradshaw in 1975/76, when the quarry was being worked by Mixconcrete. The following section is largely abstracted and interpreted from Dr. Bradshaw's fieldnotes, but with additional data taken from Bradshaw (1978) and from my own observations:

LOWER CORNBRASH	Intragrainstone/packstone with pebble bed at base; M. echinata, Pleuromya, pectinids, trigoniids	0.40m

THRAPSTON CLAY	Dark grey, carbonaceous, unfossiliferous clay. Ironstone nodules at the base	c.1.60m
WHITE LIMESTONE	Irchester Member (5.10m)	
	Fine grained, well-sorted, ripple cross-laminated biooograinstone at base, passing upwards into an increasingly sandy, less well-sorted biopelgrainstone containing micrite clasts towards the top; P. hebridica, P. socialis, M. imbricatus; Diplocraterion, Gyrochorte, Planolites and other trace fossils. Locally rootletted	0.62m
	Interlayered bioclastic sand and clay; P. hebridica; Gyrochorte, Teichichnus, Pelecypodichnus and Planolites	0.28m
	Finely laminated pelpackstone and wackestone with pelgrainstone/packstone laminae; locally ripple cross-laminated	2.01m
	Bioturbated biooopackstone/wackestone; P. hebridica, M. imbricatus and C. (Camptochlamys) obscurus	0.36m
	Large-scale cross-bedded biooograinstone; micrite clasts and small, transported gastropods. Cross-beds dip mainly towards the west	0.93m
	Bioturbated oobiopackstone and wackestone with grainstone lenses near base; abundant Epithyris; M. imbricatus, C. (Cc.) obscurus, Pseudolimea and Gressyla peregrina	0.60m
	Well-sorted, ripple cross-laminated oograinstone with micrite clasts and shell debris. Locally very sandy and argillaceous at the top. Wood debris and fish teeth abundant in places, particularly at base. May thicken laterally	0.30m
----------erosive base of Rhythm C----------		
RUTLAND FORMATION	(Rhythm B)	
	Interlayered terrigenous mud and sandy, bioclastic silt; rootletted; P. hebridica, P. socialis, Modiolus, Bakevellia, Eomiodon, Corbulomima	0.28m
	(Cranford Rhythm)	

The Irchester Member/Rhythm C succession clearly comprised Lithofacies association B overlain by Lithofacies association C.

75. Bourne End, Bletsoe (c.TL6003?)

The 0.84m of Cornbrash (all Upper Cornbrash) formerly exposed here (Woodward, 1894; Douglas & Arkell, 1932) may have represented the full thickness of the formation in this area. About 8km to the west, however, near Harrold, 0.61m of hard Lower Cornbrash limestone containing O. obovata was developed at the base of the formation (Douglas & Arkell, op. cit.).

76. Milton Ernest (TL022541?)

Smart (1959a) recorded the presence, in a ditch south of Milton Ernest, of at least 0.6m of Upper Cornbrash containing a variety of bivalves and rare Microthyridina lagenalis. No Lower Cornbrash fossils were found.

77. Sharnbrook

A temporary section through the White Limestone was exposed on the Colworth Park housing estate (c.SP9860) in March, 1960 and investigated by Smart (1961a). About 3m, low in the formation, were seen and the fauna collected indicates that the Kallirhynchia sharpi Beds were exposed. The presence of these beds in the Sharnbrook vicinity is further indicated by specimens of the index brachiopod collected by T.R. Jones from the 'lower part of the Great Oolite, Sharnbrook' prior to 1852 and later presented to the Geological Museum (specimens GSa4279-4281).

78. Wymmington Railway Cutting (c.SP959633)

A section from this cutting, a little beyond Wymmington Bridge (Thompson, MS.), was briefly described by Beeby Thompson (1927). The cutting which passes southwards into Sharnbrook Tunnel, described by Crick (1883), is on the other line, closer to Wymmington village. Thompson's description relates to an exposure created when the line was widened a few years prior to 1927:

WHITE LIMESTONE	Irchester Member (1.89m+)	
	Rubbly and very irregular limestone	0.91m
	Soft white limestone very full of D. digonoides and Epithyris	0.25m
	Clay bed, full of broken shells, particularly oysters	0.20m
	Harder, irregular bed with fossils	0.53m
	K. sharpi Beds	
	Hard blocks of limestone; K. sharpi obtained here	thickness not given

79. Hinwick (SP937618)

White Limestone was formerly quarried for use as a local building stone at Podington and Hinwick. Small openings at SP944626, SP946628 and SP937617 are now totally overgrown. A face of the quarry at SP937618 was still visible in 1981 when the following section was measured:

WHITE LIMESTONE	Irchester Member (1.45m+)	
	Bioturbated oobiopackstone and wackestone, locally argillaceous; Rollierella minima, Pleuromya, Epithyris	0.30m
	Cross-bedded oobiograinstone	1.15m

80. Dungee Stone Quarry (SP93905885)

Still worked in 1927 for walling, crazy paving and roadstone, this quarry was described by Thompson (1927); the following is abstracted from this account:

WHITE LIMESTONE	Irchester Member (2.58m+)	
	'Pendle'. Thinly-bedded, hard, blue, white-weathering, unfossiliferous limestone with rootlets	0.61m
	Shelly limestone	0.61m
	Thinly-bedded limestone	0.15m
	Rough, hard, blue-hearted limestone	0.30m
	Soft, locally shelly 'marl'	0.91m
	Hard, shelly limestone	thickness not given

As elsewhere in the district, rootlets penetrate the uppermost bed of the White Limestone.

1.2.5 Northamptonshire

81. Croughton (SP563335)

The section visible in RMC's Croughton Quarry between 1980-82 is illustrated in Enclosure A-7; the section extends from the top of Rhythm B up to the lower part of the Forest Marble 'Rhythm'. Previous authors (T. Palmer, 1974; Barker, 1976) have included details of beds of the Shipton Member no longer visible; e.g. T. Palmer (op. cit.):

Fissile blue clay with many P. hebridica; rootlets, Corbulomima, Protocardia, C. ibbetsoni and faecal pellet-filled crustacean burrows	0.50m
Hard biopelmicrite, passing down into	0.60m
Clay 'marl' with P. hebridica, passing down into	0.15m
Hard biopelmicrite, locally clayey and *sandy*; A. *loweana*, *Protocardia*, Trigonia, Globularia, Pholadomya, M. imbricatus, Isognomon, Plagiostoma, etc.	0.45m
Dark blue, peloidal clay; small shell fragments, echinoid spines, ostracods and small lignite fragments	0.15m
Very uniform, fine-grained, clayey micrite; occasional coarser patches suggesting burrows; also more obvious burrows	0.45m
Heavily burrowed, blue-grey, clayey biopelmicrite with abundant quartz sand; Isognomon, Pholadomya, A. loweana, P. hebridica, Epithyris, Modiolus, etc.	seen 0.60m

The Shipton Member at Croughton is therefore at least 1.9m thick.

Both Rhythms D and E are developed at this location, contained within the Bladon Member and the lowest part of the Forest Marble Formation. A channel cut into the top of Rhythm D was exposed in the quarry in 1980 (Plate 13).

82. Brackley Road Cutting (SP58943801)

This temporary section, which exposed the junction between the Shipton and Ardley Members, was measured by M. Bradshaw in 1976. The presence of rootlets at the top of Rhythm B here, as at Croughton, was noted by Bradshaw (1978). The following section is largely abstracted from Dr. Bradshaw's field descriptions:

WHITE LIMESTONE	Ardley Member Very hard, massive, bioclastic oograinstone, more fossiliferous towards the base	0.55m
	Shipton Member (0.86m+) Irregularly laminated, brown and green silty clay and clay, packed with oysters	0.04m
	erosive base of Rhythm C	
	'Root bed'. Finely, irregularly laminated at base, passing upwards into an olive green, slightly silty clay with drifted plant debris and ?rootlets	0.19m
	Interlayered sandy clay and quartz sand, with disarticulated oysters	0.43m
	Sandy biopelgrainstone/packstone; P. hebridica, Anisocardia	0.20m

83. Temporary exposure, Nether Radstone (SP59874013)

I am indebted to M. Bradshaw for the following description of a temporary White Limestone section made in 1976 at Coldharbour Farm (with additional data from a study of his field specimens, in parentheses):

WHITE LIMESTONE	Shipton Member (1.82m+) Hard, well-cemented, very fine to fine quartz-sandy micrite (bioturbated, very quartz-sandy biomudstone with grumeleuse texture)	0.07m
	Alternating bands (about 0.05m thick) of orange-brown, irregularly laminated, quartz-sandy clay and cream weathering micrite; Ceratomya, ?Camptonectes and M. imbricatus	0.61m
	Nodular, cream weathering, very fine quartz-sandy, argillaceous micrite with occasional oyster fragments; ?Eocallista/ Anisocardia, Protocardia, P. socialis and high-spired gastropods	0.20m
	Soft, irregularly laminated, very fine to fine quartz-sandy clay; ?Eocallista/ Anisocardia, P. hebridica and high-spired gastropods	0.09m
	Massive, soft, white weathering, very fine quartz-sandy, argillaceous, fossiliferous micrite; bioturbated; ?Anisocardia, Protocardia, Parallelodon, Pholadomya, P. socialis, P. hebridica, trigoniids, bereniciform bryozoans and high-spired gastropods (very fine to	

	fine, very quartz-sandy pelbiowackestone with argillaceous patches; serpulids)	0.54m
	Green and brown, irregularly laminated, very fine quartz-sand, P. hebridica and crushed Burmirhynchia	0.31m

Bradshaw (1978) suggested that this section was lithologically similar to his 19-22m interval in the Ardley-Fritwell Railway Cutting (Loc. 28). Blocks of white weathering, fossiliferous micritic limestone with abundant nerineid gastropods were collected loose at this exposure. The gastropods can be identified as Aphanoptyxis excavata (specimens in the M.J. Bradshaw collection) and are of considerable correlative importance. Kallirhynchia sharpi was not obtained at this exposure, but larger rhynchonellids of Burmirhynchia-type were.

84. Helmdon South Railway Cutting (SP587428)

When Woodward (1897) described this section, up to 16.05m of Jurassic strata were visible beneath 7.62m of Chalky Boulder Clay. Bradshaw (1978) has suggested that the uppermost 6.61-8.13m of the Middle Jurassic belonged to the White Limestone, with the underlying 7.92m belonging to the Rutland Formation. The White Limestone section, no longer exposed, was described by Woodward as follows:

WHITE LIMESTONE (8.13m+)	'Marls' and thin clay bands with oysters and 'marly' limestone with many Pholadomya; sandy limestone at base	6.10-7.62m
	Brown sand with lignite and oysters Irregular clay seam Brown sand and clay with oysters	0.51m
RUTLAND FORMATION (7.92m+)	Dark grey clay, passing down into greenish-grey clay	1.22-1.53m
	Yellowish clay with rootlets	3.66m
	Blue limestone with Modiolus and trigoniids	2.74m

The Wellingborough Member at the base of this section is still exposed (to about 1.5m), overlain by blue-green clay. Higher in the sloped east bank of the cutting, slumped White Limestone can be collected. This comprises quartz-sandy lithologies comparable to those of the Shipton Member at Croughton and Ardley; Camptonectes laminatus were collected. Thickness considerations suggest that the White

Limestone seen by Woodward may have included basal Ardley Member as well as the sandy and argillaceous Shipton Member. It is notable that no Kallirhynchia sharpi have ever been collected from the lower part of the White Limestone at Helmdon.

85. Old quarry, Silverstone (SP672441)

Thompson's (1927) section, made here in 1916, is as follows:

FOREST MARBLE	Blue clay	3.05m
WHITE LIMESTONE (4.27m+)	?Bladon Member Soft, 'marly' limestone	1.22m
	?Ardley Member Limestone, more compact than above, in blocks, apparently fragmental and little oolitic, with few fossils.	3.05m

The section can be compard with that at Pury End (Loc. 96). Thompson's description is very similar to that of Woodward (1894), although the latter suggests that the upper part of the ?Bladon Member yielded oysters and other bivalves, while the lower 0.91m may have been slightly oolitic or intraclastic.

86. Culworth (SP53884588)

Bradshaw (1978) suggested that most of the limestone formerly quarried at Culworth was from the Wellingborough Member, and that the rhynchonellids recorded by Thompson (1927) were Burmirhynchia rather than Kallirhynchia sharpi. White Limestone was probably once quarried at SP53884588 (Bradshaw, op. cit.), 'from whence might have come the Digonella digonoides known from the area (Thompson, op. cit.).

87. Astwell (SP6144)

A temporary section in a drainage ditch (SP61444433) near Astwell Castle was measured by A. Horton (BGS, MS) during the mapping of the Towcester Sheet (202). Over 3.5m of argillaceous limestones interbedded with clay were recorded, yielding oysters, trigoniids and rhynchonellids. Although interpreted as representing basal White Limestone, 'Upper Estuarine Series' and 'Upper Estuarine Limestone', the whole of this section may belong within the Wellingborough Member. Rhynchonellids in the 0.91m of 'pale grey and yellow mottled argillaceous limestone'

classified as basal White Limestone are more likely to have been typical Rutland Formation forms than Kallirhynchia sharpi.

Thompson (1927) noted that the quarry at SP60634353 yielded 'a rubbly, semi-crystalline limestone with various fossils including gasteropods and coral'. This was certainly White Limestone, probably basal Ardley Member. A similar lithology (a bioturbared, slightly quartz-sandy biointragrainstone) was encountered in a field traverse from SP61004368 to SP60704378 in March, 1982; it contained fish teeth, nerineid gastropods and Pholadomya. At a lower level, close to Broad Meadow Barn, a very quartz-sandy oobiowackestone containing rare rhynchonellids was collected; M. Bradshaw (pers. comm.) stated that these rhynchonellids were Wellingborough Rhythm Burmirhynchia and that the limestone was typical of the Wellingborough Member in this region. Kallirhynchia sharpi was not encountered beneath Ardley Member lithologies in this traverse.

88. Lois Weedon (SP61394728)

(Loys Weedon, Weedon Lois)

Thomson's (1927) section from a quarry on the Wappenham Road, made in 1883, can be interpreted as spanning the contact between the Shipton and Ardley Members:

WHITE LIMESTONE	Ardley Member (2.13m+)	
	Rubbly, disturbed limestone with fairly numerous gastropods (?Globularia, nerineids) and Epithyris	1.22m
	'Nerinea Bed?' Harder and more compact limestone, with many fossils including two species of nerineid gastopod and some coral	0.91m
	Shipton Member	
	Softer limestone with Pholadomya, etc.	c.1.52m

The top of the Shipton Member here contained Pholadomya, as does the upper part of the Kallirhynchia sharpi Beds at Roade (Loc. 106). Here, however, no Kallirhynchia sharpi were recorded. Bradshaw (1978) notes that at least twelve ancient quarries have been discovered in the parish of Weston and Weedon, but that these all worked the Wellingborough Member.

89. Grimscote (SP65375400)

A former exposure of the Ardley Member north of Grimscote yielded Digonella digonoides (Thompson, 1927).

90. Catanger Farm Quarry, Woodend (c.SP614482)

Thompson (1927) recorded the following small section at this location:

WHITE LIMESTONE	Ardley Member (3.07m+)	
	Disturbed 'marl' and limestone fragments	0.79m
	'Echinoderm Bed'. Soft, very fossiliferous 'marl'. Abundant small echinoids	0.91m
	Brown clay	0.15m
	'Terebratula digona Bed'. Fossiliferous limestone with Digonella digonoides and Epithyris	1.22m

The whole of this section can be assigned to Lithofacies association B, characteristic of the Ardley/Irchester Member in Northamptonshire. The section is probably at a slightly higher level, stratigraphically, than the top of the Lois Weedon section (Loc. 88), a fact which is supported by Thompson's (1927) statement that limestones from a nearby quarry at a lower topographic level yielded 'Natica' (?Globularia) and 'Nerinaea' (nerineid gastropods); these would have been from low in the Ardley Member.

91. Dalscote (SP687546)

Thompson's (1927) section from the now infilled quarry at SP687546 can be interpreted as follows:

WHITE LIMESTONE	Ardley Member (3.74m+)	
	Soil and disturbed white limestone	1.37m
	Hard, thinly-bedded oolitic limestone (called 'Pendle')	1.07m
	Hard, blue-hearted, oolitic limestone; ?coral	1.22m
	Dark-coloured 'marl'	0.08m
	Stone	thickness not given

92. Greens Norton (SP666493)

Thompson (1927) noted that stone had been quarried at both SP667496 (between the old windmill and Bengal) and at SP66354924 (west of Bengal), but that by the 1920's these exposures had disappeared. He also mentioned that locally derived Kallirhynchia sharpi were found in the material used to cover up the first section. That some exposure remained in the quarries of the vicinity is indicated by the following record made by A.D. McAdam in 1964 (BGS, MS.) at SP666493:

?FOREST MARBLE	Soil; brown clay	seen
	Green clay	0.15m
WHITE LIMESTONE	White, flaggy weathering, sparsely shelly, finely crystalline limestone	0.23m
	Green clay	0.15m
	Massive, fine-grained, non-oolitic, shelly, crystalline limestone	0.66m
	White weathering, soft, 'marly' limestone	thickness not given
	White weathering, fine-grained limestone with abundant complete shell moulds	0.15m
	Grey-brown weathering, oolitic limestone with large oysters and other shells	0.38m

This section may have extended up into the Forest Marble, but this is by no means certain.

93. Field Burcote (c.SP6651?)

1.52 metres of White Limestone, formerly exposed at Field Burcote, contained gastropods, corals, terebratulids, echinoderms and rare rhynchonellids (Thompson, 1927). Thompson's classification of the section suggests that the uppermost Kallirhynchia sharpi Beds may have been exposed, but that most of the exposure belonged to the basal Ardley Member. Thompson obtained an ammonite from here, almost certainly from the lower part of the Ardley Member. However, the ammonite, an indeterminate perisphinctid (Torrens, 1980b), is of little biostratigraphic value.

94. Maidford Limestone Quarry (SP61305215)

A section measured in a small, disused quarry southeast of Maidford is shown in Enclosure A-8. This is the quarry described by Thompson (1927) as one of two quarries south of Maidford. The other, now infilled, was at SP614521. A correlation of Thompson's description with mine is attempted on Enclosure A-8. Aveline & Trench (1860) and Woodward (1894) have also described brief sections from the Maidford quarries; that of the former authors is closely comparable to Thompson's description made in 1889. Thompson's section comprises 5.16m of White Limestone beneath 3.66m of drift, a greater exposure than was visible in November, 1983. Although Thompson may have been over-generous with the thicknesses of his beds 2-5, it appears that the lowermost 2.45m of his section is no longer exposed. These lower beds, which included oolitic limestones containing nerineid gastropods, must belong to the Ardley Member. However, it is possible that the coral bed (Thompson's bed 6) may be basal Bladon Member, as is the case in the Roade-Wooton area. If so, the possible Diplocraterion recorded beneath the coral bed occurs at the top of the Ardley Member (and at the top of Rhythm C), as is the case at other localities in the east Midlands.

95. Stowe-IX-Churches (SP64485737)

An incomplete section from the Northampton Sand up to the Cornbrash was formerly exposed at this quarry in the faulted outlier of upper Great Oolite about Church Stowe. The section, first recorded by Phillips (1871) but more fully described by Thompson (1891, 1927), Thompson & Crick (1891) and Woodward (1894), is particularly significant because of its northwesterly situation. A small exposure of White Limestone measured in 1982 is illustrated in Enclosure A-8; Thompson's (1927) equivalent bed numbers are indicated. The following, more complete section has been abstracted and reinterpreted from Thompson's various accounts; bed numbers are taken from Thompson (1891), except those in brackets which correspond with Thompson's (1927) later description:

DRIFT		0.30-1.22m
?KELLAWAYS BEDS	Blue clay	1.52m
LOWER CORNBRASH	1. Fossiliferous limestone in two beds: upper, 'rubbly' bed with abundant serpulids; lower, white bed with fairly common fossils (R. vagans, O. obovata, etc.)	1.52m
FOREST MARBLE (4.95-6.01m)	2. Variegated clay (?with vertical burrows or rootlets)	0.08-0.23m
	3. Hard, flaggy, blue-hearted limestone (probably lenticular) and shale; P. hebridica, ?M. imbricatus, ?Mactromya, ?Anisocardia/ Rollierella and bedded wood debris (?logs)	0.45m
	4. Variegated clay; lignite and carbonaceous debris; ?vertical burrows or rootlets	0.76m
	5. Hard, compact, blue-hearted limestone (probably lenticular) with abundant wood debris, and hard shale; Plac. socialis, Protocardia, etc.	0.76m
	6+7. Blue and purple clay (?locally infilling a channel in the uppermost White Limestone); abundant lignite; band of ironstone nodules and occasional oysters at base	2.90-3.81m
WHITE LIMESTONE	Irchester Member (7.68m)	
	8.(1.) Light coloured 'marl' (?argillaceous biomudstone) with occasional P. hebridica; fine carbonaceous rootlets. Bed locally cut out by a channel?	0.84m
	9. Fossiliferous white limestones with thin 'marl' partings (not 9.75m):	
	(2.) Flaggy, hard, unfossiliferous limestone	0.91m
	(3.) Soft, fossiliferous limestone with nerineid gastropods	c.0.91m
	(5.) Limestone	c.1.52m
	(6.) 'Nerinaea Bed'. Hard, cross-bedded, fossiliferous limestone	0.91m
	(7.) 'Lower Terebratula Bed'. Limestone in irregular masses in a white 'marl'. Fossiliferous with Epithyris, etc.	c.1.22m
	K. sharpi Beds (1.22m+)	
	10.(8.) Calcareous clay	c.0.91m
	11. (9.) Hard, shelly, fissile limestone with common P. hebridica and occasional K. sharpi	c.0.30m

	GAP	
RUTLAND FORMATION	12-14.	seen: only lowest 4.27-5.79m
NORTHAMPTON SAND	15-16.	seen: 6.71m

Pittham (1970) collected terebratulids, gastropods, oysters, echinoids and fish palate teeth from rubbly limestones and 'marls' which he correlated with Thompson's (1927) bed 7. Thompson's (1891) list of fossils collected from bed 9 of that account comprises a typical Irchester Member fauna.

The Forest Marble of the Stowe area, and also further south at Grimscote (Aveline & Trench, 1860), is similar to that of north Oxfordshire, although oobiograinstones are subordinate to argillaceous sediments. Specimens of biooograinstone, containing abundant wood debris and rounded micrite clasts, were collected as brash by M. Bradshaw (MS.) at the sites of former quarries in the Forest Marble at SP64005792 and SP64275755.

No trace of Upper Cornbrash has been recorded at this section, and, as in the Bedford area, Cererithyris has not been collected from the Lower Cornbrash.

96. Pury End (SP707459)

Most of the White Limestone was formerly visible at Pury End (Pittham, 1970), but only the upper part of the Ardley Member to lowermost Forest Marble section is presently exposed (Encl. A-8). The upper c.1.5m of the Ardley Member comprises biograinstones/packstones and finely laminated pelpackstones/grainstones of Lithofacies association C; there is considerable lateral variation within this part of the section. The Ardley Member at Pury End is c.4.20m thick, for the base of the member can confidently be placed at the base of Pittham's Bed 16, a thin, 'pseudo-oolitic' limestone containing Procymatoceras. Beneath this, at least 0.6m of the softer-weathering, more argillaceous K. sharpi Beds were once seen. Pittham's (1970, 1973) discovery of K. sharpi at Pury End constitutes the most southwesterly record of this brachiopod.

The top of the Ardley Member here is planed and iron-stained, but further evidence of hardground development (borings, encrusters) is lacking. The Bladon Member is thin, comprising 0.18m of green clay interlayered with bioclastic silt to coarse sand, overlain by a 0.66m

unit of argillaceous biopelmudstone and wackestone which grades up into rootletted lime mudstone.

The Pury End quarry was first described by Thompson (1927), when 'Mr Pell's Quarry' was worked for lime, roadstone and walling material. The quarry was extended in the early 1960's to supply roadstone for the M1 motorway (BGS, MS).

97. Lord Penrhyn's Quarry, Deanshanger (SP754394)

Woodward's (1894) section from 'a quarry west of Deanshanger' probably referred to this pit, called Lord Penrhyn's by Thompson (1927); Torrens (1967) recorded a similar section to Woodward's here, but the site was being infilled and little exposure remained in July, 1982 when the section in Enclosure A-8 was measured.

98. Deanshanger Brickworks (SP76103979)

Woodward's (1894) section from here (partially reported in Thompson, 1927) can be interpreted as follows:

WHITE LIMESTONE	Ardley Member (3.54m+)	
	Shelly bed with Clypeus and gastropods	0.45m
	Rotten 'marly' and 'earthy' beds	0.81m
	Clayey bed	0.15m
	Whitish, 'marly' stone	1.07m
	Blue clay with P. hebridica and thin calcareous stone	0.91m
	Grey, 'marly' bed	0.15m
RUTLAND FORMATION	Stiff, blue, black and greenish clay	c.5.48m
	White sand	seen

The overlying 2.44-3.05m of 'impure and oolitic limestones' with seams of blue clay formerly worked for building-stone was probably exposed in the disused pit west of Little London (Hurst's Pit, at SP745400), mentioned by Thompson (op. cit. & MS.). The Shipton Member/ K. sharpi Beds are apparently not developed at Deanshanger.

99. Temporary exposures, Deanshanger

Albert Horton measured a number of temporary sections exposed during the construction of a housing estate at Deanshanger in 1963 (BGS,

MS.). Two sections of the basal White Limestone can be tentatively interpreted as follows:

1. Drainage ditch: SP75943966 to SP75843986

WHITE LIMESTONE	Ardley Member (6.01m+)	
	Reddish-brown, oolitic 'marl'; oysters	0.61m
	Rubbly weathering ?oograinstone with scattered fossils	c.0.91m
	Greenish-brown 'marl'; P. hebridica	0.51m
	?Bioograinstone with occasional 'marly' to sub-porcellaneous layers; very argillaceous, rubbly, 'marly' limestone in top 0.30m	0.69m
	?Oograinstone and ?biograinstone, well-bedded and flaggy; occasional P. hebridica	c.1.22m
	Grey, argillaceous, oolitic limestone	c.0.91m
	?Oobiograinstone with shelly bands; oysters, rhynchonellids, etc.	c.1.52m
RUTLAND FORMATION	(?Cranford Rhythm)	
	Light green clay	0.30m
	Greyish-green, silty clay; ?rootlets etc.	0-0.15m

The most likely interpretation of this section is that the Ardley Member has here overstepped onto Rutland Formation (?Cranford Rhythm) sediments; the rhynchonellids seen at the base of the White Limestone were probably Burmirhynchia rather than K. sharpi.

2. Sump pit: SP75793987

WHITE LIMESTONE	Ardley Member (3.58-3.66m+)	
	White to pale, cream, shelly oolitic limestone, locally hard and massive; locally decalcified to soft, yellow ooid sand	seen 1.83m
	Pale grey, 'marly', fine-grained, shelly limestone with ooids; finely comminuted plant debris; very shelly at base	0.94m
	Dull greenish-grey clay with scattered oysters	0.15-0.23m
	Pale grey, soft, rubbly to splintery, 'marly' limestone; locally a calcite mudstone with coarser, oolitic bands; very fine-grained at base	0.66m

RUTLAND FORMATION	(?Cranford Rhythm)	
	Pale grey-green silty clay	c.0.45m
	Dull purple-grey, silty clay; green bands towards the top and dark carbonaceous bands below	c.0.30m

100. Cosgrove (SP784419)

J. Morton (1712) believed that the quarries of Cosgrove were the most ancient and noted in southern Northamptonshire, stone in Morton's time having not only been quarried but also mined north of the Cosgrove-Old Stratford road. Thompson (MS., Northampton Central Library) added the following details to his 1927 'Lime resources of Northamptonshire' publication:

'In the rock face of the open workings immediately under the road I saw 12'0" (3.66m) below the road there was, in 1908, a little door which on opening disclosed a passage going under the road to the old underground workings on the north side of the road. Some years previously, as the rector, the Rev. H.N.C. Hewson informed me, they explored the underground workings and found numerous blocks of dressed stone'.

In 1927, Thompson noted that 'the two doorways are now practically blocked by talus' while at the base of his section he recorded the presence of 7'0" (2.13m) of building stone, mostly obscured by talus. Comparison of the sections given by Thompson (1927) and Torrens (1967) clearly shows that by 1967, the building stone horizon was no longer exposed. The exposure that remains today at Cosgrove corresponds well with the descriptions of both Torrens (1967) and Horton, Shephard-Thorn & Thurrell (1974); the section I measured is illustrated in Enclosure A-8.

Lithofacies association C is well-developed within the upper part of the Irchester Member and within this facies trace fossils are conspicuous. The occurrence of Diplocraterion here was first discussed by Torrens (op. cit.) who compared them to Arenicolites statheri Bather; a photograph of a Cosgrove Diplocraterion was reproduced in Hains & Horton (1969) and in Horton et al. (op. cit.). Gyrochorte, Pelecypodichnus and Imbrichnus were observed on bedding planes towards the top of the section; these may correspond to the 'beds of flaggy sandstone plentifully marked by the tracks and sandy excrement of worms' noted by Green (MS., repeated in Woodward, 1894).

'Cosgrove Stone', which, as remarked above, came from a level within the Irchester Member lower than that presently exposed, probably came from Lithofacies association B. Judging from Thompson's (1927) description, the Irchester Member at Cosgrove is at least 6.4m thick.

101. Hartwell (SP781492)

By the time I visited Hartwell Quarry in August, 1981, all of the important faces had been buried beneath material brought from Great Houghton, where a reservoir was being excavated; the infilling of the quarry had begun only ten days earlier! Fortunately the White Limestone section formerly exposed had been described in 1976 by M. Bradshaw, who provided the following details (additions in parentheses are my observations on his field specimens; the subdivision of the section is also my own):

WHITE LIMESTONE	Ardley Member (5.09m+)	
	Thinly bedded limestone	0.17m
	Soft, white, rubbly, oolitic micrite	0.50m
	Biooosparite interbedded with undulating, finely-laminated 'algal mats' (laminated biopelgrainstone, biopelpackstone and grumuleuse biomudstone/wackestone); vertically-retrusive Diplocraterion; rare Epithyris	1.61m
	Cream weathering oolitic micrite to pure micrite with oysters and M. imbricatus; loaded base	0.24m
	Brown and green, finely interlayered clay and very fine-grained sand	0.14m
	Biooosparite interbedded with finely laminated micrite containing bioclastic sand laminae Diplocraterion	1.09m
	Hard, cream weathering oolitic micrite with abundant oysters; M. imbricatus, ?Pteroperna/Isognomon	0.45m
	Brown oolitic clay	0.02m
	Medium to fine-grained peloosparite; oysters, ?Bactroptyxis, ?Anisocardia, ?Thracia, ?rhynchonellids	0.18m
	Massive, poorly cemented, medium to fine-grained biooosparite; occasional oysters	0.26m
	Brown, finely interlayered clay and silt	0.04m

	Very hard, massive limestone (bioturbated, sandy, locally poorly-washed, intrabiograinstone; comminuted plant debris). Gradational base	0.28m
	Soft, grey to grey-green, finely and irregularly interlayered coarse bioclastic sand and clay	0.11m
	K. sharpi Beds (3.15m) Hard, massive, buff-cream, medium to fine-grained biooosparite with occasional micrite pellets; oysters, ?Limatula, small Pholadomya, ?nerineid gastropods, ?Anisocardia; Planolites (bioturbated, sandy pelbiowackestone/ packstone). Gradational base	0.70m
	Soft, black to brown, finely laminated bioclastic clay. K. sharpi at base only	0.45m
	Hard, grey, coarse to medium-grained, argillaceous, fossiliferous micrite; occasional oysters, M. imbricatus and ?Pteroperna; abundant K. sharpi	0.30m
	Black, bioclastic clay	0.08m
	Massive, fossiliferous, cream weathering but grey-hearted limestones; K. sharpi, Pholadomya, echinoid spines; Teichichnus	1.42m
	Soft, grey to black, less fossiliferous, slightly bioclastic clay	0.10m
	Black, finely laminated, silty clay with abundant K. sharpi; erosive base	0.10m
RUTLAND FORMATION	(Cranford Rhythm) Unfossiliferous, bright green, silty clay with abundant black, carbonaceous roots	0.20m+

Lithofacies association C was well developed in the upper Ardley Member/Irchester Member at Hartwell, as it is at Castlethorpe, Pury End, Cosgrove and Blisworth East (Loc. 52, 96, 100 & 107). Lower beds of the Rutland Formation were measured by Bradshaw in temporary exposures at the quarry (Bradshaw, 1978).

102. Easton Neston (SP71335107)

Thompson (1927) recorded the presence of at least 7.8m of White Limestone in this pit, but his description is difficult to interpret. K. sharpi was obtained from a trial hole sunk a little to the west of this quarry.

103. Towcester-Olney Railway Cuttings, Roade (SP754508)

Woodward (1894) recorded the following section through the White Limestone in these cuttings:

WHITE LIMESTONE	Bladon and Ardley Members (6.09m+)	
	Pale, fissile and 'earthy' limestone; *P. hebridica* abundant at the base	0.91-1.22m
	Pale, 'earthy' limestone	0.61-0.91m
	Shelly and oolitic, cross-bedded limestone	3.66-3.96m
K. sharpi Beds (2.44m+)	Rubbly 'marl' with indurated bands; *P. hebridica*, etc. sparingly; at base, a 'marl' with *K. sharpi*, *P. hebridica*, *M. imbricatus*, *Plagiostoma cardiiformis*, etc.	2.13m
	Rotten 'marly' limestones with *K. sharpi*, etc.	0.61m
	Rubbly 'marl' with *Pholadomya*, *P. hebridica*, *K. sharpi*; very shelly in places	1.52-1.83m
?RUTLAND FORMATION	Greenish grey and brown clay, with many specimens of *P. hebridica*	1.22m+

The W.D. Crick collection contains specimens of *Epithyris*, *D. digonoides* and '*Isastraea*' collected from the White Limestone of these cuttings. Thompson (1927) recorded a section through the basal 3.66m of White Limestone (overlying green, rootletted clay: ?Cranford Rhythm) from the cutting adjacent to Roade Soil Fertility Quarry (Loc. 104); his bed 2 (a 0.16m thick limestone full of *K. sharpi*) is still exposed.

104. Roade Soil Fertility Quarry (SP754511)

This quarry was described by Thompson (1927: Mr. Sturgess's Pit) and Pittham (1970). My own version of the section is illustrated in Enclosure A-9. The basal Bladon Member coral bed, described by Pittham (*op. cit.*) as a 'white, argillaceous limestone.... with *Isastraea*, *Thamnasteria*, *Clausastraea* and sponges', was no longer exposed in 1981; nor was the contact of the *Kallirhynchia sharpi* Beds with the underlying Rutland Formation. Pittham's description suggests that Rhythm B overlies the Cranford Rhythm here.

105. Roade Village Quarry (SP764516)

The following section is still visible at SP764516:

WHITE LIMESTONE	Bladon Member Rubbly weathering oobiopackstone/ wackestone containing abundant coral ('Isastraea', Lochmaeosmilia), Epithyris, Nucleolites, Plagiostoma, Pinna, 'Lithophaga'	0.48m
	GAP	
	Ardley Member Trough cross-bedded biooograinstone; graded intrasets, with micrite clasts at the base of some	1.44m

This may be the 'Mr Blunt's Quarry' mentioned by Thompson (1927), although that could also have been at SP75955154; if the latter is the case, this extant section must be the exposure 'on the northern side of the Hartwell road, close by the village', mentioned by Thompson.

106. Roade Railway Cutting (SP74605312)

I have every sympathy with the seven members of the Warwickshire Naturalists' and Archaeologists' Field Club who visited this cutting on a miserable, rain-soaked day during the summer of 1879 (Anon, 1880). I was drenched on two consecutive Sundays while examining the section here in May, 1981. The section, which holds the key to correlation of the White Limestone of Oxfordshire/S.W. Northants. with that of areas to the northeast, is illustrated in Enclosure A-9. Of particular importance is the possible occurrence of Aphanoptyxis excavata in a bed near the top of the K. sharpi Beds. The 'Nerinea Bed' developed at the base of the overlying Ardley Member here is similar to the basal sediments of the Ardley Member in Oxfordshire.

Rhythm A is developed here, close to its erosional margin. It comprises only siliciclastic sediments, is 0.45m thick and is contained entirely within the Rutland Formation.

As at Stowe to the west and Irchester and Bozeat to the east, the uppermost bed of the White Limestone is rootletted (Thompson, 1924). The overlying Forest Marble Formation is now not exposed but was described by Thompson (op. cit.). The lower part of the formation ('Great Oolite Clay' of Thompson), which appears to have been rootletted, may belong to Rhythm D and is probably laterally-equivalent to the Thrapston Clay of

areas to the east. The uppermost 1.47m ('Forest Marble' of Thompson) undoubtedly belongs to the Forest Marble 'Rhythm'.

107. Blisworth East Quarry (SP739530)

Opened in 1821 by the Duke of Grafton, this quarry once supplied limestone to the Hunsbury Hill furnaces; the limestone was shipped along a short section of railway to the nearby Grand Junction (now Union) Canal and thence by barge to the furnaces (Thompson, 1927). The quarry closed in 1912, but sections are still visible in several places. Sharp's (1870) section was measured in the quarry while it was being worked principally for building stone, paving flags, window sills and chimney pieces; it correlates well with my own section (Enclosure A-9), although lower beds were visible in Sharp's time.

The 0.6m thick unit of oyster-rich clay which Sharp named 'Blisworth Clay' is not now exposed, but it may have been developed at the base of the Bladon Member. Comparable oyster lumachelles occur within the White Limestone at Wood Eaton and Cranford (Loc. 24 & 139).

108. Blisworth Rectory Farm Quarry (SP71645293)

The section here (Enclosure A-10) was previously described by Torrens (1967) and Pittham (1970). The K. sharpi Beds are no longer exposed.

109. Richard Thomas & Baldwin's Ironstone Quarry, Blisworth (SP712533)

Prior to the closure (1967) and total infilling of this large quarry in 1969, the section here was measured by Pittham (1970), Ferguson (1970) and officers of the Geological Survey (BGS, MS.). Unlike Blisworth Rectory Farm Quarry (Loc. 108) this section exposed the base of the White Limestone, thus displaying the sharp, erosive nature of the contact between the Kallirhynchia sharpi Beds and the underlying Rutland Formation. Ferguson's (1970) section, reported in Bradshaw (1978) with additional details obtained from a study of Ferguson's field specimens, is probably our most detailed record of the White Limestone section formerly displayed:

WHITE LIMESTONE	K. sharpi Beds (1.84m+)	
	'Marly' limestone	0.15m
	Khaki clay	0.20m
	Limestone with corals (hard, white, sparse fossiliferous oomicrosparite rich in Isastraea)	0.10m
	Clay	0.07m
	Limestone with thin clay partings; K. sharpi (bioturbated, argillaceous, fossiliferous microsparite; P. hebridica, M. imbricatus, Epithyris, Anisocardia beaumonti, A. (Antiquicyprina) loweana, Isastraea, echinoid spines)	1.05m
	Brown clay; K. sharpi, M. imbricatus, P. hebridica	0.17m
	Limestone; K. sharpi, M. imbricatus, P. hebridica	0.10m
RUTLAND FORMATION	(Cranford Rhythm)	
	Grey-green clay; rootlets at top	1.00m
	Dark grey, carbonaceous clay	0.85m

All of the measured sections suggest that the Kallirhynchia sharpi Beds (Rhythm B) here rest directly upon sediments of the Cranford Rhythm, without the intervention of any representative of Rhythm A.

110. Wooton

Three quarries within the White Limestone used to exist at Wooton, one at Wooton Hall (near SP752574; Mr. Cockerill's Quarry) and the other two at the windmill (near SP75755670; one of which was Mr. Frost's Quarry). The following composite section is drawn from the descriptions of Thompson & Crick (1891) and Thompson (1927 & MS.).

WHITE LIMESTONE	Bladon Member (2.54m+)	
	Rubbly limestone	0.30m
	Clay with oysters	0.91m
	Three to four beds of rubbly limestone with some fossils	0.64m
	'Dirt bed'	0.18m
	'Coral Bed'. Hard, ruddy limestone with abundant coral	0.48m
	Brown, calcareous clay	0.23m
	Ardley Member (2.69-3.64m)	
	Limestone	0.18m
	Brownish, calcareous clay with Pholadomya	0.20m

'Upper Terebratula Bed' or 'T. digona Bed'. Thin beds of white and reddish limestone with large Epithyris and D. digonoides	0.23-1.18m
Hard limestone with ?Isocardia, Acrosalenia and Epithyris	0.97m
'Dirt bed'	0.20m
'Nerinaea Bed'. Hard, semi-crystalline very fossiliferous limestone with many nerineid gastropods, trigoniids, Clypeus and Acrosalenia	0.91m
Kallirhynchia sharpi Beds (0.46m+)	
'Rhynchonella Beds'. Mud, limestone and 'marl' with Kallirhynchia sharpi	0.46m

The succession at Wooton is comparable to other sections in the area; by reference to extant sections, the White Limestone can be subdivided into the Kallirhynchia sharpi Beds, overlain by the Ardley Member, followed by the Bladon Member with its basal coral bed. The 'Nerinaea Bed' at the base of the Ardley Member can be compared with the similar bed developed at the base of the member in Roade Railway Cutting (Loc. 106). Pittham (1970), during the course of his research, found the section at SP758565 still partially visible; he noted the presence of large rhynchonellids (Burmirhynchia) and Nucleolites, in addition to Epithyris and Digonella, in the 'T. digona Bed'. A temporary exposure of this same horizon, near the junction of the A50 with the A508, yielded him further specimens of Burmirhynchia and Digonella.

Woodward's section from the Wooton Hall Quarry was wrongly interpreted as showing the Forest Marble ('Great Oolite Clay') overlying the White Limestone. This was the result of Woodward's belief that White Limestone Digonella digonoides were D. digona ('Waldheimia digona'), representative of the Bradford Clay horizon, which he took everywhere to mark the base of the Forest Marble. Woodward's section is significantly different to that measured by Thompson, but is probably too generous with regard to thicknesses. His lowermost unit, 1.37m of 'shelly and oolitic limestone with marly partings' is probably, at least in part, Thompson's 'Nerinaea Bed'.

111. Piddington (SP801543)

Thompson's (1927) description of this quarry, still worked for lime in 1926, can be abstracted as follows:

WHITE LIMESTONE	Irchester Member (4.65m+)	
	'Marl' and soft, fossiliferous limestone with thin oyster bed Whitish clay	1.83m
	Thinly-bedded, cross-bedded, bioclastic limestone	1.09m
	Very fossiliferous, oolitic limestone	0.20m
	Soft, fossiliferous limestone	0.28m
	Soft limestone	0.18m
	Soft 'marl'	0.10m
	Hard blue limestone	0.36m
	Blue-grey, fossiliferous, 'calcareous sand'	0.61m
	K. sharpi Beds	
	Dark blue limestone with abundant small oysters	0.36m

Only a partially infilled, wooded hollow remains now, although White Limestone field brash is common in the surrounding area.

112. Hopping Hill (SP72356208)

Four sections published from the Hopping Hill Limestone Quarries (Sharp, 1870; Woodward, 1894; L. Richardson, 1925; Thompson, 1927) can be abstracted and interpreted as follows:

i) Sharp (1870)

WHITE LIMESTONE	Irchester Member (2.43m+)	
	Soft clay-like 'marl'	0.61m
	Soft 'marly' rock of varying hardness; Pholadomya	0.46-0.61m
	Band of soft 'marl', very full of shells	0.23m
	Hard 'marly' rock, with few shells	0.30m
	Compact, arenaceous stone, somewhat calcareous, with few shells; ?Lopha, costata, etc.	0.38m
	'Earthy' shale bed in thin layers, containing flattened bivalves, chiefly oysters	0.30m
	Kallirhynchia sharpi Beds (1.22m+)	
	'Earthy' shale bed, more argillaceous and paler, greyer than above bed	0.30m
	Very hard, blue-hearted limestone; K. sharpi, etc.	0.46m
	Soft limestone, full of shells; K. sharpi, M. imbricatus, ?Globularia, Procymatoceras, Clypeus, etc.	0.46m
	Blue brick-clay	thickness not given

ii) Woodward (1894)

WHITE LIMESTONE	Irchester Member (2.19m+)	
	Pale, flaggy, oolitic limestone	0.61m
	Fossiliferous, oolitic and shelly limestone; P. hebridica, M. imbricatus and echinoids	0.66m
	Grey, 'earthy' and oolitic limestone; large Pholadomya	0.41m
	Brown clay with oysters	0.51m
	Kallirhynchia sharpi Beds (1.98m+)	
	Fossiliferous, shelly, oolitic 'marl' bed with echinoids	1.22m
	Pale, blue-hearted, 'earthy' limestone; M. imbricatus, P. hebridica, K. sharpi and echinoid spines	0.15m
	Blue clay) Hard, pale 'marl')	0.61m
	Hard, blue-hearted, calcareous sandstone	thickness not given

iii) L. Richardson (1925)

WHITE LIMESTONE	Irchester Member (3.65m+)	
	Yellow/green-grey, clayey, unfossiliferous 'marl'	0.61m
	Cross-bedded, oolitic limestone	1.37m
	Massive, sparsely oolitic limestone	0.46m
	Pale yellow 'marl'; P. hebridica	0.15-0.23m
	Grey limestone	0.15-0.30m
	Shaly, arenaceous limestone, ferruginous at the base	0.08m
	Hard, grey, blue-hearted limestone; P. hebridica, Pholadomya, P. socialis	0.30m
	Brown shale with common P. hebridica	0.30m
	K. sharpi Beds (1.52m+)	
	Hard, grey limestone; P. hebridica, K. sharpi	0.30m
	Blue-hearted limestone; K. sharpi	0.46m
	Softer limestone, rubbly at top and bottom; Procymatoceras, ?Stegoconcha ampla, common K. sharpi, Clypeus, Nucleolites	0.30-0.46m
	Blue-grey, clayey shale; fairly common P. hebridica; P. socialis	0.30m
	Hard, blue-hearted, calcareous sandstone*) Clay)	thickness not given not given

*Footnote:
V. Wilson (1946) recorded this bed as 0.38m thick; it was exposed in a temporary excavation in 1945, overlying 0.61m of blue-grey clays ?belonging to the White Limestone Formation.

iv) Thompson (1927)

WHITE LIMESTONE	Irchester Member (2.36m+)	
	Soil and white 'marl'	0.91m
	'Nerinaea Bed'. Cross-bedded, fossiliferous limestone; small nerineid gastropods	0.69m
	Soft, light-coloured limestone with thin central 'marl' parting	0.30m
	Thin limestone bands embedded in 'marl'	0.46m
	K. sharpi Beds (?1.63m+)	
	'White Stone' of quarrymen.	0.30m
	'Hard Blue' of quarrymen. Blue-hearted stone with many fossils; K. sharpi	0.26m
	?Clay or 'marly' bed, not well exposed	?0.46m
	Limestone, softer than the 'Hard Blue', with many fossils; K. sharpi, P. hebridica, echinoids, etc.	0.61m

Each section exhibits noticeable differences, particularly in the upper parts; this suggests that rapid lateral changes are to be found within the Lithofacies association B sediments of the Irchester Member in the Hopping Hill area, as is the case elsewhere in Northamptonshire. The occurrence of nautiloids in the K. sharpi Beds (Sharp, 1870; L. Richardson, 1925) is notable; cephalopods are relatively rare in Rhythm B sediments in the east Midlands. The K. sharpi Beds at this locality yielded the holotype and paratype of the index species (Muir-Wood, 1938).

Thompson (1930) gave a record of a well sunk in the older part of the quarry (SP72456213). Beneath the limestone rubble of the earlier workings came clay (c.0.15m), calcareous sand (c.0.23m), hard, unfossiliferous limestone (c.0.23m) and 'soft, shaly stuff' (c.0.15m), overlying 0.46m of 'marly' clay containing P. hebridica, P. socialis and K. sharpi. All of these beds (c.0.91-1.21m) must be classified as Kallirhynchia sharpi Beds. A very pale-blue weathering clay beneath them, containing abundant rootlets, may have belonged to the Cranford Rhythm (Rutland Formation). The 'calcareous sand' and 'hard, unfossiliferous limestone' mentioned above are probably the lateral equivalents of the 'hard, blue-hearted, calcareous sandstone' in the accounts of Woodward (1894) and Richardson (1925); if so, the Kallirhynchia sharpi Beds of Hopping Hill total between c.2.59m (following Richardson) and c.3.05m (following Woodward). At least 6.24m of White Limestone would, therefore, be present in the area. Pittham (1970) collected Burmirhynchia at Hopping Hill from what he believed was

White Limestone, but was actually the Wellingborough Member (Bradshaw, 1978).

113. Trench section, Hopping Mill

An unlocated trench section near Hopping Mill is of considerable interest (Woodward, 1894):

FOREST MARBLE (1.82m+)	Dark green-grey clay	0.61m
	Pale 'marly' bed	0.91m
	Grey clay with oysters	0.30m
WHITE LIMESTONE	Irchester Member (4.62m+)	
	Hard grey, more or less oolitic, shelly limestone with gastropods; oysters on upper surfaces of stone	0.66m
	Seam of grey clay with oysters	
	Fossiliferous, 'marly' beds in harder and softer bands, blue and shaly in places, and occasionally oolitic	2.74m
	Flaggy and shelly oolite	0.91-1.22m

If, as above, Woodward's (op. cit.) subdivision of the section is followed, this description suggests that the White Limestone was here capped by an oyster-encrusted hardground, possibly at the top of the 'A. bladonensis Bed' (although the identification of Woodward's gastropods as A. bladonensis cannot be confirmed). A possible alternative interpretation is that a hardground was developed at a stratigraphic level equivalent to the top of the Ardley Member; the gastropod bed could then be correlated with the gastropod bed at Blisworth (Loc. 108), while the 'grey clay with oysters' and the 'pale marly bed' could be correlated with the Bladon Member developed to the south and southwest. The first alternative is preferred here, but confirmation by way of a temporary exposure in the area would be welcomed.

114. Wood's Quarry, Kingsthorpe (SP75856432)

Sharp's (1870) section from this quarry is easily interpreted:

WHITE LIMESTONE	Irchester Member (c.5.63m+)	
	Soft and hard 'marly' limestone	0.61-0.91m
	'Earthy' shale bed; flattened bivalves	0.30-0.45m

'Top Soft Bed'. Soft, 'marly' limestone containing large Pholadomya, Homomya, Pleuromya, P. hebridica subrugulosa, Globularia, Clypeus, etc.	0.30-0.45m
'Pendle'. Two 'marly' limestone beds, the upper softer and more fossiliferous than the lower.	0.61-0.91m
Cream-coloured, soft, fossiliferous, clay-like seam.	0.15-0.30m
'Paving'. Hard limestone, very full of fossils; nerineid gastropods, trigoniids, Acrosalenia, Clypeus, fish teeth	0.61-0.76m
'Paving'. As bed above, but less fossiliferous	0.61-0.69m
'Top Jubs'. Soft, 'marly' stone full of Pholadomya, Modiolus, Globularia, large Procymatoceras, large Clypeus, etc.	0.76-0.91m
'Bottom Jubs' - stone similar to last, but softer	0.61-0.76m
'Bottom Jubs' - lower zone. More compact limestone, rather coarsely oolitic in places; Procymatoceras, abundant P. hebridica	0.30-0.38m
K. sharpi Beds	
'Bottom Soft Bed'. Soft, 'marly' bed with K. sharpi, M. imbricatus	0.30-0.45m

At a temporary exposure nearby, Pittham (1970) collected Digonella digonoides and terebratulids from a 'rubbly, marly limestone' which he suggested was laterally equivalent to Sharp's 'Top Jubs'. A large macroconch Choffatia (Subgrossouvria) sp. in Northampton Museum probably came from the lower zone of the 'Bottom Jubs' (Torrens, 1980b).

115. Moulton Park House Pit (SP766641)

This quarry was described by both Woodward (1894) and Thompson (1927), from whose work the following section is derived:

WHITE LIMESTONE	Irchester Member (5.47m+)	
	Soft 'marly' limestones and 'marls'	1.06m
	'Earthy' and 'marly' limestone with bedded plant debris	0.45m
	Laminated, calcareous clay; serpulids, Pholadomya, Praeexogyra	0.61m
	'Paving'. Hard, sparitic limestone; nerineid and other gastropods	0.52m
	Laminated, calcareous clay	0.10m

	'Paving'. Sparitic limestone	0.76m
	'Jubs'. 'Marly' and oolitic limestones; fossiliferous with Procymatoceras	1.97m
	K. sharpi Beds	
	'Marly' clay with K. sharpi, P. hebridica and Modiolus	seen

The 'Paving' was formerly used for hearthstones and floor pavements. The uppermost bed of 'Paving' yielded a specimen of Choffatia (Subgrossouvria) cf. cerealis (Torrens, 1980b).

116. Buttocks Booth Pits (SP777641)

Thompson (1927) recorded the following section in these pits:

WHITE LIMESTONE	Irchester Member (2.43m+)	
	Rubbly limestone and soil	0.91m
	Sandy, 'earthy-looking' layer	0.30m
	Limestone, very fossiliferous in the upper part	1.22m
	K. sharpi Beds	
	Blue clay	0.45m
	Hard blue limestone	seen

Sharp (1870) noted that fish teeth, conifer and crocodile remains and crustaceans were commonly encountered at this locality.

117. Denton (SP84335759)

Quarries opposite Stonepit House, southeast of Denton were formerly the source of the 'Denton Stone' ('Denton Blue' and 'Denton White'). Judging from specimens displayed in the Geological Museum, Denton Stone was obtained from the Irchester Member. By the 1920's only broken ground marked the site of the once large stone pits (Thompson, 1927).

118. Yardley Hastings (SP863564?)

The upper part of the Irchester Member was formerly exposed in the Ingram Lane Pits (Thompson, 1927), while beds within the K. sharpi Beds were exposed between these pits and the village. Pittham (1970) recorded a temporary exposure of these beds at SP865570.

119. Castle Ashby (c.SP864586)

Thompson's (1927) section, made in 1892, can be interpreted as comprising entirely Irchester Member:

WHITE LIMESTONE	Irchester Member (4.46m+)	
	Soil and white, rubbly limestone	0.91m
	Thinly-bedded limestone ('Pendle')	1.07m
	'Marl'	0.30m
	Hard, shaly limestone	0.15m
	'T. digona Bed'. Soft 'marl' with D. digonoides and Epithyris	0.20m
	Semi-crystalline limestone	1.83m+

120. Strixton (SP90176160)

No exposure remains in the small village quarry at Strixton, which formerly exposed over 1.5m of White Limestone yielding Epithyris and ?Arcomytilus asper (Thompson, 1927). This belonged within the Irchester Member and can be compared with the upper part of the section at Irchester New Lodge Pit (Loc. 121).

121. Irchester New Lodge Pit (SP910641)

The section in this now infilled pit is illustrated in Enclosure A-10. The underlying Rutland Formation succession was illustrated by Bradshaw (1978). The base of Rhythm C was markedly erosive in this quarry and cut down southeastwards close to the base of Rhythm B (cf. Torrens, 1967; Pittham, 1970).

122. Irchester Old Lodge Pit (SP914648)

This quarry has been designated as the type section of the Irchester Member. The section here, from the top of the Rutland Formation up to the Thrapston Clay, is depicted in Enclosure A-10. The quarry has been described previously by Torrens (1967), Ferguson (1970), Pittham (1970) and Bradshaw (1978).

The Irchester Member is composed largely of Lithofacies association B sediments. These exhibit considerable lateral variabiliy, with bioturbated oobiopackstones/wackestones, containing diverse Biofacies 4 faunas, passing rapidly into cross bedded grainstones. In one part of the quarry the edge of a sand bar can be seen, the inter-bar trough being filled with predominantly argillaceous sediments.

The uppermost limestone of the Irchester Member is rootletted. It contains probable Aphanoptyxis bladonensis. The overlying Thrapston Clay has yielded a non-marine palynoflora only (Fenton, 1980).

123. Irchester North Pit (SP919662)

This locality is also known as Wembley Pit or Irchester Country Park (Bradshaw, 1978; Sutherland & Hudson, 1982). The section illustrated in Enclosure A-11 is a composite one, measured at the northeastern end of the quarry. The White Limestone section here has previously been described by Torrens (1967) and Ferguson (1970).

124. Wellingborough No. 5 Pit (SP92556988)

This former ironstone quarry was worked by Stewarts & Lloyds until the late 1950's (Bradshaw, 1978). The section here is illustrated in Enclosure A-11. Of particular interest is an in situ oyster-rhynchonellid bank, developed within the K. sharpi Beds (Plate 11), which passes laterally into coral-bearing sediments. This section has been designated as the type section of the Wellingborough Member and its embracing rhythm by Bradshaw (1978; in prep.)

125. Wellingborough Middle Pit (SP92127019)

This Stewarts & Lloyds quarry has been totally infilled since 1975, when Bradshaw (1978 & MS.) measured the section. Rhythm B (=K. sharpi Beds) directly overlies the Cranford Rhythm here. The section was similar to that in the extant Wellingborough No.5 Pit (Loc. 124).

126. Wellingborough No. 6 Pit (SP91707061)

This pit has also been totally infilled in recent years. At SP91957065, Rhythm B rested directly on the Cranford Rhythm (Bradshaw, 1978), but at c.SP91587061, 0.5m of Rhythm A (containing K. sharpi) appears to have been preserved beneath the base of Rhythm B (Ferguson, 1970; Bradshaw, op. cit.). The White Limestone of this locality has also been described by Pittham (1970).

127. Irthlingborough Premier Portland Cement Co.'s Pit (SP934702)

I was able to piece together a composite section of nearly the entire White Limestone succession here, using Richardson & Kent's (1938) and Pittham's (1970) accounts for guidance; this composite section is shown in Enclosure A-11.

128. Irthlingborough Limestone Quarries (c.SP946712 & SP948714)

Thompson's (1927) section from these quarries can be compared with the higher part of that visible in the Cement Works Quarry (Loc. 127); the section, of uppermost Irchester Member, can be abstracted as follows:

WHITE LIMESTONE	Irchester Member (2.75m+)	
	White 'marl'	0.46m
	Oyster-rich shale	0.36m
	'Coral Bed'. Fossiliferous limestone with corals and echinoids	0.61m
	Limestone	0.18m
	White 'marl'	0.38m
	Limestone	0.38m
	Thinly-bedded, cross-bedded, hard limestone	0.38m

Richardson & Kent (1938) recorded the presence of abundant rootlets at the top of the White Limestone (in their 'Plant Bed') in these quarries. The 'coral bed', obviously correlatable with that in the Cement Works Quarry, may also be correlatable with similar coral beds developed at the base of the Bladon Member south of Northampton; however, it is more probably developed within Rhythm C.

129. Stanwick (SP97557055)

This section is illustrated in Enclosure A-12. The uppermost bed of the White Limestone is rootletted here. It is unclear whether this locality corresponds with either 'Mr. Stretton's Pits' or 'Mr Lay's Pits' of Thompson (1927).

130. Raunds Ironstone Working (SP99957280)

Thompson's (1930) section can be interpreted as follows:

WHITE LIMESTONE	Limestone with abundant oysters	1.65m
	Unfossiliferous 'marls'	0.38m
	Soft white 'marl' crowded with K. sharpi and a few P. hebridica	0.51m
	Reddish, sandy mud band with an oyster-band towards the bottom; also many specimens of K. sharpi in fragments	0.20m
RUTLAND FORMATION	Stamford Member (1.24m)	
	Purple clay with much carbonaceous debris	0.07m
	Greyish sand, passing into red sand with plant markings in the upper part	1.17m
NORTHAMPTON SAND		

The upper bed of oyster-rich limestone, which Bradshaw (1978) stated was still exposed behind modern houses, may belong within the Irchester Member; it has not yet been examined. The rest of the White Limestone belongs within the K. sharpi Beds.

131. Raunds Main Street (SP99857302)

Discussed by Bradshaw (1978), this old exposure is still extant: the basal 0.6m of the K. sharpi Beds, comprising interlayered mud and sand and argillaceous biomudstone, directly overlies 0.4m of rootletted, purple mud (all Stamford Member), which in turn overlies the Northampton Sand Formation.

132. Raunds temporary exposure (SP998734)

During archaeological excavations at Furnell's manor house site, a section from the White Limestone up to the Cornbrash was made visible in laterally extensive exposures. These were examined in 1982 by Roy Clements and Diana Sutherland of Leicester University who have kindly supplied the following details:

CORNBRASH	Upper Cornbrash (0.60m) Massive, yellowish limestone with relatively few fossils but a layer of Lopha marshii; burrowed in the lower part	0.45m
	Pebble bed. Clay matrix containing limestone pebbles, bored and encrusted by serpulids and oysters; Digonella siddingtonensis, Lopha marshii and derived Lower Cornbrash fossils (Meleagrinella, Pleuromya, Obovothyris)	0.15m
	Lower Cornbrash (0.07m) Massive, light grey limestone with pockets of M. echinata; irregular, bored hardground top	0.40m
	Rubbly weathering, grey, muddy, shelly limestone with Meleagrinella, Trigonia, oysters and brachiopods; grades up into overlying bed	0.30m
THRAPSTON CLAY	Varicoloured (grey, green, etc.) clay	c.2.00m
WHITE LIMESTONE	Rubbly limestone with P. hebridica	c.0.30m
	Rubbly limestone	c.0.30m

The Lower Cornbrash is probably 'complete' here, unlike at Thrapston (Loc. 148) where no capping hardground is developed. The pebbles at the base of the Upper Cornbrash were perhaps derived from this same hardground elsewhere in the Raunds area.

A specimen of medium-grained biograinstone, containing abundant M. echinata, which was collected in 1981 at a building site (c.TL003727), by comparison with the above section, probably came from the uppermost bed of the Lower Cornbrash. In this section this lithology was seen to comprise abundant brachiopod and bivalve debris with subordinate serpulid, echinoderm and bryozoan material, textularid and rotalid foraminiferans and scattered pellets (including Favreina), cemented by strongly ferroan, blocky calcite.

133. Glebe Quarry, Finedon (SP919711)

A section measured in this heavily wooded pit is illustrated in Enclosure A-12; there is apparently no published description of the section here. Woodward (1894) recorded a section in the Finedon area, the exact location of which is unknown; this can be interpreted as follows:

THRAPSTON CLAY		1.83m
WHITE LIMESTONE	Irchester Member	3.96m
	K. sharpi Beds	2.16m
RUTLAND FORMATION		

134. Buccleuch Quarry, Finedon (SP912727)

A well-exposed White Limestone section remains in this quarry (formerly worked by R. Thomas & Baldwin's) despite the gradual southward migration of yet another rubbish tip. Pittham (1970) has previously recorded the White Limestone succession, which was remeasured and is illustrated in Enclosure A-12: Bradshaw (1978) gave the Rutland Formation succession from this pit.

135. Great Addington (SP96597521)

Rhythm A is not developed in this overgrown, former ironstone quarry; instead, Rhythm B directly overlies the Cranford Rhythm (Bradshaw, 1978). However, only the basal K. sharpi Beds were ever exposed by quarrying here.

137. Woodford Ironstone Pit (SP96287749)

A White Limestone section exposed in the former Newbridge Iron Ore Co.'s Woodford Pit (abandoned 1891) was briefly described by Ferguson (1970); his account suggests that 3.9m of Irchester Member was then visible.

138. Isebrook Pit, Burton Latimer (SP89277570)

As at Cranford South and the Finedon pits (Loc. 133, 134, 139) Rhythm A is developed between the Cranford Rhythm and Rhythm B. However, no limestone is present within Rhythm A here (Bradshaw, 1978).

139. Cranford South (SP925763)

A composite section measured at this locality is illustrated in Enclosure A-12. The section from the upper part of the Rutland Formation to the top of the K. sharpi Beds was measured at SP935762, the Irchester Member succession at SP925763. The lower part of the Irchester Member, in particular, exhibits a moderate degree of lateral variability in this pit, although it is dominated by oyster-rich sediments at both points.

Oysters become the dominant element in all Irchester Member faunas encountered north of the Cranford district.

Lateral variation within Rhythm A at this locality has been discussed and illustrated by Bradshaw (1978). Rootletted, interlayered sands and muds pass westwards into an argillaceous, micritic limestone which lacks rootlets and which perhaps should, on lithostratigraphic grounds, be included in the White Limestone. This limestone passes back into interlayered sands and muds, now no longer rootletted, at the northwest end of the pit. While this stratigraphic horizon is now poorly exposed at Cranford South, these lateral facies can still be observed; they are illustrated in Figure 7.4.

The development of carbonate sediment in Rhythm A at Cranford South is discussed in section 7.2.2; the rhythm thins northwards and is cut out beneath Rhythm B in Cranford North Pit.

140. Cranford North (SP929775)

The section at Cranford North (Enclosure A-13) is similar to that in the southern pit (Loc. 139). It has been previously described by J. Taylor (1963), Pittham (1970) and Bradshaw (1978).

Rhythm A is only 0.12m thick at SP929775 and further north, at SP92807825 (Bradshaw, 1978), it has been overstepped by Rhythm B.

141. Twywell Ironstone Pit (SP94757800)

J. Taylor's (1963) section of the 'Great Oolite Limestone' in the former Stewarts & Lloyds Ironstone Pit, Twywell differs from my own (illustrated in Enclosure A-13), partly because of lateral facies variations within the Irchester Member. Pittham (1970) obtained an ammonite here, probably from the lower part of the Irchester Member. The horizon from whence this Procerites came is indicated in Enclosure A-13.

142. Twywell Limestone Pit (SP941778)

This section continues upwards that seen in Twywell Ironstone Pit (Loc. 141). Although previously described by J. Taylor (1963), it was remeasured in 1983 and is illustrated in Enclosure A-13. The Thrapston Clay is now very poorly exposed.

143. Cargo Fleet Pit, Twywell (SP952789)

A section (Enclosure A-13) was measured at the northern end of this large pit, which although only abandoned in 1970 (Bradshaw, 1978) is rapidly becoming overgrown; the contact between the White Limestone and Rutland Formations is not exposed at present.

144. Valentine's Pit (SP955792)

J. Taylor (1963) noted that 4.27m of 'Great Oolite Limestone' (=White Limestone) was poorly exposed at this locality, but the pit is now extremely overgrown and this exposure was not discovered. Both the K. sharpi Beds and the Irchester Member were formerly visible.

146. Church Pit, Lowick Lodge (SP96687859)

The Kallirhynchia sharpi Beds (including 0.81m of clay and 'marly' clay, with K. sharpi at the base) were formerly seen here, overlying at least 7.65m of Rutland Formation (J. Taylor, 1963; Bradshaw, 1978).

147. Bridle Limestone Pit (SP97457823)

Islip Furnaces Limestone Pits (SP96807845; SP96307860)

All of these pits have now been infilled and landscaped. Quarrying at Bridle Limestone Pit to supply limestone to the Islip furnaces had begun by 1900 when the locality was visited by a G.A. fieldtrip (Blake, 1900). A section was first published for this location by Blake (1905-1907) under the name 'Thrapston'. In 1921, another G.A. trip to the area stopped at 'one of the limestone quarries of the Islip Ironstone Co.' (Thompson, 1921), but this could have been one of the pits north of the Kettering-Thrapston road. Thompson (1927) gave a section based on information from both the Islip Furnaces and the Bridle Limestone Pits; that from the former quarries can be interpreted as follows:

CORNBRASH THRAPSTON CLAY		) thickness) not given
WHITE LIMESTONE	Irchester Member (3.95m+) A shaly-looking rock passing downwards into a gritty rock composed of 'oolitic granules' and oyster fragments; some M. imbricatus	0.61m

Compact, unfossiliferous limestone	0.45m
White 'marl' with few fossils	0.30-0.45m
'Marble Bed'; limestone in one compact bed, the lowermost 0.30m of which is cross-bedded	1.22m
'Lower Terebratula Bed'; soft, crumbly white 'marl'; essentially an oyster bed but with M. imbricatus and many Epithyris in patches	1.22m

Richardson & Kent (1938) noted the occurrence of rare rootlets at the top of the White Limestone at Bridle Limestone Pit, a record confirmed by the presence of rare rootlets at the same level at Thrapston (Loc. 148).

Details of the upper part of the succession at these quarries were given by Douglas & Arkell (1932), Hollingworth & Taylor (1947, 1951) and J. Taylor (1963). Above the White Limestone, between 4.11m (Hollingworth & Taylor, 1951; Taylor, 1963) and 4.27m of slumped 'Great Oolite Clay' (=Thrapston Clay) were recorded at Bridle Limestone Pit. The Cornbrash section here was given by Douglas & Arkell (1932); 0.99m of Upper Cornbrash, with a basal pebble bed, overlay 0.69m of Lower Cornbrash in a section very similar to that still visible at Locality 148, although there the Lower Cornbrash is thinner. At the Islip Furnaces Limestone Pits, 0.51m of Lower Cornbrash was present beneath the Upper Cornbrash, here without a basal pebble bed (Douglas & Arkell, op. cit.).

148. Thrapston L.M.S. Railway Station Quarry (TL000776)

This section was cleared by the Nature Conservancy Council in 1982. The succession from the White Limestone up to the basal Kellaways Clay is illustrated in Enclosure A-14. The locality has been described previously by Woodward (1894), Douglas & Arkell (1932), Torrens (1968) and Pittham (1970).

It is designated, in this thesis, as the type-section of the Thrapston Clay Formation. Fenton (1980) palynologically sampled the Thrapston Clay here. Although some samples proved to be barren, due to oxidation, his results suggest that clays of a marine facies are thinly developed at the base of the formation but that these pass rapidly upwards into non-marine clays. The whole of the Thrapston Clay probably belongs within Rhythm D.

A pebble-bed is very well developed at the base of the Upper Cornbrash, here overlying attenuated Lower Cornbrash. The Lower Cornbrash is probably overstepped to the east of Thrapston.

152. Slipton Limestone Pit (SP955808?)

3.96m of limestone was formerly exposed at Slipton (J. Taylor, 1963). The fauna listed by Taylor suggests that only Irchester Member was exposed.

153. Hell's Kitchen Pit, Sudborough (SP96408175)

The succession in this now totally restored quarry was given by J. Taylor (1963) and re-interpreted by Bradshaw (1978). The 1.52m of rubbly limestone, with Kallirhynchia sharpi at the base, and the underlying 0.15m of mottled yellow-brown to grey clay can be interpreted as belonging to the White Limestone; beneath the mottled clay were grey-green clays classified as Cranford Rhythm (Rutland Formation) by Bradshaw (op. cit.). The 1.52m of rubbly limestone, on thickness considerations, may have included basal Irchester Member lithologies.

154. Geddington

The most easterly excavations of the large complex of former ironstone quarries west of Geddington include White Limestone at the top of their overburden. Torrens (1968) recorded a section through the base of the White Limestone in Geddington Grange Pit (also known as Storefield Pit), supposedly measured at SP890823. The face of this pit subsequently migrated to the southwest until the pit was abandoned in the mid 1960's. In 1980, a section was measured at the top of the abandoned face at SP88898192. A further section through the basal White Limestone was measured in the Glendon-Geddington Pit (abandoned 1980) at SP88468171 and is illustrated in Enclosure A-14. None of the three sections exhibited beds above the Kallirhynchia sharpi Beds, here at least 1.87m thick. The Glendon-Geddington Pit had been totally filled and landscaped by June, 1985.

155. Duke of Buccleuch's Pit, Geddington Chase (SP90878616)

J. Taylor (1963) noted the existence of an old, overgrown pit at SP90878616 in which White Limestone was overlain by Thrapston Clay. This

is probably the quarry described by Judd (1875) as lying at the north end of Geddington Chase, close to Stanion. Thompson (1927) gave an abridged version of Judd's description, but here Judd's section is re-iterated more fully with my own intepretation:

THRAPSTON CLAY (0.60m+)	Green, blue and purple clay	0.30m
	Pale green-white 'marl', full of irregular, concretionary, hard, sub-crystalline, calcareous nodules which weather white	0.15m
	Green and variegated clay with carbonaceous markings	0.15m
WHITE LIMESTONE (5.70m+)	Grey, foetid, slightly sandy limestone	0.10m
	Laminated, 'marly' parting	0.05m
	Extremely hard, sub-crystalline, drab limestone	0.46m
	'Marly' parting	0.05m
	'Marly' bed abounding in 'Beef'	0.15m
	Variegated, dark, carbonaceous clays, finely stratified	0.61m
	Finely laminated 'marl' with 'Beef'	
	Hard, white, shelly limestone with many shells and an oyster-bed at the bottom, with P. hebridica subrugulosa	0.15m
	'Marly' bed crowded with P. hebridica	0.05m
	Variegated, dark, carbonaceous clays, finely stratified	0.30m
	Beds of hard limestone with few traces of 'marly' partings. The limestone is sometimes compact and full of oysters, at others made up of comminuted shells; in places very oolitic. Near the bottom there are traces apparently of pebbles of compact oolite. This limestone contains wood, P. hebridica and Nucleolites	3.78m

Most, or all of the White Limestone section belongs within the Irchester Member.

156. Park Farm Old Pit, Brigstock (SP93518559)

J. Taylor (1963) recorded the following section from this pit:

THRAPSTON CLAY	Brown, yellowish brown and grey clay	2.44m
WHITE LIMESTONE	Irchester Member (1.85m+)	
	Shelly, argillaceous calcite-mudstone	0.18m

	Greyish brown clay	0.13m
	Hard, blue-hearted, shelly limestone	1.02m
	Soft, brown, argillaceous limestone with clay bands	0.25m
	Hard, blue-hearted shelly limestone	0.30m

The shelly, argillaceous micrite at the top of the White Limestone may have been comparable to the rootletted micrite developed at the top of the formation at Irthlingborough and Stanwick (Loc. 127, 129), where it belonged to Lithofacies 5 and 6.

159. Lilford Lodge (TL038851)

Judd's (1875; repeated by Thompson, 1927) account of this section can be given as follows:

THRAPSTON CLAY	1. Bluish-green and mottled clay	0.61m
WHITE LIMESTONE (6.89m+)	2. Clayey band crowded with oysters	0.30m
	3. Oyster limestone	0.23-0.38m
	4. Compact, very hard, bioclastic limestone	0.45m
	5. Soft, white, slightly oolitic limestone, 'marly' at the base and crowded with oysters	0.61m
	6. Irregularly-bedded, bioclastic limestone	1.83m
	7. Softer, 'marly' bed, full of oysters	c.0.30m
	8. Beds of hard limestone	1.83m

The quarry was later described by J. Taylor (1963):

WHITE LIMESTONE (4.11m+)	Rubbly oyster bed (?=Bed 3 of Judd)	0.23m
	Flaggy, shelly, sparsely oolitic limestone (=Beds 5 (pars.) + 4 of Judd)	0.61m
	Soft, white, rubbly limestone (=Bed 5 (pars.) of Judd)	0.15m
	Grey, irregular oyster bed	0.08m
	Massive cross-bedded bioclastic limestone with shell bands; locally, a 0.15m finely laminated limestone at top (=Beds 6+7 of Judd)	2.44m
	Soft, brown, bioclastic limestone (=Bed 8 of Judd)	0.30m
	Massive, even-grained, bioclastic limestone (Bed 9 of Judd)	0.30m

Part of this section is still exposed (J. Hudson, pers. comm.) but has not yet been investigated.

160. Barnwell Castle Quarry (c.TL04858537)

Thompson's (1927) brief section from this pit can be repeated fully, with slight modification:

CORNBRASH		c.1.52m
THRAPSTON CLAY		c.1.52m?
WHITE LIMESTONE (?4.27m+)	Top course, hard and blue; very difficult to work; cannot dress it for building but can split it and use it for walling	0.61m?
	Middle course shaly - used for lime	0.61m?
	Bottom courses - building stone, very fossiliferous with many oysters	3.05m?

161. Barnwell Stream (TL83850485)

The Cornbrash is still exposed in this stream. The section was described in detail by Douglas & Arkell (1932) who recorded the presence here of 1.46m of Lower Cornbrash, overlain by about a metre of Upper Cornbrash. A pebble bed is developed at the base of the latter, as elsewhere in Northamptonshire.

163. Oundle (TL0488)

White Limestone was formerly extensively quarried in the Oundle area, largely for building stone. An old quarry within the town (unlocated), which was once the source of numerous specimens of ophinroids, but which was closed long before 1873, was described by Sharp (1873); the following is a revised version of Sharp's account:

WHITE LIMESTONE	Longthorpe Member (?1.44m+)	
	Cream, ?argillaceous lime mudstone	0.61m
	Very hard, flaggy limestone; M. imbricatus	0.15m
	Blue clay	0.23-0.30m
	Oyster-rich, ?argillaceous, micritic limestone	0.30-0.38m
	?K. sharpi Beds (?2.81m)	
	Hard, thinly-bedded, bioclastic limestone	0.23m
	Hard, blue-hearted ?biograinstone	0.91m
	Shelly, argillaceous limestone	0.91m
	Very hard, blue-hearted ?biograinstone	0.76m

?RUTLAND FORMATION	Clay	seen

The occurrence here of both the Longthorpe Member and the underlying K. sharpi Beds is suggested by Sharp's (op. cit.) faunal list. If the Rutland Formation was exposed as Sharp's account indicates, then the K. sharpi Beds here evidently included the basal, hard ?biograinstones and therefore may have been 2.81m thick; such bioclastic limestones characterise these beds at other localities north of the Kettering-Peterborough Line. The ophiuroids of this quarry may have come from the K. sharpi Beds, for comparable specimens have been obtained more recently from these beds at Kingscliffe (Loc. 171).

Judging from Judd's (1875) faunal list, both the Longthorpe Member and the K. sharpi Beds were also once exposed in the Oundle Golf Course Pits (TL022881); the oyster beds of the Longthorpe Member (locally termed 'hurr') were formerly well exposed in Oundle Union Stonepit (unlocated; Judd, op. cit.)

164. Tilley Hill Limestone Quarry, Oundle (TL03618915)

The following section was formerly exposed here (summarised from Thompson, 1927):

WHITE LIMESTONE	Longthorpe Member (2.43m)	1.52m
	Oyster-rich limestone	0.10m
	Fossiliferous, oyster-rich clay, 'marl' and limestone	0.15m
	Cross-bedded, bioclastic limestone	0.61m
	Oyster bed	0.08-0.10m
	Very fossiliferous, oyster-rich limestone	0.76m
	'Marly' layer	0.10m
	Fossiliferous limestone	0.61m
	?K. sharpi Beds	
	'Hard Blue'. Hard, blue-hearted limestone with few fossils	?0.76m

Most of the White Limestone here, dominated by oyster-rich limestones and muds, can be assigned to the Longthorpe Member. Arkell (1933) recorded the occurrence of abundant corbulids and Bakevellia waltoni in the uppermost, 0.10m thick bed of the White Limestone (a 'soft, argillaceous marlstone') at this locality. He included this and the underlying bed within the 'Blisworth Clay' (=Thrapston Clay), but

this classification is not accepted herein. The lowest bed of this section (the 'Hard Blue') may belong to the K. sharpi Beds.

165. Temporary exposure, Oundle (TL03358855)

A temporary exposure in Oundle was measured by M. Bradshaw in 1975 (Bradshaw, MS.). The top of the White Limestone here correlates with the upper part of the White Limestone at Tilley Hill. A minimum of 3.33m of Thrapston Clay was exposed in one of the four pits made by Soils Engineering Limited and the combined thickness of Thrapston Clay was at least 4.4m (although the Cornbrash was not seen). Fenton (1980) undertook palynological analyses on samples from the formation here.

168. Bulwick Road Cutting (SP96429385)

This cutting has been briefly discussed by Judd (1875); the basal White Limestone and underlying Rutland Formation section was illustrated by Bradshaw (1978). The K. sharpi Beds are still poorly exposed here. Rhythm A is only 0.15m thick at this locality.

169. Wakerley Oaks Railway Cutting (SP971991)

The only description of the geology in the cutting is apparently Bradshaw's (1978) account of the Rutland Formation section at SP97069909. Basal White Limestone is still quite well exposed; the section visible in July, 1982 is illustrated in Enclosure A-14.

170 Fineshade Railway Cutting (c.SP982976)

Blake's (1905-07) section from this cutting can be interpreted as follows:

OXFORD CLAY/ KELLAWAYS BEDS	Oxford Clay with widely separated doggers	12.19m
CORNBRASH (1.52m)	Loose, dark brash; L. marshii abundant	0.30m
	Two courses of purplish, massive limestone	1.22m
THRAPSTON CLAY	Clay	3.05m
WHITE LIMESTONE	Five courses of Great Oolite Limestone	3.05m

171. Adamix Refractories Pit, Kingscliffe (TL008966)

A section measured in this pit is illustrated in Enclosure A-14. The K. sharpi Beds appear to show considerable lateral variation here, for at TL.01309645 the section is significantly different (Bradshaw, 1978). Oobiopackstones (Lithofacies 3) are frequently developed within the K. sharpi Beds, both here and elsewhere in the neighbourhood. Rhythm A is about 1.5m thick at Kingscliffe.

172. Mountjoy Sale (c.TL043958)

Arkell (1954) recorded a section here of what he believed was the complete Cornbrash succession. However, the entire Upper Cornbrash section of the area may not have been encountered, for the uppermost part may have been removed by Recent erosion. A pebble bed, containing a condensed Lower/Upper Cornbrash fauna, appears to have been developed at the base of the Upper Cornbrash. The oyster bed developed beneath the pebble bed, said to belong to the 'Blisworth Clay', may have been basal Lower Cornbrash.

174. Spires Wood Railway Cutting (TL048969)

Bradshaw (1978 & MS.) measured a section here, uncovered by slippage, from the Cranford Rhythm 0.93m up into the White Limestone. The section, which was very similar to that visible in Spires Wood Pit, is now largely overgrown. Of particular interest was the small clump of oysters, in life position, observed at the base of the 0.85m thick Rhythm A.

175. Spires Wood Pit (TL04929707)

The entire White Limestone succession is still exposed in this pit (Torrens, 1967) and is illustrated in Enclosure A-14. Rhythm B appears to be thin here (0.93m), but is very fossiliferous.

176. Fotheringhay Railway Cutting (TL07359335)

A section through the Longthorpe Member measured in this overgrown cutting in 1982 is illustrated in Enclosure A-15. From a slightly lower stratigraphic level exposed at TL07359335, Bradshaw (MS.) collected Kallirhynchia sharpi and Praeexogyra hebridica from a soft, argillaceous micrite which was overlain by 0.30m of hard, flaggy oyster-rich micrite; however this exposure was not found during my visit.

1.2.6 Cambridgeshire

177. Nene Barge & Lighter Co.'s Quarry, Sibson (TL086960)

A section from the Grantham Formation up to the White Limestone, apparently undescribed in the literature, was exposed here in 1982. The Lincolnshire Limestone is only 1.25m thick. The White Limestone section is illustrated in Enclosure A-15. Rhythm B appears to directly overlie the Wellingborough Rhythm, as at Peterborough.

178. Castor Springhead (TL12979856)

The section here is illustrated in Enclosure A-15; 1.8m of Longthorpe Member is still moderately well exposed. The same section was described by Horton, Lake, Bisson & Coppack (1974) who classified the uppermost 0.38m of their succession as 'Blisworth Clay' (=Thrapston Clay).

179. Alwalton

The Alwalton Lynch escarpment was formerly the source of 'Alwalton Marble', a calcite-cemented biograinstone which took a polish, and which was once used for pillars and memorials in Peterborough Cathedral and local churches (Porter, 1861; Judd, 1875). It was developed in the upper part of the Longthorpe Member.

An exposure in the A1 road cutting at Alwalton (TL12889595) was recorded by Horton, Lake, Bisson & Coppack (1974). Underlying the basal Cornbrash was c.3.65m of clay with some limestone in the lower part (all of which was classified as 'Blisworth Clay' by Horton et al.).

180. Orton Waterville Road Cutting (TL15259667)

Horton, Lake, Bisson & Coppack (1974) recorded the presence of Cornbrash here, overlying about 2.9m of clays belonging to the Thrapston Clay Formation. The clays became increasingly calcareous and fossiliferous downwards and contained bivalve shells in the lower part. A massive, shelly limestone, about 2.6m below the base of the Cornbrash, may be the uppermost bed of the White Limestone Formation. A clay-ironstone band was developed directly beneath the Cornbrash. Ironstone nodules from the Thrapston Clay elsewhere in the Peterborough area have

been found to consist of microgranular aggregates of colourless siderite (Horton et al., op. cit.)

181. Orton Longueville (?TL173970)

A former quarry near St. Botolph's Bridge once showed the following section (Porter, 1861):

CORNBRASH	Rubbly limestone	1.83m
THRAPSTON CLAY (3.35m)	Bituminous clay with ironstone	2.13m
	Argillaceous shale full of fossils; P. hebridica	1.22m
WHITE LIMESTONE (2.29m)	'Marly' limestone; P. hebridica	0.61m
	Hard, blue and brown compact limestone	0.61m
	Calcareous sandstone; P. hebridica	0.61m
	Buff coloured sandstone; M. imbricatus	0.15m
	Hard blue limestone	0.30m
RUTLAND FORMATION	Green and blue clay	5.18m

Porter (op. cit.) classified the whole of this section beneath the Cornbrash as Forest Marble, largely because of the occurrence of the Alwalton Marble within the same succession in the Alwalton area, and also because he believed that the Lincolnshire Limestone at Stibbington and elsewhere was 'Great Oolite'.

182. Longthorpe Road Cutting (TL15629859)

This section, which is illustrated in Enclosure A-15, has been designated as the type section of the Longthorpe Member, the oyster-rich upper division of the White Limestone between Oundle and Stamford.

183. Temporary exposures, Longthorpe (TL15259835)

During the construction of the Thomas Cook and Pearl Assurance buildings at Longthorpe, temporary exposures were measured by M. Bradshaw; the following description is based on his field notes:

WHITE LIMESTONE	Longthorpe Member (1.76m+)	
	Argillaceous, oyster-rich biopackstone/ wackestone with biograinstone intercalations; abundant P. hebridica	

subrugulosa; M. imbricatus, P. socialis, serpulids	0.31m+
Shelly clay	0.08m
Argillaceous, oyster-rich pelbiopackstone/ wackestone with biograinstone intercalations; abundant P. hebridica subrugulosa; M. imbricatus, fish teeth	0.15m
Silty clay; abundant P. hebridica subrugulosa; Pseudolimea, P. socialis	0.15m
Biowackestone with shelly clay interlayers; abundant P. hebridica subrugulosa; Pseudolimea, P. socialis	0.15m
Biowackestone with shelly clay interlayers; abundant P. hebridica; M. imbricatus, Pseudolimea, Protocardia, Vaugonia, Isognomon, serpulids, Hyporosopora	0.60m
Silty clay packed with oysters; serpulids	0.03m
Oobiopackstone/wackestone; abundant P. hebridica; Anisocardia, P. socialis	0.08m
Silty clay packed with oyster debris; P. socialis	0.05m
Biograinstone/packstone, locally oolitic; P. hebridica, M. imbricatus, Anisocardia, Vaugonia, Pleuromya, Favreina. Sharp base	0.31m
K. sharpi Beds (1.32m)	
Interlayered clay and quartz/bioclastic sand; plant debris, P. hebridica, P. socialis, M. imbricatus, ?Pteroperna, echinoid spines, fish teeth	0.59m
Oobiopackstone/wackestone; abundant M. imbricatus; Anisocardia, P. hebridica, trigoniids, wood fragments	0.55m
Silty, shelly clay; P. hebridica, trigoniids, P. socialis, Anisocardia, Pholadomya, fish teeth, echinoid spines	0.18m

----------erosive base----------

RUTLAND FORMATION Wellingborough Rhythm

The White Limestone is probably about 3.2m thick at Longthorpe. The overlying Thrapston Clay may be only 1.4m thick.

184. Temporary exposures, Bretton (TF16100185)

In late 1973/early 1974, during construction work in the Bretton area, a number of temporary exposures were examined by M. Bradshaw; he has kindly allowed me to use his MS. descriptions. At TF16?01?, an oyster-encrusted hardground appears to have capped the K. sharpi Beds/

Rhythm B, which was at least 1.57m thick. The overlying Longthorpe Member is about 1.4m thick.

At TF16100185, the Upper Cornbrash was seen directly overlying rootletted Thrapston Clay terrigenous mudstones; pebbles of reworked Lower Cornbrash limestone were present at the base of the Upper Cornbrash. At TF16900205, this pebble bed was not developed. A similar section was recorded by Bradshaw (MS.) at Bourges Boulevard (TL18659925), where 1.27m of Upper Cornbrash (with a basal pebble bed) was seen directly overlying 0.75m of Thrapston Clay (a dark blue-green, homogeneous, unfossiliferous mud in which rootlets were not observed).

185. Nab Lane, Paston (TF19020216)

M. Bradshaw has kindly supplied the following descriptions (here slightly modified) of the temporary exposure he measured in 1975 at Nab Lane, Paston (see also Fenton, 1980, for palynological data):

KELLAWAYS CLAY	Green and blue-grey, slightly silty, unfossiliferous clay	0.50m
CORNBRASH	Upper Cornbrash (2.18m)	
	Yellow-green, packed, fine to very coarse shelly, silty mud with very abundant fauna; ?L. marshii	0.67m
	Massive, grey, very fine to fine, slightly quartz-sandy biosparite	0.38m
	Very thinly, irregulated laminated, sandy clay	0.15m
	Massive, grey, bioturbated limestone; Pholadomya	0.48m
	Irregularly laminated, shelly clay; large oysters	0.03m
	Massive, bioturbated limestone	0.25m
	Shelly mud; oysters, serpulids, Pleuromya, echinoid spines; pebbles encrusted by L. marshii	0.22m
	Lower Cornbrash (0.55m)	
	Massive, grey, fine to medium grained, bioturbated, shelly limestone	0.39m
	Finely interlayered, fine to very coarse shell debris in soft, silty clay and shelly sand; P. hebridica.	
	Abrupt base	0.16m

THRAPSTON CLAY (3.90m)	Dark green-black, carbonaceous, slightly silty clay; abundant bedded wood debris; rootlets truncated at the base of the Cornbrash; occasional planar lamination and ironstone nodules	0.69m
	Finely laminated clay with silt lenticles; silt laminations become finer upwards and die out 0.5m above the base. Rare ?Isognomon and aragonitic bivalves in the basal 0.29m. Rootletted throughout. Gradational base	1.00m
	Sharp-based oyster biosparite; P. hebridica subrugulosa, large M. imbricatus	0.27m
	Black-grey clay with fine laminae of medium-grained shell debris: Camptonectes, P. hebridica, Tancredia, ?Neomiodon, 'Gervillella' ovata, Plac. socialis, corbulids. P. hebridica subrugulosa and M. imbricatus in lowermost laminae only	0.82m
	Fine to coarse, weakly-cemented oyster lumachelle; P. hebridica subrugulosa, large M. imbricatus. Sediment becomes more argillaceous upwards	0.28m
	Grey, very slightly silty, laminated clay; wood fragments and occasional shelly laminae; ?Neomiodon, ?P. socialis	0.10m
	Sharp-based, dark grey, poorly cemented oyster lumachelle	0.32m
	Green, shelly, sandy clay; abundant P. hebridica	0.11m
	Dark grey, fine to medium-grained, poorly cemented bioclastic sand: abundant P. hebridica; M. imbricatus, P. socialis, echinoid spines, serpulids. Increasingly argillaceous upwards. Gradational base	0.31m
WHITE LIMESTONE	Very hard, pale grey, fossiliferous biomicrite. Pseudolimea duplicata, Plac. socialis, M. imbricatus, P. hebridica and serpulid colonies	0.30m

The lithostratigraphic subdivision of this section follows Bradshaw, although in this area it is impossible to place the lithostratigraphic junction between the White Limestone and Thrapston Clay with any confidence.

1.2.7 Leicestershire

186. Ketton (SK97750530 and SK97200585)

The entire White Limestone succession is still exposed in the disused Grange Quarry (SK97750530; L. Richardson, 1939a; Torrens, 1968) while the basal part of the White Limestone is exposed in Ketton Main Quarry (SK97200585; Bradshaw, 1978); Rhythm A, contained within the Rutland Formation, is also well exposed in the latter. The section in Enclosure A-15 is a composite one, measured in both quarries.

187. Banthorpe Railway Cutting (TF060112)

The Cornbrash developed at the top of this cutting (Morris, 1853; Sharp, 1873) is still exposed (Bradshaw, pers. comm.) but has not been examined. In Morris's and Sharp's time, beneath 2.13m-2.74m of Cornbrash, a complete section of Thrapston Clay and the uppermost 2.13m of White Limetone was exposed, but by 1940 the cutting was overgrown (L. Richardson, 1940). Sharp (op. cit.) obtained a Cetiosaurus caudal vertebra from the Thrapston Clay here and a large nautiloid from the White Limestone. Both the Upper and Lower Cornbrash were formerly exposed in the Casewick Cutting (TL074101; Morris, op. cit.)

189. Essendine Railway Cutting (TF045126)

The White Limestone is still well exposed here but has not been examined because of the difficulty of access. Morris (1853) gave the following description:

WHITE LIMESTONE (5.18m+)	Upper beds full of oysters, with patches of serpulids	0.91-1.52m
	Sandy and 'marly' limestone, becoming occasionally very compact, calcareous and bluish; sometimes shaly. Fossiliferous, with M. imbricatus, ?Trigonia, Pholadomya, Epithyris, ?Camptonectes, ?Plagiostoma, P. hebridica, ?Isognomon, Procymatoceras, Acrosalenia, etc.	3.05-3.66m

RUTLAND FORMATION

A section through the Rutland Formation up to the base of the White Limestone was given by Bradshaw (1978).

190. Clipsham New Quarry (SK988160)

Only the basal White Limestone is exposed in this Lincolnshire Limestone quarry (Bradshaw, 1978); the relevant part of the section is shown in Enclosure A-16.

1.2.8 Lincolnshire

191. Danes Hill Railway Cutting (TF0315)

Morris's (1853) description of the upper Great Oolite Group succession formerly exposed in this cutting can be abstracted and interpreted in the following manner:

CORNBRASH	Cornbrash, with characteristic fossils	0.61-0.91m
?THRAPSTON CLAY (1.68m)	Compact, sandy and 'marly' limestone	1.06m
	'Marly', fossiliferous limestone	0.61m
?WHITE LIMESTONE (5.18m)	Oyster-bed, compact at bottom, soft at top. Full of flatly-bedded oysters, ?Isognomon/Bakevellia, etc.	2.44m
	Irregular clay and soft, 'marly' limestone	1.22m
	Clay and shelly limestone	1.22m
	Green sandy clay; Pholadomya, etc.	0.30m
RUTLAND FORMATION		

The Thrapston Clay and White Limestone are difficult to distinguish in Morris's account.

192. Witham-on-the-Hill (TF063163)

Oyster-rich White Limestone was formerly well exposed in quarries between Witham-on-the-Hill and Manthorpe (Judd, 1875). Most of the White Limestone in this area appears to be similar to the Longthorpe Member of further south, except for a fossiliferous, hard, blue-hearted limestone developed at the base of the formation.

193. Adamantine Clinker & Fireclay Co.'s Pit, Little Bytham (TF01251860)

This section is illustrated in Enclosure A-16. The White Limestone is better exposed here than at Locality 194, but higher beds

are visible at the latter. The Rutland Formation succession here was described by Bradshaw (1978).

194. Railway Cutting, Little Bytham (TF02851788)

This overgrown cutting should not be confused with Little Bytham Railway Cutting (TF014185) of Morris (1853) and Bradshaw (1978), which is on the London to York main line and exposes Lincolnshire Limestone. The near complete White Limestone succession measured at this locality is illustrated in Enclosure A-16.

197. Pickworth (TF0433)

The following section was recorded in Pickworth Stone Pit by W.H. Holloway (Jukes-Browne, 1885):

WHITE LIMESTONE	'Marly' oyster bed, full of P. hebridica and P. hebridica subrugulosa	0.38m
	'Marly' parting,	0.08m
	'Rotten' limestone, full of oysters	0.15m
	'Marly' oyster bed, full of oysters	0.15m
	Locally ferruginous, 'marly' parting	0.15m
	Oyster bed	0.30m
	'Marly' parting	0.15m
	Argillaceous limestone	0.30m
	Hard, blue-hearted, locally oolitic, bioclastic limestone	0.91m

Most of the White Limestone here, above the lowermost 1.22m seen, was made up of oyster beds (Lithofacies 7), apparently similar to those of the Longthorpe Member to the south.

198. Thompson's Quarry, Ancaster (SK992410)

The White Limestone section of this disused quarry (Enclosure A-16) has been described previously by Aslin (1965), Torrens (1968) and Bradshaw (1978). All of the White Limestone exposed belongs within Rhythm B. The fauna (Biofacies 4) includes K. sharpi, O. thrapstonensis, Burmirhynchia, Epithyris and Nucleolites. The diversity of this fauna is probably related to a marine transgression which, during Rhythm B times, is thought to have followed the line of the Widmerpool Gulf. The Grantham-Ancaster district contains the area of outcrop closest to the Widmerpool Gulf.

199. Quarrington Railway Cutting (TF057455)

Bradshaw (MS.) recorded the presence of about 4m of White Limestone at the eastern end of this cutting. The basal 0.40-0.50m of the White Limestone is a massive bed of very fine to medium grained oobio- and pelbiograinstone containing P. hebridica and Anisocardia. This passes up into softer limestones and eventually up into oyster-rich beds at the top of the formation. I have not yet visited the cutting.

Lincoln District

Evans (1952) described the White Limestone of the Lincoln district as comprising between 5.79-7.32m of shelly limestone, with Kallirhynchia sharpi, interbedded with 'calcareous marl'. The overlying Thrapston Clay (c.7.6m thick) is dominated by clays but contains subordinate oyster limestones; rhynchonellids occur within this formation at Bunker's Hill. (Evans, op. cit.; L. Richardson, 1940).

201. Heighington Railway Cutting (TF028691)

The near complete White Limestone section in this quarry, noted by Bradshaw (1978), has not yet been measured. Ussher et al. (1888) recorded the presence of 3.35m of White Limestone here.

202. Greetwell Railway Cutting (TF013717)

About 4.5m of White Limestone was formerly exposed here, overlying the Rutland Formation. The bulk of the formation consisted of a hard, fossiliferous 'ragstone', containing fish teeth, bivalves, echinoids and corals (Ussher et al., 1888). 'Marl' was developed at the base of the formation.

203. A.R.P. Shelter, St. Giles, Lincoln (c.SK9873)

A temporary section recorded by L. Richardson (MS., at present missing from the University of Leicester, but published in Torrens, 1967) from the end of Macaulay Drive, St. Giles appears to be comparable to the uppermost part of the section at Thompson's Quarry, Ancaster (Loc. 198); Richardson's section belongs entirely within Rhythm B.

WHITE LIMESTONE	Bedded limestone; K. sharpi	0.20m
	Rubbly limestone with clay	0.76m
	Dark brown clay	0.15m
	Light grey 'marl' with angular limestone fragments.	0.61m
	Blue clay with abundant P. hebridica	thickness not recorded

Batters (1939) recorded the presence at this same section, of the brachiopods 'Epithyris bathonica Buckman' and 'Kutchithyris circumdata Deslongchamps' (?both Epithyris sp.), Burmirhynchia, and 'Rugitela cf. ranvilliana Deslongchamps' (?Ornithella thrapstonensis).

204. Sudbrooke Park (TF036756?)

Shallow quarries in Sudbrooke Park were first mentioned by Woodward (1894) who listed a large number of fossils collected here from both members of the Cornbrash. The section was described by Douglas & Arkell (1932), from whose work the following account is adapted:

KELLAWAYS BEDS	Yellow, micaceous sandstones	
	Clay with rhynchonellids	0.30m
CORNBRASH	Upper Cornbrash (1.06m)	
	Purplish, flaggy limestone; Kamptokephalites herveyi, Trigonia Myophorella, Plagiostoma rigidula, Lopha marshii, Rhynchonelloidea	0.91m
	Fossiliferous, rubbly limestone, becoming 'marly' downwards; L. marshii, Rhynchonelloidea, Pleuromya, Pseudomelania	0.15m
	Lower Cornbrash (c.0.55m)	
	Hard, shelly limestone with O. obovata, K. yaxleyensis, trigoniids, R. vagans, Entolium, M. echinata, Pinna, Protocardia, Homomya, Pleuromya, Acrosalenia	0.30m
	Blackish, argillaceous, shelly limestone with abundant P. hebridica; Nanogyra nana, M. echinata, M. imbricatus, Arcomytilus asper, Vaugonia, R. vagans	0.20m
	Black clay, crowded with oysters	c.0.05m
THRAPSTON CLAY	Black clay	c.0.25m

The lowermost 0.25m of the Lower Cornbrash were classifed as 'Blisworth Clay' by Douglas & Arkell (op. cit.) but the diverse and stenotopic fauna of these beds suggests that they instead belong within the Cornbrash. A specimen of Clydoniceras legayi figured by Blake (1905-7) from Sudbrooke probably came from the uppermost 0.30m of the Lower Cornbrash. It is the most northerly record of Clydoniceras.

206. Spital Gas-pipeline Trenches (near SK966903?)

Kent (1970) recorded the presence of probable Kallirhynchia sharpi in the very sandy basal White Limestone temporarily exposed near Spital in 1964. These are the most northerly recorded examples of this east Midlands brachiopod. In recent BGS mapping of this area and that immediately to the north, the lowermost White Limestone has been included in their 'Priestland Clay'.

207. Bishops Norton Gas-pipeline Trench (near SK9992?)

Kent (1972) published a section from the Thrapston Clay up to the Oxford Clay, measured in a gas-pipeline trench southeast of Bishops Norton. Kent suggested that the whole of the Cornbrash, here up to 1.22m thick and very argillaceous, probably *belonged to the lower member*, but it is possible that the uppermost 0.76m could have instead belonged to the Upper Cornbrash. The 0.10m thick bed immediately underlying this contained a pebble with Lithophaga borings, suggesting the presence of the basal Upper Cornbrash pebble bed, which is common elsewhere in eastern England. However, the fauna obtained from the same bed was typical of the Lower Cornbrash, and included both Obovothyris obovata and Cererithyris intermedia.

Beneath the Cornbrash, at least 2.54m of tea-green to deep green clays and sandy clays belonging to the Thrapston Clay were seen.

1.3 Boreholes

1.3.1 Oxfordshire

B1 Apley Barn (SP34381066)

The Apley Barn borehole penetrated the lowermost 10.52m of the White Limestone (Poole, 1969). The base of Rhythm A can be placed at 10.92m; if the green, mud-filled tubes in the greenish-grey calcareous clay developed between 7.70m and 8.74m represented rootlets, Rhythm A may be about 3.2m thick in the Witney area. The borehole must have started in the basal Ardley Member and penetrated a complete Shipton Member succession, although the lithostratigraphic junction between these members cannot be recognised from Poole's account.

B2 North Leigh (SP38291296)

Basal White Limestone has probably been included in the Hampen Marly Beds in the published formational abstract log of this borehole (IGS, 1978). The White Limestone/Forest Marble succession here was illustrated by Sumbler (1984, fig. 3).

B3 Oxford (SP507068)

Pocock's (1908; revised in Pringle, 1926) description of the 1898 city brewery boring is particularly difficult to interpret beneath 78.33m (base of the Cornbrash); Pringle's (1926) figure of 9.96m for the thickness of the Forest Marble may include uppermost White Limestone. Beneath 88.29m the sequence cannot easily be subdivided into the lithostratigraphic units recognised at outcrop to the north, partly because of an increase in the amount of limestone developed within the Hampen Marly Formation on passing south (and southwest) towards Oxford.

Although Pringle (op. cit.) categorically stated that the beds directly overlying the Lias could not be Clypeus Grit, it is probable that this unit is developed (?5.17m thick) ovelying 1.07m of ?Northampton Sand. At the base of the Great Oolite Group, c.4.9m of Lower Fuller's Earth is present (cf. 9.5m at Harwell; ?3.02m at Shipton), developed between 117.7m and 122.5m.

B4 Shipton (SP47621718)

Blue Circle's OH11 borehole is now lodged in the Geology Department, King's College, London where Professor J.E. Prentice kindly allowed me to log the core.

The full lithostratigraphic succession encountered in this borehole can be summarised as follows:

		Thickness (m)	Depth (m)
TOPSOIL		0.23	0.23
CORNBRASH		2.09	2.32
FOREST MARBLE		6.15	8.47
WHITE LIMESTONE	Bladon Member	0.95	9.42
(14.52m)	Ardley Member	7.24	16.66
	Shipton Member	6.33	22.99
HAMPEN MARLY FORMATION		7.00	29.99
TAYNTON STONE		5.39	35.38
SHARP'S HILL FORMATION		5.47	40.85
CHIPPING NORTON FMN/LOWER FULLER'S EARTH		6.10	46.95
CLYPEUS GRIT		7.46	54.41
UPPER LIAS		0.70+	55.11

Both Rhythms A and B were cored. Rhythm A is 2m thick (21.29m-23.29m) and overlies rootletted ?Cranford Rhythm sediments. Rhythm B is 4.47m thick in this borehole (16.82m-21.29m).

Thickness data and limited facies information have also been used from the following Oxfordshire boreholes:

B5	Swalecliffe No. 3 (SP36803585)	Bradshaw (1978)
B6	Hook Norton (SP35643588)	BGS (MS., Keyworth)
B7	Tadmarton (SP4067837830)	A. Horton (in litt.)
B8	Middleton Stoney (SP527233)	)
B9	Gowell Farm, Bicester (SP570239)	) Data provided by
B10	Chesterton (SP561212)	) RMC
B11	Bucknell (SP563261)	)
B12	Bicester (SP58722081)	D.o.E. well release data

B13	Chalgrove (SU65659620)	BGS (1985)
B14	Wytham Park (c.SP4708)	Blake (1902)
B15	Faringdon (SU32249399)	Falcon & Kent (1960); Martin (1967)
B16	Harwell No. 3 (SU4680186441)	Gallois & Worssam (1985)

1.3.2 Buckinghamshire

B17 Calvert (SP690245)*

Davies & Pringle's (1913) record of this borehole has been previously reinterpreted by Arkell (1933a), T. Palmer (1974) and Bradshaw (1978). The following is my interpretation of part of their account:

		Thickness (m)	Depth (m)
OXFORD CLAY		28.42	29.64
FOREST MARBLE (3.05m)	Bluish-grey and grey limestone, oolitic in places, becoming 'earthy' below; unfossiliferous	0.53	30.17
	Dark grey, 'earthy' limestone	0.23	30.40
	Hard grey limestone, shelly in places; abundant oyster fragments; base of bed yellowish and somewhat sandy	0.61	31.01
	No core (?clay)	1.68	32.69
WHITE LIMESTONE	Bladon Member (1.07m)		
	Grey, 'earthy' limestone with plant fragments; ?B. waltoni	0.38	33.07
	Bright bluish-green clay	0.08	33.15
	Grey 'earthy' limestone	0.61	33.76
	Ardley Member (7.70m)		
	Irregularly thin-bedded, bluish-grey limestone, oolitic and shelly in places	0.45	34.21
	Dark grey 'earthy' limestone Paler grey, blotchy limestone, oolitic in places	2.13	36.35
	Grey 'marly' clays with a bed of sandstone and a hard band of limestone; lignite plentiful	5.11	41.45

* This borehole was wrongly plotted by Martin (1967) on his isopach map.

	Shipton Member (5.64m)		
	Very compact, blotchy, grey limestone*	0.45	41.90
	Yellowish 'marly' limestone, shelly in places	0.61	42.51
	Grey 'marly' limestone, full of dark grains; limestone becoming darker below	1.83	44.34
	Grey, blotchy limestone yielding Epithyris	0.76	45.10
	Grey 'marl'	0.15	45.25
	Dark 'marly' clay full of P. hebridica and Burmirhynchia	0.76	46.02
	Grey limestone, somewhat 'earthy': unfossiliferous	1.52	47.54
	Dark grey 'marl'; abundant Pholadomya	0.15	47.70
HAMPEN MARLY FORMATION		10.28	57.98
TAYNTON LIMESTONE		3.89	61.87
LIAS		73.31	135.18
ORDOVICIAN		290.93	426.11

The sequence between c.32.00m and c.48.70m can tentatively be subdivided into five rhythmic units as follows:

Rhythm E	(c.1.07m)	c.32.00m-33.07m
Rhythm D	(0.69m)	33.07m-33.76m
Rhythm C	(8.80m)	33.76m-41.45m
Rhythm B	(4.57m)	41.45m-46.02m
Rhythm A	(c.2.68m)	46.02m-c.48.70m

The top bed of Rhythm B, judging from Davies & Pringle's (op. cit.) description, may have been rootletted.

B18 Little Horwood (?near SP7930)

Using the Tattenhoe borehole for guidance, the following tentative interpretation may be placed on W. Whitaker's (1921) account of a well and boring sunk at Horwood House:

CORNBRASH	Rock	1.14m
FOREST MARBLE	Clay	4.04m
WHITE LIMESTONE	Dark green sandstone	1.83m
(7.54m)	Very hard rock	4.42m
	Dark green sandstone	0.76m
	Light green rock	0.53m

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* Davies & Pringle's published description of the petrography of this bed suggests a ?pelbiowackestone.

RUTLAND FORMATION (6.70m)	Dark green clay	0.69m
	Dark green sand and shells	0.91m
	Gritty stone	3.35m
	Dark sand-rock	0.46m
	Light coloured sandy loam; cuts as rock in the solid	1.68m
	Hard rock	0.61m
UPPER LIAS	Blue clay	0.76m+

B19 Tattenhoe (SP82893437)

The formational abstract of this borehole given in Horton, Shephard-Thorn & Thurrell (1974) can be re-interpreted as follows:

OXFORD CLAY	17.02m
KELLAWAYS BEDS	0.68m
FOREST MARBLE	1.10m
WHITE LIMESTONE	11.12m
RUTLAND FORMATION	10.21m
LIAS	70.05m
TREMADOCIAN	63.98m

Further details of the White Limestone succession are given in Horton et al.'s figure 7. The absence of the Cornbrash and most of the Forest Marble here is due to Early Callovian erosion.

B20 Great Linford, MK30 (SP85274179)

This borehole was described in detail by Horton, Shephard-Thorn & Thurrell (1974). The succession can be interpreted as follows:

a) Lithostratigraphy

?UPPER CORNBRASH MEMBER	1.07m	6.22-7.29m
FOREST MARBLE FORMATION	5.05m	7.29-12.34m
WHITE LIMESTONE FORMATION	6.63m	12.34-18.97m
RUTLAND FORMATION	21.90m	18.97-40.87m

b) Event stratigraphy

Forest Marble 'Rhythm'	2.46m	7.29-9.75m
Rhythm D	3.20m	9.75-12.95m
Rhythm C	4.91m	12.95-17.86m
?Rhythm B	0.58m	17.86-18.97m
Cranford Rhythm	2.29m	18.97-21.26m
Wellingborough Rhythm		

The lowermost 2.59m of the Forest Marble Formation is probably laterally equivalent to the Thrapston Clay Formation of areas to the

east. The upper part of the Forest Marble 'Rhythm' appears to be rootletted here.

The Lower Cornbrash may have been overstepped by the Upper Cornbrash.

B21 Lodge Farm, D688 (SP86274048)

Horton et al.'s (op. cit.) description of this borehole can be interpreted as follows:

a) Lithostratigraphy

?UPPER CORNBRASH MEMBER	0.15m	12.68-12.83m
FOREST MARBLE FORMATION	5.72m	12.83-18.55m
WHITE LIMESTONE FORMATION	7.36m	18.55-25.91m

b) Event stratigraphy

Forest Marble 'Rhythm'	2.56m	12.83-15.39m
Rhythm D	4.07m	15.39-19.46m
Rhythm C	5.49m	19.46-24.95m
?Rhythm B	0.96m	24.95-25.91m
Cranford Rhythm		

B22 Tongwell Farm, D512 (SP8684742120)

Only a short core was taken in this borehole (Horton et al., op. cit.). The Upper Cornbrash appears to overlie the Forest Marble 'Rhythm', which is probably 2.06m thick here.

Thickness data and limited facies information have been used from the following Buckinghamshire boreholes:

B23	Twyford-3 (SP68592659)	D.o.E. well release data
B24	Twyford-4 (SP66972561)	D.o.E. well release data
B25	Marsh Gibbon (SP6423)	D.o.E. well release data
B26	Little Missenden (SU900980)	Strahan (1916); Bradshaw (1978)

1.3.3 Northamptonshire

B27 Quinton (?near SP7854)

A well dug at a new house near Quinton in 1899 encountered the following succession (abstracted from B. Thompson's MS.):

		Thickness (m)	Depth (m)
SOIL & DRIFT		1.83	1.83
CORNBRASH	Cornbrash with R. vagans, M. echinata, Chomatoseris and other characteristic fossils	0.91	2.74
FOREST MARBLE (c.3.81m)	Flaggy limestone with few fossils	c.0.76	c.3.51
	Oyster bed, also containing M. imbricatus and ?Mactromya	1.22	c.4.72
	White calcareous clay with shell fragments Greenish clay Blue clay with many ironstone nodules	c.1.83	c.6.55
WHITE LIMESTONE	Hard, blue-hearted stone with softer partings; very shelly; abundant P. hebridica; K. sharpi	c.4.27	c.10.82
RUTLAND FORMATION		c.7.01	c.17.83

In an unpublished MS. on the Northamptonshire Cornbrash, Thompson noted that not only were Obovothyris and Cererithyris obtained here but that Microthyris lagenalis (=Microthyridina lagenalis) was also collected, thus indicating the presence of Upper Cornbrash. The thickness estimated for the White Limestone is too low; the formation is over 6m thick elsewhere in the area.

B28 Denford (TL000761)

The succession encountered in a trial hole sunk near Denford prior to 1914 for the Ebbw Vale Steel Co. was recorded by Thompson (MS.). The succession can be interpreted as follows:

		Thickness (m)	Depth (m)
CORNBRASH	'Red Backs'	1.52	11.27
THRAPSTON CLAY	Clay	3.25	14.52
WHITE LIMESTONE (c.6.21m)	Limestone	3.81	18.33
	Clay	0.38	18.71
	Limestone	0.71	19.42
	Clay and Limestone	0.30	19.72
	Limestone	0.61	20.33
	Clay	c.0.40	20.73

RUTLAND FORMATION (c.5.43m)	Clay	c.0.51	21.24
	Sand	2.13	23.37
	Clay and sand	2.31	25.68
	Clay	0.48	26.16
NORTHAMPTON SAND	Ironstone	4.09	30.25
UPPER LIAS	Clay	3.96+	34.21

If this interpretation is correct, the Rutland Formation is here thicker than at both Kimble's Pit (SP979758) and a temporary exposure (SP994776) at Denford to the west (Bradshaw, 1978), or at Raunds (Loc. 131) to the east.

Thickness data and limited facies information have also been used from the following Northamptonshire boreholes:

B29	Brackley (SP584374)	Woodward & Thompson (1909); Walford (1912); Bradshaw (1978)
B30	Bedford Road, Rushden (SP96426490)	Woodward & Thompson (1909); Thompson (1930)
B31	Ashton Wold (TL08058810)	Woodward & Thompson (1909)
B32	Clopton Hall (TL06258015)	Woodward & Thompson (1909)

1.3.4 Bedfordshire

B33 Holwellbury (TL159352)

The borehole at Holwellbury referred to by Edmonds & Dinham (1965) is of interest in that it appears that the Cornbrash has here overstepped onto the Rutland Formation:

		Thickness (m)	Depth (m)
LOWER GREENSAND			116.97
CORNBRASH	Hard, grey bioclastic limestone with shell and echinoderm fragments	1.07	118.03
RUTLAND FORMATION	Dark green, blue and grey clay, the latter with pale chalky-looking material	4.19	122.22

B34 Ickwellbury (TL146460)

Edmonds & Dinham's (1965) record of this borehole can be interpreted as follows:

		Thickness (m)	Depth (m)
KELLAWAYS BEDS	Oyster bed	0.15	50.44
(4.25m)	Grey clay and sand	4.11	54.55
CORNBRASH	Hard, pyritic rock	1.37	55.92
THRAPSTON CLAY	Green and grey clay	0.30	56.22
WHITE LIMESTONE	Rock and limestone	5.94	62.16
RUTLAND FORMATION	Sandy clay	seen: 2.29	64.45

Bradshaw (1978) has noted the similarity of this succession and that at Bromham (Loc. 74). This borehole is close to the overstep of the Cornbrash onto the White Limestone, with the Thrapston Clay here represented by only 0.30m of green and grey clay.

B35 Northill Rectory (TL148465)

An old borehole west of the church proved the following succession (Edmonds & Dinham, op. cit.):

		Thickness (m)	Depth (m)
KELLAWAYS BEDS	Sand	2.74	55.47
(5.49m)	Blue sandy clay	2.74	58.22
CORNBRASH	Sand rock	2.24	60.46
THRAPSTON CLAY	Blue clay with shells	0.76	61.22
WHITE LIMESTONE	Rock and blue clay	0.53	61.75
with uppermost	Limestone	0.81	62.56
RUTLAND FORMATION	Sandy clays containing a		
(6.99m)	1.22m bed of limestone and		
	a 1.07m bed of 'blue stone'	5.64	68.20

The White Limestone apparently had a higher clay content here than at Ickwellbury, only 0.54km distant. In a nearby borehole at Blunham Grange (TL150523), Edmonds & Dinham's (op. cit.) record suggests that the Thrapston Clay was 0.61m thick, beneath 0.76m of Cornbrash and overlying at least 2.06m of White Limestone; however, the succession in this borehole may have been faulted.

B36 Roxton (TL135543)

A well-shaft and boring near Woodlands Barns, Roxton passed through the following succession (Edmonds & Dinham, 1965):

		Thickness (m)	Depth (m)
CORNABRASH	'Rock' struck at 35.97m. Grey, shelly 'marl' with M. echinata from 37.03m to 37.34m overlying 0.76m of limestone	2.13	38.10
THRAPSTON CLAY	Green clay and shale with grey mottling	0.91	39.01
WHITE LIMESTONE (5.17m)	White, crystalline limestone	0.30	39.32
	Grey, 'marly' clay crowded with oysters; Plagiostoma sp.	0.30	39.62
	Rock and clay	2.13	41.75
	Very hard rock	2.44	44.20
RUTLAND FORMATION (10.36m+)	Rootletted green and purple-grey clay	4.88	49.07
	Soft sand and clay	0.91	49.99
	Rootletted sandy muds with interlayered textures	1.52	51.51
	Black and brown-black clays with green and white silt inclusions; abundant plant debris and shelly, micaceous layers	3.05	54.56

The presence of Meleagrinella echinata in the Cornbrash suggests that the Lower Cornbrash is developed here, as it is locally in the Bedford area.

B37 Wyboston (TL17595723)

The Geological Survey's deep borehole at Wyboston passed through 104.5m of Jurassic strata before entering the Palaeozoic basement. The following succession can be abstracted from that given by Edmonds & Dinham (1965):

		Thickness (m)	Depth (m)
KELLAWAYS BEDS	Sandy clay and clay, mostly fossiliferous	4.89	24.45

CORNBRASH (2.66m)	Limestone autobreccia	0.31	24.76
	Hard, grey, fairly shelly, oolitic limestone	1.75	25.07
	Shelly clay with a little limestone at the top	0.61	26.82
WHITE LIMESTONE	Shelly clay and shelly limestone with abundant oysters in places	4.52	27.43
RUTLAND FORMATION	Green, purple and grey clay, often silty, with rootlets in places; some muddy sand	10.26	42.21
UPPER & LOWER LIAS		68.38	110.59
OLD RED SANDSTONE			

The apparent overstep of the ?Lower Cornbrash onto the White Limestone must occur between Roxton and Wyboston.

1.3.5 Cambridgeshire

B38 St. Neots (TL183601)

No Thrapston Clay was recorded in the borehole sunk at Messrs Paine & Co.'s Brewery in about 1890 (Matthews & Harvey, 1965; Edmonds & Dinham, 1965). The Cornbrash and White Limestone appear to have a combined thickness of 10.36m, although some of the underlying Rutland Formation may be included in this figure; the latter formation is certainly thicker than the 2.74m of 'sandy clay and marl' recorded beneath the Cornbrash/White Limestone and overlying the 17.98m of clay supposedly belonging to the Lias.

B39 Great Paxton (TL20886389)

The IGS Annual Report for 1966 (IGS, 1967) contained a brief account of a deep borehole at Great Paxton. The following formational abstract of the Middle Jurassic succession is taken from this, and from Bradshaw (1978):

	Thickness (m)	Depth (m)
KELLAWAYS CLAY	1.27	47.32
CORNBRASH	1.60	48.92
THRAPSTON CLAY	1.27	50.19
WHITE LIMESTONE	5.94	56.13*
RUTLAND FORMATION	5.89	65.07
UPPER, MIDDLE & LOWER LIAS	70.76	135.84
ORDOVICIAN (Llanvirn)	65.25+	201.09

* The depth to the base of the White Limestone given in (IGS, op. cit.), 194'2" (59.18m), was a misprint for 184'2" (56.13m); consideration of nearby boreholes suggests that the thickness of 5.94m for the White Limestone is correct.

B40 Graveley (TL248640)

A well west of the church penetrated 78.81m of Oxford Clay and Kellaways Beds before reaching the Cornbrash; this was 0.46m thick and overlay 0.30m of Thrapston Clay, which in turn overlay White Limestone (Edmonds & Dinham, 1965). The Thrapston Clay probably disappears a little to the west of Graveley.

B41 Cambridge (TL43165948)

Although Worssam & Taylor's (1969) account of this borehole, together with a more detailed BGS core description, were reinterpreted by Bradshaw (1978), the following is a slightly different interpretation of the same data:

		Thickness (m)	Depth (m)
KELLAWAYS CLAY		1.88	106.27
UPPER CORNBRASH (2.47m)	Hard, grey, slightly oolitic limestone, with oysters at the top	0.10	106.38
	Dark blue, oolitic limestone crowded with oysters	0.05	106.43
	Grey limestone	1.17	107.59
	Hard, grey, shelly, slightly oolitic limestone	1.07	108.66
	Dark, shelly limestone with clay and phosphatic nodules	0.08	108.74
WHITE LIMESTONE (1.22m)	Dark blue-black, iridescent shale with irregular limestone	0.23	108.97
	Buff, argillaceous limestone with irregular clay partings	0.25	109.22
	Fairly soft, dark grey, argillaceous limestone with bivalve shells	0.46	109.68
	Dark grey, very shelly limestone, full of shells in the lower part	0.28	109.96
RUTLAND FORMATION		9.52	119.48
LOWER LIAS		12.57	132.05
CARBONIFEROUS LIMESTONE		103.12	235.17

The White Limestone here is attenuated and argillaceous. The Upper Cornbrash may overstep onto lower formations a little to the east.

B42 Huntingdon (TL23697143)

The summary log of this borehole (IGS, 1967) included the following Great Oolite Group succession:

	Thickness (m)	Depth (m)
CORNBRASH	1.30	51.90
THRAPSTON CLAY	0.30	52.20
WHITE LIMESTONE	6.05	58.25
RUTLAND FORMATION	9.64	67.89

Ordovician (Llanvirn) basement was encountered at 172.59m. This borehole must be sited close to the erosional limit of the Thrapston Clay.

B43 Great Stukeley (TL223749)

A borehole was sunk at Great Stukeley Hall in 1928 to a depth of 81.69m (Matthews & Harvey, 1965); the Cornbrash (0.30m thick?) may have directly overlain 6.71m of White Limestone at the bottom of this borehole, but the record is equivocal.

B44 Warboys (TL29037839)

The abstract log of the Warboys borehole (IGS, 1966) has been slightly revised by Riding (1982); this more recent log can be interpreted as follows:

		Thickness (m)	Depth (m)
DRIFT		1.30	1.30
OXFORD CLAY		63.27	64.57
KELLAWAYS BEDS		5.51	70.08
CORNBRASH		1.22	71.30
WHITE LIMESTONE		3.89	75.18
RUTLAND FORMATION	Wellingborough Rhythm?	1.44	76.62
	Stamford Member	10.53	87.15
UPPER, MIDDLE & LOWER LIAS		83.31	170.46
DIORITE (?Caledonian)		46.71+	217.17

Riding's (op. cit.) figure of 217.459m for the termination depth of the borehole is incorrect. The occurrence of Nannoceratopsis ambonis Drugg in a sample from 85.34m is believed by Riding to indicate an Aalenian date, in which case either the above interpretation is incorrect and Grantham Formation is preserved in the borehole or, more likely, N. ambonis was reworked from older strata into the Stamford Member.

Dinocyst floras from 70.10m suggest a macrocephalus Zone age (U. Cornbrash), but Lower Cornbrash may also occur.

B45 Upwood (TL24938304)

The Great Oolite Group succession in this borehole is as follows (after Horton, Lake, Bisson & Coppack, 1974):

	Thickness (m)	Depth (m)
KELLAWAYS CLAY	2.43	33.27
CORNBRASH	2.21	35.48
WHITE LIMESTONE	3.82	39.30
RUTLAND FORMATION	12.29	51.59

The White Limestone becomes increasingly argillaceous downwards, and contains rhynchonellids (?K. sharpi) in the lower part.

B46 Soham (TL59287448)

The relevant part of Worssam & Taylor's (1969) account of this borehole can be reinterpreted to show that, as at Holwellbury (B33), the Cornbrash has overstepped onto the Rutland Formation (partially after Bradshaw, 1978):

		Thickness (m)	Depth (m)
OXFORD CLAY		42.26	77.62
CORNBRASH (2.01m)	Grey, fine-grained limestone, slightly shelly at base	0.86	78.49
	Grey, variably argillaceous and sandy limestone with shelly and silty clay bands	1.14	79.63
RUTLAND FORMATION		11.18	90.81
LOWER LIAS		42.27	133.07
?OLD RED SANDSTONE		29.69	162.76
DEVONIAN		79.40	242.16

A less likely alternative is that 1.14m of argillaceous White Limestone here underlies the Upper Cornbrash.

B47 Wisbech (TF4066008425)

The summary log of the Wisbech borehole (data provided by Texaco), by reference to the Parson Drove succession (B48), can be reinterpreted as follows:

		Thickness (m)	Depth (m)
KELLAWAYS BEDS (5.49m)	Hard, grey, very fine- to fine-grained, well-sorted, shelly sandstone	2.44	111.86
	Firm, brown, calcareous claystone (illustrated as a limestone)	3.05	114.91
CORNBRASH	Hard, grey, lumpy, fossiliferous, shaley, sandy limestone	2.44	117.35
THRAPSTON CLAY	Soft, grey, fossiliferous, calcareous clay	1.22	118.57
WHITE LIMESTONE	Hard to firm, grey to brown, lumpy limestone grading to calcarenite	2.13	120.70
RUTLAND FORMATION	Soft, grey, slightly calcareous clay, with common thin, very fossiliferous limestone bands; all with abundant quartz	5.79	126.49
LINCOLNSHIRE LIMESTONE (3.96m)	Described as above but illustrated as an argillaceous limestone	1.83	128.32
	Soft, light grey to white, calcareous clay with abundant loose quartz grains	2.13	130.45
LIAS	Soft grey-green to green, calcareous clay with occasional beds of hard, brown, argillaceous limestone (only illustrated below 143.26m)		

If correctly reinterpreted then the Lincolnshire Limestone has thinned dramatically in the 3.4km between Parson Drove and Wisbech; this borehole probably lies close to the erosional margin of the Lincolnshire Limestone, with only the argillaceous base of the formation exposed, as at Sibson (Loc. 177) or in the Geddington area.

B48 Parson Drove (TF37931052)

This borehole (IGS, 1980) shows the eastward continuation of thick Lincolnshire Limestone in an area where the formation was expected to be attenuated or absent. In view of this, subsequent reappraisal of north Norfolk borehole successions has suggested that the Lincolnshire Limestone persists as far east as Lexham (B64) and South Creake (B63). Isopachytes suggest that the presence of thick Lincolnshire Limestone at Parson Drove may be associated with a northwest-southeast trending Middle Jurassic 'basin'; greater Bathonian sedimentation occurred in roughly the same area. This 'basin' may be a direct continuation of the Mesozoic 'basin' developed north of Melton Mowbray (Kent, 1937) which is known to coincide with the Carboniferous Widmerpool Gulf.

The Great Oolite and Inferior Oolite of Parson Drove were as follows:

	Thickness (m)	Depth (m)
CORNBRASH	2.99	121.01
THRAPSTON CLAY	1.44	122.45
WHITE LIMESTONE	1.65	124.10
RUTLAND FORMATION	9.65	133.75
LINCOLNSHIRE LIMESTONE	23.35	157.10
UPPER LIAS	16.01	173.11

The Great Oolite Group succession is closely comparable to that encountered in nearby boreholes to the west, and also at outcrop around Peterborough.

B49 Thorney (TF254056)

W. Whitaker's (1922) account of the Thorney borehole, by comparison with Parson Drove, can be interpreted to give the following succession:

CORNBRASH	2.97m
WHITE LIMESTONE	1.96m
RUTLAND FORMATION	13.06m
LINCOLNSHIRE LIMESTONE	15.11m
NORTHAMPTON SAND IRONSTONE	0.30m

Thickness data and facies information have also been used from the following Cambridgeshire boreholes:

B50	Wharf Works No. 1 (TL18539797)	Horton, Lake et al. (1974)
B51	P'boro' Telephone Exchange No. 7 (TL19059850)	
B52	Peterscourt No28E/510832 (TL19519883)	
B53	P'boro' Development Corp. No. 11E/5936 (TL17590136)	
B54	Glinton (TF15000528)	Kent (1962)
B55	Etton Waterworks (TF14240518)	Horton, Lake et al. (1974)
B56	Farcet (TL201947)	W. Whitaker (1922); Bradshaw (1978)
B57	New England Brickworks (c.TF179008)	Porter (1861)
B58	Westwood Airfield (TF170007)	Bradshaw (1978)

1.3.6 Hertfordshire

B59 Tring (SP912103)

An abstracted lithological section of Superior Overseas Development Co.'s 1965 Tring well, with a stratigraphic interpretation, was presented by Bradshaw (1978). Relevant details are repeated here with my own stratigraphic interpretation:

		Thickness (m)	Depth (m)
LOWER GREENSAND		22.86	179.83
CORALLIAN		6.71	186.54
OXFORD CLAY		66.75	253.29
KELLAWAYS BEDS	Clay at base, becoming a silty shale between 256.33m and 255.73m, passing to white, muddy, fine quartz sand	4.42	257.71
CORNBRASH (?Lower Cornbrash)	Grey-white, hard and well-cemented coarse-grained bioclastic and oolitic limestone	1.68	259.39

WHITE LIMESTONE (13.41m)	Sandy, cross-bedded limestone capped by 0.15m of rubbly, sandy limestone	0.61	260.00
	Hard, grey, often cross-bedded limestone, occasionally oolitic, with thin clay seams; recrystallised corals. Quartz sandy below 270.97m and the basal 0.61m is a blue-grey calcareous siltstone	12.80	272.80
RUTLAND FORMATION	Silts and muds at base, becoming a loose, buff to blue to dark grey coarse to medium quartz sand between 275.54m and 274.02m, fining upwards to silt; shelly fauna	4.57	277.37
UPPER DEVONIAN	Hard mudstones dipping at 22°		

The assignment of the Palaeozoic mudstones to the Upper Devonian follows Allsop & Jones (1981). Bradshaw (op. cit.) has suggested that both the Stamford Member and the Wellingborough Rhythm could be represented within the overlying Rutland Formation. The White Limestone is suprisingly thick here; the presence of both corals and cross-bedding in the formation is consistent with fairly open-marine conditions being maintained well to the east of today's outcrop during White Limestone times. The Cornbrash has clearly overstepped the Forest Marble onto the White Limestone at Tring.

B60 Ashwell (TL286390)

Another Superior O.D.Co. well reported by Bradshaw (1978) showed the following succession:

		Thickness (m)	Depth (m)
LOWER GREENSAND			134.42
CORNBRASH	Light grey calcareous sandstone with brachiopods and bivalves	0.76	135.18
WHITE LIMESTONE	Bioturbated silts and argillaceous limestones with Trigonia sp. and wood fragments. Continues up into argillaceous limestones and calcareous muds	5.94	141.27
RUTLAND FORMATION (Wellingborough Rhythm; 0.90m)	Very dark-brown, slightly silty and calcareous clay	0.15	141.42
	Very dark-brown, slightly calcareous clay with rootlets and small bivalves	0.30	141.72
	Light grey limestone with plant fragments	0.15	141.87

	Soft, friable, calcareous clay with small bivalves and wood fragments	0.30	142.17
Stamford Member	Clays, sandy muds and silts, generally non-calcareous, variably lignitic, locally rootletted and with abundant wood at the base	10.83	153.00
UPPER DEVONIAN	Horizontally bedded clays and silts with marine limestones		

Once again, the Cornbrash has overstepped onto the White Limestone, which here exhibits a high terrigenous clay and silt content, as at Northill Rectory (B35).

1.3.7 Norfolk and Suffolk

B61 Wiggenhall (TF59411537)

The Middle Jurassic succession in Texaco's Wiggenhall borehole was wrongly classified in that company's summary log. Comparison with other Norfolk and Cambridgeshire boreholes allows the following interpretation to be made of their graphic and gamma-ray logs:

		Thickness (m)	Depth (m)
KELLAWAYS BEDS	Sand, with thin clay at the base	c.3.35	c.180.75
CORNBRASH	Very fine-grained, light grey calcitic sandstone	2.13	182.88
RUTLAND FORMATION	Clays	6.10	188.98
LINCS. LST.	Poorly consolidated calcarenite with ooids and much lignite	9.14	198.12
LIAS	Dark grey, bituminous, calcareous clay with occasional thin, silty, sandy or finely oolitic limestones; passes down in dark grey, bituminous calcareous, pyritic clay		

B62 North Creake (TF85653870)

The succession encountered in BP's 1945 North Creake borehole was published by Kent (1947). A thick limestone unit developed immediately above the Upper Lias was classified as 'Great Oolite Limestones' (herein White Limestone) by Kent, largely because oysters were common in this unit. Kent's classification, although initially accepted by Bradshaw (1978), has subsequently been questioned (M. Bradshaw, pers. comm.).

Following a suggestion that the thick limestone unit at North Creake was Lincolnshire Limestone, I have looked closely at the stratigraphic logs of adjacent Norfolk and Fenland boreholes, and also of selected Southern North Sea boreholes. I have concluded that 11.89m of Lincolnshire Limestone, rather than White Limestone, was encountered at North Creake, although palynological confirmation of this would be welcomed.

The North Creake succession (from Kent, 1947, and BP's summary log) can be interpreted as follows:

		Thickness (m)	Depth (m)
CORNBRASH	Brownish-grey, shelly, finely crystalline limestone; oysters, etc.	1.83	346.86
THRAPSTON CLAY) WHITE LIMESTONE) RUTLAND FORMATION) (part)	Soft clay with a little grey shale and a central brownish limestone	12.19	359.05
RUTLAND FORMATION	Dark grey and buff, oyster-rich shale	5.49	364.54
LINCOLNSHIRE LIMESTONE (11.89m)	Medium to light brownish grey, finely crystalline, hard, impure limestone with a little dark shale; oysters	3.66	368.20
	Light grey, finely crystalline limestone; rare echinoderm debris in lower part	3.05	371.25
	Grey, raggy limestone crowded with ?oysters	5.18	376.42
LIAS		164.90	541.32
RHAETIC		4.27	545.59
TRIASSIC		196.60	742.19
PRECAMBRIAN		60.05+	

The White Limestone cannot be recognised as a distinct unit here, although its presence is suggested by the brownish limestone encountered about 11.6m above the top of the Lincolnshire Limestone.

B63 South Creake (TF8573034019)

Although only 4.7km from the North Creake borehole, the Middle Jurassic succession encountered in BP's South Creake well (D.o.E. well-release data) is very different, a rapid southeastward attenuation of the sequence having occurred.

The Great Oolite/Inferior Oolite succession at South Creake can be interpreted as follows:

		Thickness (m)	Depth (m)
OXFORD CLAY			370.03
CORNBRASH	Yellow-brown, oolitic limestone	2.13	372.16
RUTLAND FORMATION	Grey, silty, calcareous clay) Grey, very fine-grained sandstone)	2.44	374.60
LINCS. LST.	Basal limestone	1.83	376.42

The attenuation of the succession here may be related to the borehole's proximity to the tectonically positive area west of the Dowsing Fault Belt; as at Wiggenhall, the Cornbrash has overstepped onto the Rutland Formation which, in turn, has almost overstepped onto the Lias.

B64 Lexham (TF850180)

D.o.E. well-release data for Norris Oil's Lexham borehole does not include a detailed lithological log. The top of the Lias was encountered at a depth of 245.36m and the overlying 20.42m can be interpreted from the wireline log as follows:

		Thickness (m)	Depth (m)
CORNBRASH) WHITE LIMESTONE)	?Limestone	6.70	231.65
RUTLAND FORMATION	?Clay	12.19	243.84
LINCS. LST.	?Limestone	1.52	245.36
LIAS, ?RHAETIC & PERMO-TRIAS		93.27	338.63
PRECAMBRIAN		25.60+	364.24

The attenuated nature of the Lincolnshire Limestone suggests that Lexham must lie close to the formation's erosional margin. The Cornbrash must directly overlie the White Limestone here, rather than the Rutland Formation, otherwise it is impossible to account fully for the 6.7m of ?limestone which was encountered.

B65 Denver Sluice (TF59110106)

A summary stratigraphic log of the Denver Sluice borehole was reproduced by Gallois (1979). The Kellaways Beds to Upper Lias part of the succession can be re-interpreted as follows:

		Thickness (m)	Depth (m)
KELLAWAYS BEDS (c.2.20m)	Belemite-rich, dense limestone	c.0.70	c.138.50
	Silt and silty clay	c.1.50	c.140.00
CORNBRASH	Limestone	c.1.60	141.60
THRAPSTON CLAY	Shelly clay	0.81	142.41
WHITE LIMESTONE	Dense shelly limestone	1.50	143.91
RUTLAND FORMATION (6.64m)	Shelly clay	0.30	144.21
	Loose fine sands	0.99	145.20
	Shelly clay	0.45	145.65
	Clay and sand (disturbed by drilling)	1.20	146.85
	Core loss (probably loose sands)	3.49	150.34
	Greenish grey clay	0.21	150.55
UPPER LIAS	Tough, fissile, faintly bituminous, brownish-grey, laminated mudstones with burrowed upper junction	8.93	159.48

The erosional margin of the Lincolnshire Limestone must lie between Denver Sluice and the two Texaco boreholes at Wiggenhall (B61) and Wisbech (B47). The Great Oolite Group succession here is comparable with that at Wisbech and Parson Drove (B48) to the northeast but thicker than that at Wiggenhall to the north. Following Bradshaw (1978; in prep.), it is clear that the 4.9m of clays and sands classified as 'Lower Estuarine Series' by Gallois (op. cit.) belong to the Rutland Formation, and probably to the Stamford Member. The overlying 1.74m of sands and shelly clay may belong to the Wellingborough Rhythm, although some may instead belong to the White Limestone, as defined at outcrop.

B66 Ellingham (TM02729847)

The succession in the Ellingham borehole, given by Bradshaw (1978), can be abstracted (with slight modification) as follows:

		Thickness (m)	Depth (m)
GAULT			282.55
LOWER GREENSAND or CARSTONE		6.10	288.65
CORNBRASH (1.99m)	Tough, grey, very hard, fossiliferous limestone, with strongly eroded and oxidised top; brachiopods and bivalves	0.61	289.41
	Grey-green, fairly hard, very calcareous and fossiliferous clay with a trace of fine quartz silt; bivalves and foraminifera.	1.07	290.47
	Very dark brown, moderately hard and very slightly calcareous, fossiliferous clay	0.31	290.78
RUTLAND FORMATION	Very soft, non-calcareous, variegated and massive clays, becoming sandy upward	4.57	295.35
LOWER LIAS		42.06	337.41
MERCIA MUDSTONE		29.26	366.67
DEVONIAN			

B67 Rocklands (TL99529670)

An abstract formational log of this Norris Oil borehole was given on the 1975 Norwich Sheet (161). Using the more detailed record of the Ellingham succession for comparison, the relevant part of the log can be reinterpreted as follows:

		Thickness (m)
GAULT		11.00
CARSTONE		10.00
CORNBRASH) WHITE LIMESTONE)	Great Oolite	4.27
RUTLAND FORMATION	Inferior Oolite	4.57
LOWER LIAS		43.00
PERMO-TRIAS		32.30
DEVONIAN		12.80+

B68 Breckles (TL95519469)

The third of Norris Oil's Norfolk boreholes proved the following section (reinterpreted from D.o.E. well-release data, again using Ellingham for comparison):

		Thickness (m)	Depth (m)
GAULT		12.50	236.22
CARSTONE	Carstone (L. Greensand)	8.84	243.96
CORNBRASH)	?Lower Estuarines		
WHITE LIMESTONE)	('Great Oolite' had been deleted)	4.27	c.249.33
RUTLAND FORMATION	Lower Estuarines	7.32	256.64
LOWER LIAS	Lias	42.06	298.70
DEVONIAN	Devonian	29.87+	328.57

Unlike at Ellingham, the Cornbrash probably overlies White Limestone at both Breckles and Rocklands.

B69 Southery-Severals House (TL692964)

Pringle (1923) interpreted the 2" diameter cores of this borehole as showing 3.05m of ?Cornbrash and Forest Marble overlying Middle Lias, but this interpretation is not supported by regional facies and thickness considerations. Either the borehole showed 0.61m of Cornbrash immediately overlying 2.44m of White Limestone (e.g. Bradshaw, 1978), or else the entire 3.05m of limestone and shelly clay belonged to the Cornbrash. The lowest 1.30m contained rhynchonellids, Modiolus, 'Astarte', Praexogyra and Radulopecten vagans, together with lignite, but such a fauna is consistent with either the White Limestone or Cornbrash.

	Thickness (m)	Depth (m)
LOWER GREENSAND	0.93	31.32
KIMMERIDGE CLAY	45.78	77.10
AMPTHILL CLAY	20.40	97.50
WEST WALTON BEDS	7.70	105.20
OXFORD CLAY	40.95	146.15
CORNBRASH	3.05	149.20
MIDDLE LIAS	11.73	160.93
LOWER LIAS	43.28+	204.21

B70 Eriswell (TL74237887)

The following formational abstract log has been published for the Eriswell borehole (IGS, 1980).

	Thickness (m)
CRETACEOUS	100.60
CORALLIAN (incl. WEST WALTON BEDS)	15.03
OXFORD CLAY	17.71

CORNBRASH	1.29
LIAS (Undifferentiated)	39.42
TRIAS (and core loss)	37.91+2.54
DEVONIAN (?O.R.S.)	1.59+

The Cornbrash has overstepped onto the Lias here also.

B71 Lakenheath (TL748830)

Details of Superior O.D.Co.'s Lakenheath borehole were given by Bradshaw (1978); the Oxford Clay apparently rests unconformably upon the Lias in this area, although the thin Cornbrash seen at Eriswell (B70) may have been missed in this uncored well.

B72 Saxthorpe (TG12263016)

D.o.E. well-release data for Duntex's Saxthorpe borehole indicates that the Lower Cretaceous has here overstepped onto the Lias, although no samples were obtained from the c.15m directly underlying the Cretaceous.

B73 East Ruston (TG353268)

A copy of the wellsite lithologic log for this borehole was kindly supplied by F. Sharpe of Hamilton Brothers. This can be interpreted as showing Lower Cretaceous sands, clays and shales unconformably overlying Lower Jurassic clays.

B74 Somerton (TG4607021201)

Chroston & Sola (1982, fig. 2) depict the Lower Cretaceous directly overlying the Rhaetic in this borehole. As a thick Carboniferous to Triassic succession is developed here, the absence of the Jurassic at Somerton undoubtedly reflects the control of the Dowsing Fault Belt on Jurassic/Cretaceous subsidenee and erosion in northeast Norfolk.

B75 Trunch (TG29333455)

Condensed Red Chalk and Carstone unconformably overlies ?Middle Lias in this borehole (IGS, 1976), again reflecting the attenuation of the Jurassic succession towards the Dowsing Fault Zone. The overstep of the Albian over the Middle Jurassic, onto lower parts of the Mesozoic

succession in the vicinity of this fault belt is closely comparable to the similar, well-documented Albian overstep across the Market Weighton Block.

B76 Hunstanton (TF69234270)

The formational abstract log of Place Oil & Gas Company's Hunstanton borehole (D.o.E. well release data) can be provisionally interpreted as follows, bringing it in line with my interpretation of the succession at North Creake; however, neither a detailed lithological log nor any wireline data have been examined:

		Thickness (m)	Depth (m)
WEST WALTON BEDS	Ampthill Clay	c.27.13	c.219.76
OXFORD CLAY	Oxford Clay	c.53.34	c.273.10
KELLAWAY BEDS) CORNBRASH)	Kellaway Beds and Cornbrash	?c.25.34	c.298.44
THRAPSTON CLAY) WHITE LIMESTONE) RUTLAND FORMATION)	Blisworth Clay	18.90	320.95
LINCS. LST.	Great Oolite Limestone & U.E.S.	20.73	341.68
LIAS	Lias	182.27	523.95
RHAETIC	Rhaetic	6.71	530.66
MERCIA MUDSTONE	Keuper Marl	197.51	728.17
SHERWOOD SANDSTONE (& PERMIAN)	Bunter; lower c.51.82m may be Rotliegendes	107.29	835.46
PRECAMBRIAN	Precambrian metamorphic basement	26.82+	862.28

1.3.8 Lincolnshire and Humberside

B77 Tydd St Mary (TF43071737)

A summary formational log for this borehole has recently been published (BGS, 1985). However, since this description included Lower Estuarine Beds above the Lincolnshire Limestone, the relevant part of the log can safely be reinterpreted as follows:

	Thickness (m)	Depth (m)
UPPER CORNBRASH	3.09	134.75
THRAPSTON CLAY	1.67	136.42
WHITE LIMESTONE	2.11	138.53
RUTLAND FORMATION	8.24	146.77
LINCOLNSHIRE LIMESTONE	1.68	148.45
LIAS	148.21+	296.66

The succession at Tydd St Mary is very similar to the reinterpreted sequence in the Wisbech borehole (B47).

B78 Spalding (TF2434414781)

The summary log of this Texaco well includes the following Great Oolite Group succession:

	Thickness (m)	Depth (m)
CORNBRASH	1.83	96.01
THRAPSTON CLAY	4.57	100.58
WHITE LIMESTONE	2.44	103.02
RUTLAND FORMATION	13.11	116.13
LINCOLNSHIRE LIMESTONE	15.44	131.67
UPPER LIAS TO ?DEVONIAN	362.72	494.39
T.D.		500.18

B79 Gosberton (TF24483148)

A. Horton's core log was kindly supplied by the Oundle Division of Anglian Water. The Upper Great Oolite succession can be summarised as follows:

		Thickness (m)	Depth (m)
UPPER CORNBRASH	'Marly' limestone and clay	c.1.50	c.76.50
THRAPSTON CLAY	Green, silty mudstone	c.5.50	c.82.00
WHITE LIMESTONE	Mudstone and shelly limestone	c.0.42	82.42
	Micritic limestone with abundant oysters	0.45	82.87
	Micritic limestone with shell-debris wisps; large bivalves (mostly oysters). Very fossiliferous at base, with oysters, Modiolus and rhynchonellids	0.83	83.32
RUTLAND FORMATION	Rootletted mudstone		

It is unclear whether the rhynchonellids at the base of the White Limestone were K. sharpi or Burmirhynchia.

B80 Sibsey (TF361502)

The gamma-log for this hydrocarbon well can be interpreted as showing the following (S. Holloway, pers. comm.):

Top of Cornbrash to top of Lincolnshire Limestone	18.29m
Lincolnshire Limestone	9.75m

I have not personally inspected the relevant D.o.E. well-release data.

B81 Timberland (TF106585)

The basal 2.5m of the White Limestone and the underlying Rutland Formation were cored in this well and have been logged by Bradshaw (1978). The uppermost rhythm of the Rutland Formation (56.80-57.50m) is 0.7m thick and is probably Rhythm B, laterally equivalent to the K. sharpi Beds to the west and southwest. The rhynchonellids in the overlying White Limestone were probably Burmirhynchia, not K. sharpi as Bradshaw (MS.) believed.

B82 Owmby (TF013875)

K. sharpi occurs throughout the basal 2.96m of the White Limestone here, according to Bradshaw (MS.). However, the rhynchonellids above the basal 1.93m of the formation may be Burmirhynchia. The White Limestone is dominated by calcite-cemented, bioclastic, quartz sandstones.

B83 Nettleton (TF12459823)

The stratigraphy of the Nettleton borehole was described in detail by Bradshaw & Penney (1982), while the Bathonian palynology of the borehole has been the subject of a second paper (Riding, 1983). The Great Oolite Group succession can be interpreted from Bradshaw & Penney (op. cit.) as follows:

	Thickness (m)	Depth (m)
CORNBRASH	1.50	322.17
THRAPSTON CLAY	8.48	330.64
'WHITE LIMESTONE'	4.02	334.66
RUTLAND FORMATION (Stamford Member)	5.86	340.52

Using M. Bradshaw's MS. log of the borehole, the base of the Forest Marble Rhythm can be placed within the upper part of the 'White Limestone' at 331.26m, where a rootletted, locally calcareous, silty mudstone, containing Neomiodon-dominated shell plasters and early diagenetic siderite nodules, was erosively overlain by calcareous interlayered sands and muds containing Modiolus and other marine bivalves. This graded up into a thinly laminated black to very dark green claystone with interlayered bioclastic silt, containing shell plasters of Cuspidaria, ?Quenstedtia and Neomiodon with Modiolus and abundant ostracods, which, in lithostratigraphic terms, is the basal unit of the Thrapston Clay Formation. A marine macrofauna was only encountered in the basal 1.2m of the ?Forest Marble 'Rhythm'. Higher parts of the rhythm exhibited extensive rootletting; layers of fish debris and Cyzicus plasters from between 328.6 and 328.2m, with which the only associated palynomorphs found were Botryococcus and bisaccate pollen-dominated miospore assemblages, were interpreted by Bradshaw & Penney (1982) as indicating very low salinity or freshwater conditions. Freshwater ostracods were obtained from an intraclastic lime mudstone near the top of the rhythm.

The 'White Limestone' at Nettleton was found to consist largely of mudstone, silty mudstone and calcite siltstone. For the most part it contained a variable diversity molluscan fauna comparable to that encountered in Rutland Formation rhythms in Northamptonshire. Within the lithostratigraphic unit, a single shallowing-upwards rhythm can be recognised, terminating upwards at the erosive base of the ?Forest Marble 'Rhythm'.

In the recent BGS terminology employed in Humberside, only the uppermost part of the 'White Limestone Formation' is assigned to their Snitterby Limestone; the rest of the formation is classified as Priestland Clay (Riding, 1983).

B84 Tetney Lock (TA33150105)

The relevant part of BP's summary log for this well can be abstracted and interpreted as follows (partially after Bradshaw, 1978):

		Thickness (m)	Depth (m)
KELLAWAYS BEDS		15.54	552.60
CORNBRASH (3.05m)	Grey silty, shelly clay with quartz sand and phosphatic pebbles; bivalves	1.52	554.12
	Shale	0.91	555.03
	Grey to pale grey, occasionally pyritic, detrital limestone with scattered ooids and a trace of dark shale	0.61	555.65
THRAPSTON CLAY (6.10m)	Dark grey, locally calcareous, silty shale with traces of pale green to olive brown shale; traces of shell fragments and ?echinoderm fragments	2.13	557.78
	Dark grey, pyritic shale with traces of fine-grained sandstone	0.91	558.70
	Dark, silty, finely-laminated shale with fine-grained sandstone; trace of limestone	2.44	561.14
	Brown, fissile, bituminous shale; some lignite and coal	0.61	561.75
WHITE LIMESTONE (8.84m)	Grey, very variable, locally shelly, sandy, oolitic limestone; trace of fine-grained sandstone and silty mudstone; oysters, pectinids, Pentacrinites, serpulids	6.71	568.45
	Dark grey shale and grey, calcitic sandstone	0.91	569.37
	Dark grey, fine-grained, shelly limestone and calcitic sandstone	1.22	570.58
RUTLAND FORMATION		5.18	575.77
LINCOLNSHIRE LIMESTONE & GRANTHAM FORMATION		33.83	609.60

This interpretation differs from Bradshaw's (op. cit.) in that the 568.45m-570.58m interval (567.84m-569.04m interval of Bradshaw) is assigned to the White Limestone Formation rather than to the underlying Rutland Formation. At Nettleton (B83), the Rutland Formation consists only of sands, mudstone and claystone equivalent to the Stamford Member, with overlying rhythmic units not developed. The presence of thick White

Limestone (8.84m; ?all Rhythm C) at Tetney Lock suggests a major marine incursion into north Lincolnshire from the Anglo-Dutch Basin. Both Upper and Lower Cornbrash were probably present here (Upper Cornbrash =?2.44m; Lower Cornbrash =?0.61m).

B85 Cleethorpes (TA3023707090)

Data given on the Middle Jurassic succession in the Cleethorpes No. 1 geothermal well by Kirby (1985) can be interpreted as follows:

		Thickness (m)	Depth (m)
CORNBRASH	Brown, sandy, well-cemented limestone	1.50	553.50
THRAPSTON CLAY	Soft, yellow, green and pink, non-calcareous mudstones with carbonaceous debris; a few silty or sandy horizons, particularly towards the base	11.50	565.00
WHITE LIMESTONE	(based on geophysical logs)	2.60	567.60
RUTLAND FORMATION	Interbedded sandstones, siltstones and mudstones; succession becomes muddier downwards	14.0	581.60
LINCS. LST.		17.2	598.80

While the Great Oolite Group is here thicker than at Tetney Lock, the White Limestone has apparently thinned markedly at the expense of both the Thrapston Clay and Rutland Formations. This rapid northwards attenuation can be compared with the better documented thinning of the White Limestone between Worlaby and the River Humber (B86 and B87-B97).

B86 Worlaby (SE99751596)

The succession in this well was described by G. Richardson (1979). The sequence must be reclassified, however, as follows:

	Thickness (m)	Depth (m)
UPPER CORNBRASH	1.19	100.28
LOWER CORNBRASH	c.2.80	c.103.08
THRAPSTON CLAY	c.7.02	c.111.10
WHITE LIMESTONE	2.39	113.49
RUTLAND FORMATION	7.21	120.70

BGS Humberside boreholes

B87 Brough No. 2 (SE95102683)
B88 Brough No. 1 (SE94432677)
B89 South Cave (SE93663230)
B90 Brown Moor (SE81266203)
B91 Low Farm (SE95972128)
B92 Welton Waters 'A' (SE95442476)
B93 Welton Waters 'B' (SE96252467)
B94 East Clough (SE97572490)
B95 Alandale (TA00072584)
B96 Low Field Lane (SE96392629)
B97 Welton Crossing (SE95522613)

Ten of the Humber boreholes discussed by Gaunt et al. (1980) penetrated the Great Oolite Group of the area; in addition, the Brown Moor borehole north of the Market Weighton Block penetrated sands assigned to the Scalby Formation and possibly equivalent in age to part of the Great Oolite succession. In each of the Humber boreholes the Great Oolite Group is dominated by unfossiliferous sandstones, siltstones and mudstones. Satisfactory subdivision of the group in these boreholes into smaller lithostratigraphic units is not possible; Gaunt et al. (op. cit.) classified the entire succession here as Upper Estuarine Beds, but Bradshaw's (in prep.) new lithostratigraphic unit (the Drewton Member), introduced to encompass these siliciclastic-dominated deposits developed between the Lincolnshire Limestone and the Upper Cornbrash/Kellaways Beds in Humberside, is used here.

In the most southerly of the Humber boreholes (Low Farm), a thin, decalcified, heavily pyritised limestone was encountered 10.19m above the top of the Lincolnshire Limestone. This limestone, which contained a marine fauna (a terebratulid and gastropods), was almost certainly the feather-edge of the White Limestone. However there is some doubt as to whether or not it was in situ (Gaunt et al., op. cit.). In the same borehole, beneath the Upper Cornbrash, brackish-marine palynomorphs were obtained from mudstones in the uppermost 2.88m of the Drewton Member. It is possible that these are of discus Subzone age and represent the

maximum extent of the Lower Cornbrash marine transgression northwards towards the Cleveland Basin.

The only borehole north of the River Humber in which the Drewton Member yielded any indication of marine influence was at Welton Crossing. Here brackish water sporomorphs and dinocysts have been obtained from mudstones over 5.33m above the base of the Drewton Member; in this instance they may be of White Limestone age. In the same borehole, 4.18m below the top of the Drewton Member, a 0.11m thick mudstone contained a marginal marine fauna of corbulids, mytilids, ?Meleagrinella and indeterminate bivalves, together with serpulids. This yielded palynomorphs and ostracods of Bathonian age. While this unit may be of discus Subzone age, it is difficult to envisage the discus Subzone being represented by over 4m of mudstones in this area.

B98 Winestead (TA2741024334)

Using log data, Candecca interpreted their Winestead well as showing Kellaway Beds sitting on Lincolnshire Limestone (?Cave Oolite) at a depth of 544.98m. However, it was stated in the relevant D.o.E. well-release data that no confidence was placed on the collection of samples from the interval 504.75m-760.17m; the possibility obviously exists that the Drewton Member was thinly developed between the Kellaways Beds and Lincolnshire Limestone/Cave Oolite, but was not picked up on the wireline log.

Thickness and facies data have also been used from the following Lincolnshire/Humberside boreholes:

B99	Tallington (TF09750867)	Bradshaw (1978)
B100	Crowland Bridge (TF22981067)	Bradshaw (1978)
B101	Pepper Hill (TF184180)	Bradshaw (1978)
B102	Deeping St Nicholas (TF22291798)	Bradshaw (1978)
B103	Cuckoo Bridge (TF20131969)	Bradshaw (1978)
B104	Aslackby (TF08753050)	Woodward (1904b)
B105	Dowsby (TF11253050)	Woodward (1904b)
B106	Dunsby (TF143267)	Woodward (1904b)
B107	Dunsby Fen (TF163275)	Woodward (1904b)
B108	Pinchbeck North Fen (TF169265)	Jukes-Browne (1885)
B109	Aslackby Fen (TF16153065)	Woodward (1904b)

B110	Horbling (TF118353)	Jukes-Browne (1885)
B111	Swarby (TF048405)	Jukes-Browne (1885)
B112	Donington (TF222362)	Bradshaw (1978)
B113	Bicker (TF247383)	Bradshaw (1978); Fenton (1980)
B114	Cheal Bridge (TF226294)	Bradshaw (1978)
B115	Helpringham (TF17533884)	Bradshaw (1978)
B116	Swineshead Station (TF218428)	Preston (1916)
B117	Asgarby (TF11704525)	Woodward (1904b)
B118	Ruskington (TF09184980)	Bradshaw (1978)
B119	Martin (TF122600)	Woodward (1904b)
B120	Stixwould (TF18506530)	Bradshaw (1978)
B121	Bardney (TF1191568617)	Bradshaw (1978)
B122	Oakholt (TF047694)	Bradshaw (1978; MS.); Fenton (1980)
B123	Fiskerton (TF05857156)	Data provided by Anglian Water
B124	Reepham (TF05487386)	
B125	Stainton-by-Langworth (TF06357764)	
B126	Faldingworth (TF04468406)	
B127	Toft Newton (TF03918741)	
B128	Caenby (SK999895)	Bradshaw (MS.)
B129	Kingerby (TF04059140)	Data provided by Anglian Water
B130	Snitterby Carr Lane (TF00289471)	
B131	South Kelsey (TF01989721)	
B132	Brigg (SE997072)	Ussher (1890)

1.3.9 Other areas

The following boreholes have been used to delineate the Cretaceous overstep onto the pre-Permian Palaeozoic floor of the London-Brabant Massif; all have shown either Gault or Lower Greensand resting on Upper Devonian or older rocks (Allsop & Jones, 1981)

B133	Lowestoft (TM5493)	Chatwin (1954)
B134	Four Ashes (TM022718)	Bradshaw (1978)
B135	Stowlangtoft (TL94756882)	BGS (1985)
B136	Culford (TL835700)	Chatwin (1954)
B137	Clare (TL78344536)	IGS (1980)

B138	Little Chishill (TL452363)	Bradshaw (1978)
B139	Ware (TL3614)	Etheridge (1879)
B140	Chesthunt (TL3602)	Etheridge (1879)
B141	Bushey (TQ1395)	Edmunds (1936)
B142	Southall (TQ127794)	Proctor (1913)
B143	Chiswick (TQ215778)	Barrow & Wills (1913)
B144	Park Royal (TQ2182)	Barrow & Wills (1913)
B145	Stonebridge Park (TQ2084)	Barrow & Wills (1913)
B146	Willesden (TQ20868477)	Falcon & Kent (1960)
B147	Kentish Town (TQ283861)	Prestwich (1856); W. Whitaker (1889)
B148	Beckton (TQ42708161)	Barrow & Wills (1913); Smart et al. (1964)
B149	Crossness (TQ48338079)	Prestwich (1878)
B150	Thamesmead (TQ4779)	R.A. Whittle (pers. comm.)
B151	Fobbing (TQ71518422)	Dewey et al. (1925)
B152	Cliffe (TQ7277)	Lamplugh et al. (1923)
B153	Canvey Island (TQ82158330)	Smart et al. (1964)
B154	Sheerness East (TQ9373)	Lamplugh et al. (1923)
B155	Weeley (TM1422)	Kent (1968)
B156	Harwich (TM2332)	Chatwin (1954)
B157	Stutton (TM1434)	Chatwin (1954)

At a further location (B158. Saffron Walden - TL53863840; H. White, 1932), the Lower Cretaceous apparently overlies a thick Jurassic succession (?possibly 90-115m thick), although the exact nature of this succession is not known.

The following boreholes, wells and shafts have provided a database for the isopach map in Enclosure 2.1.

B133	Iden Green (TQ8132531570)	)
B134	Dentition-1 (TQ746402)	) Data provided by Conoco
B135	Ashour-1 (TQ65404424)	)

B136	Penhurst (TQ542443)	Dines et al. (1969)
B137	Cowden-1 (TQ4668042778)	D.o.E. well release data
B138	Ashdown-1 (TQ50063035)	Bristow & Bazley (1972)
B139	Ashdown-2 (TQ51072924)	
B140	Wallcrouch-1 (TQ6605729863)	Data provided by Conoco
B141	Brightling-1 (TQ6820)	Falcon & Kent (1960); Martin (1967)
B142	Grove Hill-1 (TQ60081359)	Martin (1967)
B143	Westham-1 (TQ60970535)	D.o.E. well release data
B144	Bolney-1 (TQ2801124269)	
B145	Henfield-1 (TQ17991457)	Martin (1967)
B146	Middleton-1 (SU97390151)	D.o.E. well release data
B147	Baxter's Copse-1 (SU9149617733)	Data provided by Conoco
B148	Godley Bridge-1 (SU95253665)	
B149	Bletchingley-1 (TQ3622547727)	D.o.E. well release data
B150	Bletchingley-3 (TQ32754876)	
B151	Bletchingley-4 (TQ34934838)	
B152	Collendean Farm-1 (TQ24804429)	
B153	Tatsfield-1 (TQ42455705)	
B154	Shalford-1 (SU98214680)	Martin (1967); S. Smalley (in litt.)
B155	Strat A-1 (SU94785278)	S. Smalley (in litt.)
B156	Portsdown-1 (SU63800652)	Taitt & Kent (1958)
B157	Winchester-1 (SU50342849)	Martin (1967)
B158	Fordingbridge-1 (SU18761180)	Falcon & Kent (1960); Martin (1967)
B159	Arreton-1 (SZ53078564)	Falcon & Kent (1960); Martin (1967)
B160	Cranborne-1 (SU0340809073)	Rhys et al. (1982)
B161	Bere Regis-1 (SY86449563)	Martin (1967)

B162	Wareham-1 (c.SY9172)		Martin (1967)
B163	Arne-1 (SY95758704)	)	D.o.E. well release data
B164	Stoborough-1 (SY91268659)	)	
B165	Wytch Farm-1 (SY98048536)		Colter & Havard (1981)
B166	Kimmeridge-3 (SY898790)		Brunstrom (1963)
B167	Lulworth Banks-1	)	
B168	Chaldon Herring-1 (SY784839)	)	
B169	Radipole-1 (c.6781)	)	Martin (1967)
B170	Langton Herring North-1 (c.6183)	)	
B171	Lockerley-1 (SU3067125910)	)	Data provided by Shell
B172	Farley South-1 (SU2358928529)	)	
B173	Devizes-1 (ST9602656987)	)	
B174	Cooles Farm-1 (SU0164192135)	)	D.o.E. well release data
B175	Highworth-1 (SU18109155)	)	
B176	Egbury-1 (SU4447552361)		Data provided by RTZ
B177	Kingsclere-1 (SU49845820)		Martin (1967)
B178	Inwood Copse-1	)	J. Rodd (in litt.)
B179	Hook Lane-1	)	
B180	Strat B-1 (SU68226522)	)	D.o.E. well release data
B181	Sonning Eye-1 (SU742758)	)	
B182	Humbly Grove-3 (SU7261445185)		Sellwood et al., 1985
B183	Ebbsfleet (TR337619)		Lamplugh et al. (1923)
B184	St Margaret's (TR36654533)	)	Bisson et al. (1967)
B185	Ringwould (TR35294812)	)	
B186	Betteshanger (TR3253)	)	
B187	Woodnesborough (TR299564)	)	
B188	Maydensole (TR318474)	)	Lamplugh et al. (1923)
B189	Bere Farm (TR3343)	)	

B190	Dover No. 2 (TR2939)		Lamplugh & Kitchin (1911)
B191	Folkestone (TR242366)	)	
B192	Chilton (TR278434)	)	
B193	Trapham (TR234571)	)	Lamplugh *et al.* (1923)
B194	Tilmanstone Colliery (TR288505)	)	
B195	Chilham (c.TR0753)	)	
B196	Littlebourne (TR19565760)		Bisson *et al.* (1967)
B197	Walmestone (TR259593)		Lamplugh *et al.* (1923)
B198	Lydden Valley (TR371541)	)	
B199	Oxney (TR352469)	)	
B200	Herne (TR15166449)	)	Lamplugh *et al.* (1923)
B201	Snowdon Colliery (c.TR250512)	)	
B202	Fredville (TR245512)	)	
B203	West Court Farm (TR24554815)		Bisson *et al.* (1967)
B204	Elham (TR1743)	)	Lamplugh *et al.* (1923)
B205	Harmansole (TR14165285)	)	
B206	Adisham (c.TR228544)		Pringle (1928)
B207	Chislet Park (TR21126311)		Baker (1920)
B208	Brabourne (TR07754236)		Lamplugh & Kitchin (1911)
B209	Bobbing (TQ8765)		Lamplugh *et al.* (1923)
B210	Streatham Common (TQ295710)		W. Whitaker (1889)
B211	Tottenham Court Road (TQ298814)		Judd (1884); W. Whitaker (1889)
B212	Richmond (TQ177747)		Judd (1884); W. Whitaker (1889)
B213	Warlingham (TQ34765719)		Worssam & Ivimey-Cook (1971)
B214	Marchwood (SU39911118)		A. Whitaker (1980)
B215	Southampton (SU44151120)		Thomas & Holliday (1982)
B216	Seabarn Farm (SY62638054)		I. Penn (BGS), pers. comm.

B217	Winterborne Kingston (SY847979)	Penn (1982)
B218	Stalbridge (c.ST7317)	Whitaker & Edwards (1926)
B219	Stowell (c.ST675230)	Pringle (1909)
B220	Wincanton (c.ST7128)	Edwards & Pringle (1926)
B221	Shrewton-1 (SU0313741989)	D.o.E. well release data
B222	Westbury (ST86155195)	Pringle (1922)
B223	Frome (ST76324769)	Penn & Wyatt (1979)
B224	Rudge (ST82295235)	
B225	Faukland (ST74395395)	
B226	Baggridge 3 (ST74385661)	
B227	Trowbridge (ST85525817)	Green & Donovan (1969)
B228	Hilperton (ST87695981)	Penn & Wyatt (1979)
B229	Holt No. 1 (ST87006255)	
B230	Staverton (ST857610)	Green & Donovan (1969)
B231	Melksham (ST90886466)	Penn & Wyatt (1979)
B232	Norrington (ST88216442)	
B234	Atworth (ST858668)	IGS (1973)
B235	Patterdown Farm (ST90777137)	Green & Donovan (1969)
B236	Bathampton Down (c.ST772646)	
B237	Grittleton (ST87197975)	Cave (1977)
B238	Shipton Moyne No.5A (ST89918865)	
B239	Milbourne No. 1 (ST94878763)	
B240	Chalton (ST99758947)	IGS (1971)
B241	Long Newton No.2 (ST91709129)	Cave (1977)
B242	Hillsome Farm (ST90879482)	
B243	Sherston (ST84748542)	
B244	Minchinhampton (c.S08600)	

B245	Cirencester (c.SP0201)	L. Richardson (1933)
B246	Ready Token (SP105044)	L. Richardson (1932)
B247	Stowell Park (SP084118).	Green & Melville (1956)
B248	Palmer's Wood (TQ3644552623)	Data provided by Conoco
B249	Reculver (TR226691))	Baker (1920)
B250	Rushbourne (TR19326355))	

APPENDIX 2

KEY TO SYMBOLS AND CODES USED IN FIGURED SECTIONS

2.1 Introduction

Most of the symbols used in Enclosures A-1 to A-16 have been adapted from the Shell Standard Legend, Robertson Research Standard Legend and from Bradshaw (1978).

2.2 Representation of biota

The faunal and floral content of any given horizon has been illustrated using numerical codes. This has been done primarily as a space-saving exercise. A system of numerical codes has been preferred to Bradshaw's (1978) use of symbols for faunal identification, mainly because symbols are not always distinctive.

List of numerical codes

Algae (1)

1. Solenopora jurassica Brown
2. Hyporosopora sp.
3. Stomatopora sp.
4. Undifferentiated bryozoan

Brachiopoda (5-14)

5. Kallirhynchia sharpi Muir-Wood
6. Kallirhynchia yaxleyensis (Davidson)
7. Burmirhynchia sp.
8. Undifferentiated rhynchonellid
9. Ornithella thrapstonensis Pittham MS.
10. Obovothyris obovata (J. Sowerby)
11. Undifferentiated ornithellid
12. Digonella digonoides (S. Buckman)
13. Epithyris sp.
14. Cererithyris intermedia (J. Sowerby)

Echinodermata (15-23)

15. Acrosalenia sp.
16. Nucleolites sp.
17. Clypeus muelleri Wright
18. Holectypus depressus (Leske)
19. Pygurus sp.
20. echinoid spines
21. Pentacrinites sp.
22. Isocrinus sp.
23. Undifferentiated ossicles

Corals (24-29)

24. 'Isastraea' sp.
25. Lochmeaosmilia radiata (Lamouroux)
26. Cladophyllia sp.
27. Cyathophora sp.
28. Chomatoseris orbulites (Lamouroux)

29. Undifferentiated coral

'Vermes' (30-31)

Serpulid tubes

31. Sarcinella socialis

Bivalvia (32-109)

32. Palaeonucula menkei (Roemer)

33. Dacryomya lacryma (J. de C. Sowerby)

(Eonavicula) subminuta (J. de C. Sowerby)

35. Parallelodon hirsonensis (d'Archiac)

36. Cucullaea sp.

37. Limopsis (L.) minima (J. de C. Sowerby)

38. Undifferentiated arcoid

39. Arcomytilus asper (J. Sowerby)

40. Falcimytilus sublaevis (J. de C. Sowerby)

41. Inoperna plicatus (J. Sowerby)

42. Modiolus (M.) imbricatus J. Sowerby

43. 'Lithophaga' sp.

44. Pinna sp.

45. Stegoconcha ampla (J. Sowerby)

46. Bakevellia waltoni (Lycett)

47. Bakevellia islipensis (Lycett)

48. Pteroperna costulata (Deslongchamps)

49. Costigervillia crassicosta (Morris & Lycett)

50. 'Gervillella' ovata (J. de C. Sowerby)

51. Undifferentiated gervillid

52. Pulvinites mackerrowi Palmer

53. Isognomon (I.) promytiloides Arkell

54. Isognomon (I.) sp.

55. Isognomon (Mytiloperna) sp.

56. Parainoceramus sp.

57. Camptonectes (C.) 30. laminatus (J. Sowerby)

58. Camptonectes (Camptochlamys) obscurus (J. Sowerby)

59. Radulopecten vagans (J. de C. Sowerby) 34. Arca

60. Meleagrinella echinata (W. Smith)

61. Placunopsis socialis Morris & Lycett

62. Plicatula sp.

63. Ctenostreon rugosum (W. Smith)

64. Limatula gibbosa (J. Sowerby)

65. Plagiostoma cardiiformis J. Sowerby

66. Plagiostoma sp.

67. Pseudolimea duplicata (J. de C. Sowerby)

68. Praeexogyra hebridica (Forbes)

69. P. hebridica subrugulosa (Morris & Lycett)

70. Liostrea wiltonensis (Lycett)

71. Exogyra sp.

72. Nanogyra sp.

73. Undifferentiated oyster

74. Lopha costata (J. de C. Sowerby)

75. Myophorella sp.

76. Trigonia (T.) costata W. Smith

77. Vaugonia (V.) impressa (Broderip)

78. Undifferentiated trigoniid
79. 'Mactromya' depressa (Phillips)
80. Mesomiltha bellona (d'Orbigny) (Morris)
81. Sphaeriola oolithica (Rollier)
82. Protocardia stricklandi (Morris & Lycett)
83. Protocardia sp.
84. Quenstedtia bathonica (Morris & Lycett)
85. Tancredia extensa Lycett
86. Tancredia sp.
87. Anisocardia (A.) beaumonti (d'Archiac)
88. A. (Antiquicyprina) loweana (Morris & Lycett)
89. Rollierella minima (J. Sowerby)
90. Eomiodon angulatus (Morris & Lycett)
91. Pseudotrapezium cordiiforme (Deshayes)
92. Isocyprina (I.) sp.
93. Pronoella (P.) lycetti (Cossmann)
94. Eocallista antiopa (Thevenin)
95. Corbulomima cf. attenuata (Lycett)
96. Corbulomima sp.
97. Ceratomya concentrica (J. de C. Sowerby)
98. Homomya gibbosa (J. Sowerby)
99. Arcomya sp.
100. Pholadomya (Bucardiomya) lirata (J. Sowerby)
101. Pleuromya uniformis (J. Sowerby)
102. Pleuromya alduini (Brongniart)
103. Pleuromya calceiformis (Phillips)
104. Pleuromya sp.
105. Gressyla peregrina (Phillips)
106. Thracia (Th.) curtansata Morris & Lycett
107. 'Cuspidaria' ibbetsoni
108. Undifferentiated veneroid
109. Undifferentiated bivalve

Gastropoda (110-140)

110. Aphanoptyxis compressa Barker MS.
111. Aphanoptyxis excavata Barker MS.
112. Aphanoptyxis cf. langrunensis (d'Orbigny)
113. Aphanoptyxis ardleyensis Arkell
114. Aphanoptyxis bladonensis Arkell
115. Aphanoptyxis sp.
116. Eunerinea arduennensis (Buvignier)
117. Nerinella cf. acicula (d'Archiac)
118. Nerinella cf. pseudocylindrica (d'Orbigny)
119. Bactroptyxis implicata (d'Orbigny)
120. Cossmannea bathonica (Cossmann)
121. Melanioptyxis altararis (Cossmann)
122. Fibuloptyxis witchelli (Cox & Arkell)
123. Endiaplocus muneiri (Rigaux & Sauvage)
124. Undifferentiated nerineid
125. Rigauxia varicosa (Rigaux & Sauvage)

126. Globularia sp.
127. Pleurotomaria sp.
128. Trochotoma sp.
129. Amberleya bathonica Cox & Arkell
130. Naricopsina sp.
131. Neridomus (Neritoma) sp.
132. Pseudomelania sp.
133. Dicroloma sp.
134. Ceritella sp.
135. Cylindrobullina sp.
136. Fibula sp.
137. Undifferentiated procerithid
138. Undifferentiated gastropod
139. Viviparus sp.
140. Valvata sp.

Cephalopoda (141)

141. Procymatoceras sp.

Vertebrate material (142-146)

142. Asteracanthus sp.
143. Mesodon sp.
144. Undifferentiated fish teeth
145. Undifferentiated fish plates
146. Undifferentiated crocodile teeth

Where an identification is uncertain, a question mark has been placed after the numerical code. Where a particular fossil type is so abundant that it forms a major component of a given horizon, the numerical code is followed by the letter 'A'. In cases where particular fossil type is common enough to form a significant component of a given horizon, the numerical code is followed by the letter 'C'. Rare and frequent occurrences of a particular fossil type have not been distinguished. For horizons on which a bulk faunal analysis has been performed, approximate percentages of respective fossil types are given.

2.3 Lithofacies distribution

The vertical distribution of the Lithofacies and Lithofacies associations described in Chapter 5 is illustrated in Enclosures A-1 to A-16 using the following codes:

Lithofacies 1:	Cross bedded, offshore lime sands	LF1
Lithofacies 2:	Winnowed, shifting lime sands	LF2
Lithofacies 3:	Muddy, stable lime sands	LF3
Lithofacies association A:	Cross bedded lime sands and terrigenous muds	LAA

Lithofacies association B:	Cross bedded lime sands; interlayered lime sands and lime muds; bioclastic/oolitic lime muds	LAB
Lithofacies 4:	Pelletal lime sands	LF4
Lithofacies 5:	Bioturbated, pelletal lime muds	LF5
Lithofacies association C:	Pelletal lime sands/lime muds and oolitic/bioclastic lime sands	LAC
Lithofacies 6:	Lime muds	LF6
Lithofacies 7:	Oyster reefs	LF7
Lithofacies 8:	Hardgrounds and pebble beds	LF8
Lithofacies 9:	Interlayered sands and terrigenous muds	LF9
Lithofacies association D:	Interbedded argillaceous, bioclastic lime muds and interlayered sands and terrigenous muds	LAD
Lithofacies association E:	Homogeneous terrigenous muds and 'swirl-based', fossiliferous terrigenous muds	LAE

SEDIMENTARY STRUCTURES

Massive

Horizontal lamination

Graded bedding

Cross stratification (undifferentiated)

Trough cross stratification

Ripples/cross lamination

Hummocky cross stratification

Interlayered mud and sand

Particle lineation

Rootlets

Mottling

Bioturbation

Burrows — vertical & inclined

U-shaped burrows (undifferentiated)

Cryptalgal lamination

Oyster bioherm/biostrome

Ironstone (limonite/siderite) nodules

Pebbles

Encrusting organism

Bivalve borings

ICHNOGENERA

Gyrochorte

Imbrichnus

Planolites

Pelecypodichnus

Teichichnus

Thalassinoides

Diplocraterion

Favreina

Gnathichnus pentax

Terebelloid worm tubes

Trypanites

LITHOLOGIES

Mudstone 

Siltstone 

Sandstone 

Limestone 

Argillaceous limestone 

BED CONTACTS

Sharp, erosive 

Sharp 

Gradational 

Loaded 

Convoluted 

GRAIN TYPES

Bioclast 

Ooid 

Intraclast 

Pellet 

Silt 

Sand 

Plant debris

Lignitic 

Carbonaceous 

LITHOLOGIES — ACCESSORIES

Carbonaceous 

Calcareous 

Consolidated 

DUNHAM CLASSIFICATION

Lime mudstone ..... M

Wackestone ..... W

Packstone ..... P

Grainstone ..... G

Enc. A – 1

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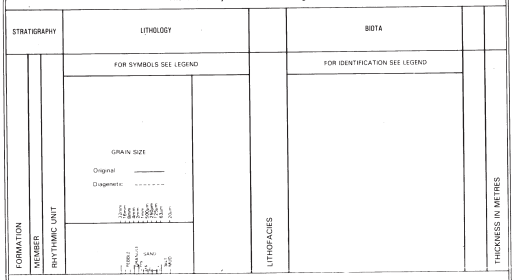
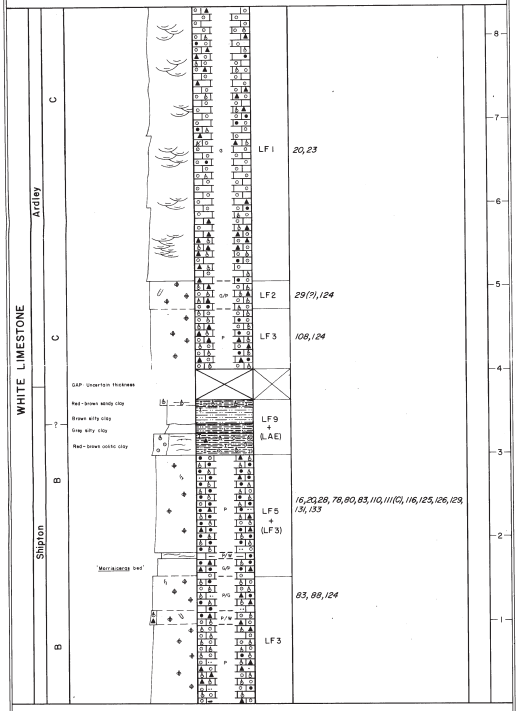
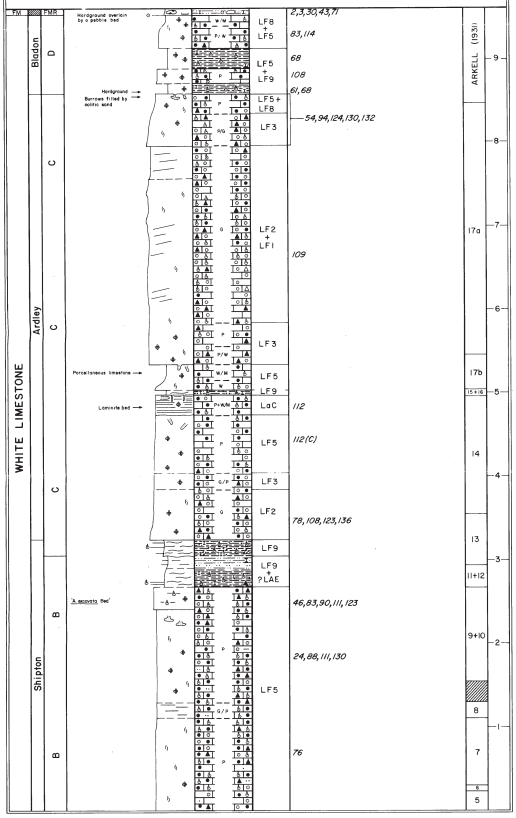
The University of Aston in Birmingham 1986



4 WHITEHILL QUARRY, STURT FARM



5 ETON COLLEGE QUARRY



Enc. A-2

A FACIES ANALYSIS OF THE UPPER GREAT OOLITE GROUP IN CENTRAL AND EASTERN ENGLAND

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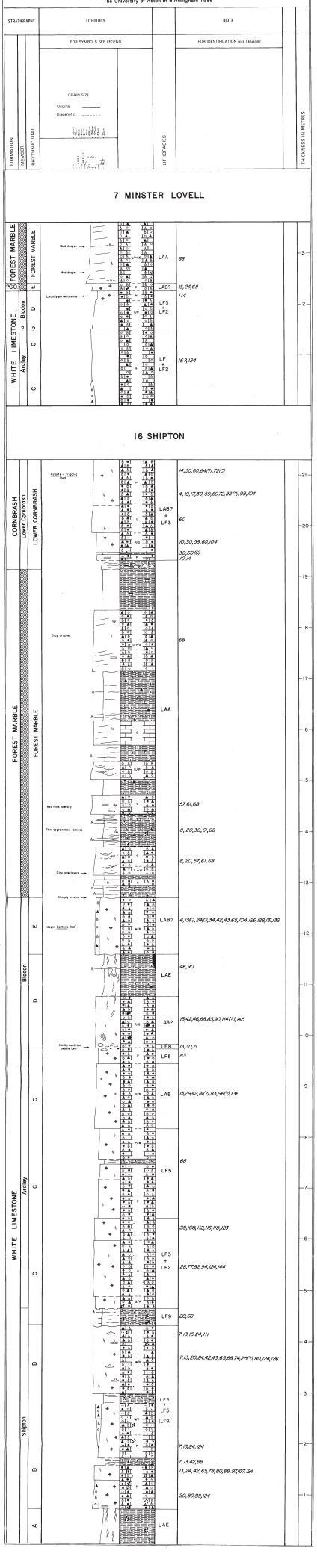

Enc. A – 3

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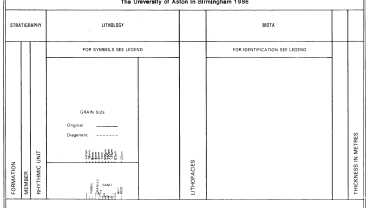
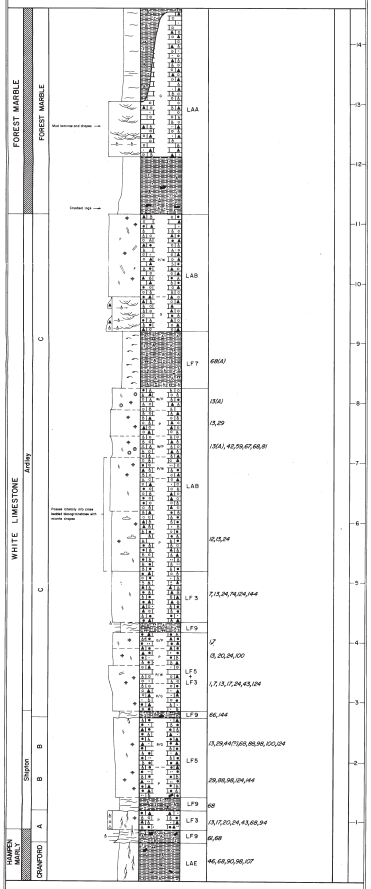
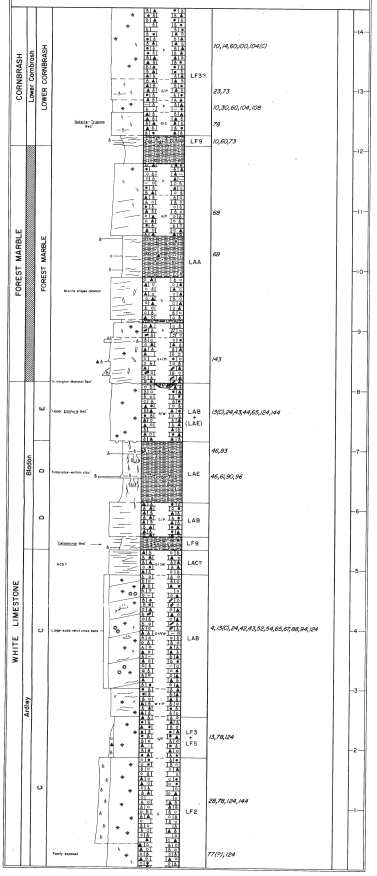


24 WOOD EATON



26 KIRTLINGTON



Enc. A–4

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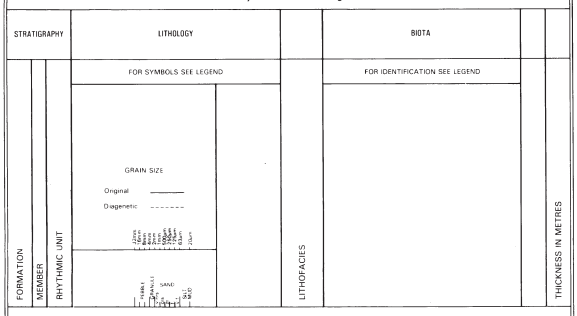
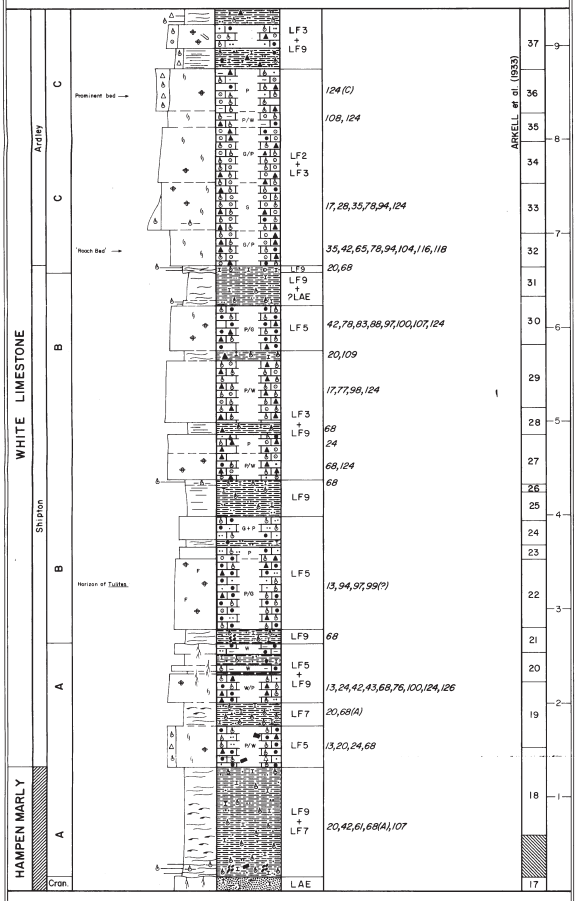
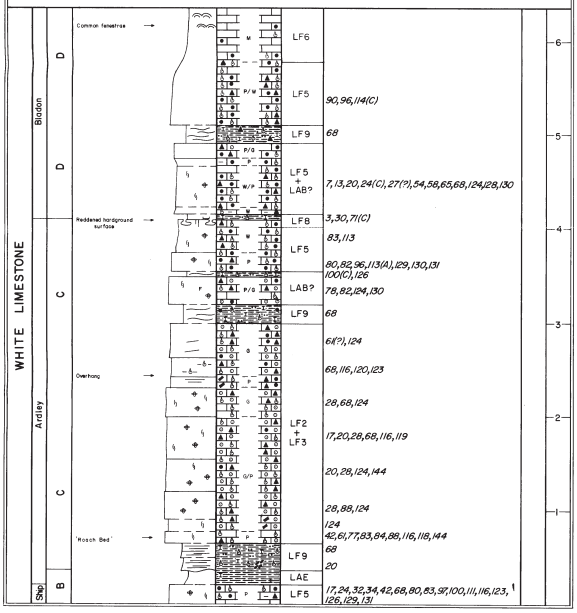


28 ARDLEY — FRITWELL RAILWAY CUTTING



30 ARDLEY FIELDS FARM QUARRY



Enc. A–5

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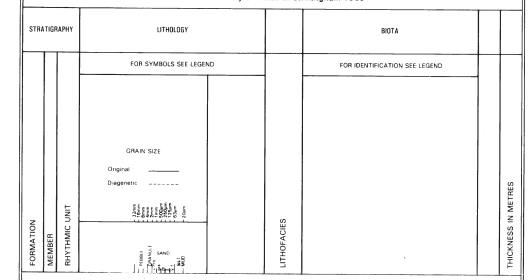
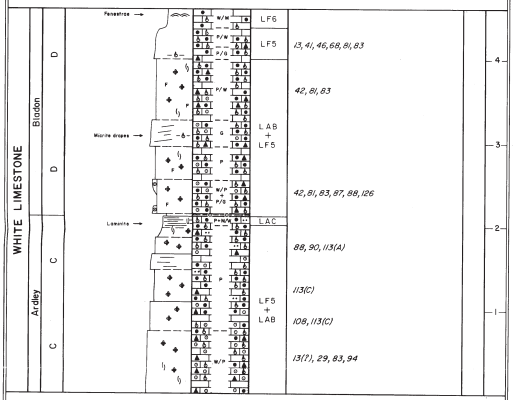
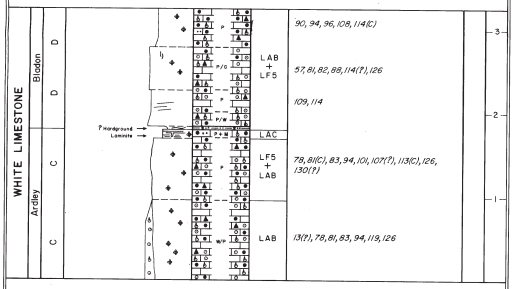


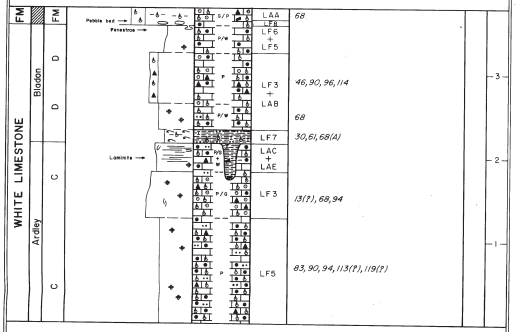
32 WHITEWAYS QUARRY



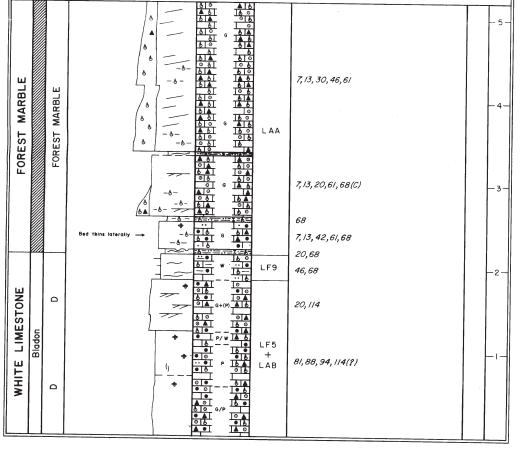
33 GREAT ROLLRIGHT



35 TEMPLE MILLS



37 STOURSWELL



Enc. A–6

A FACIES ANALYSIS OF THE UPPER GREAT OOLITE GROUP IN CENTRAL AND EASTERN ENGLAND

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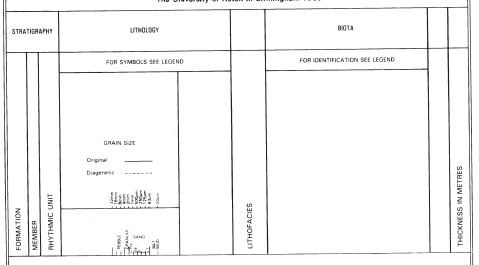
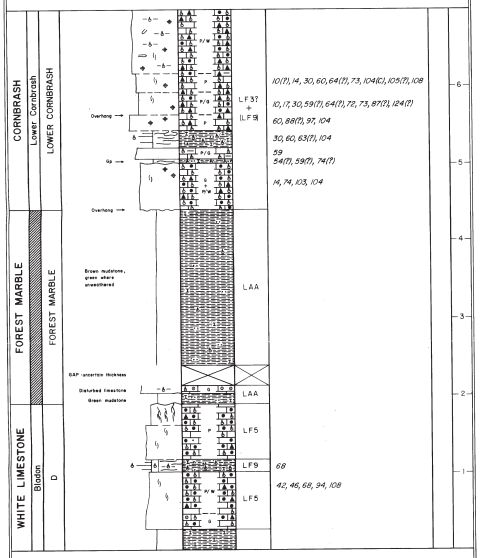
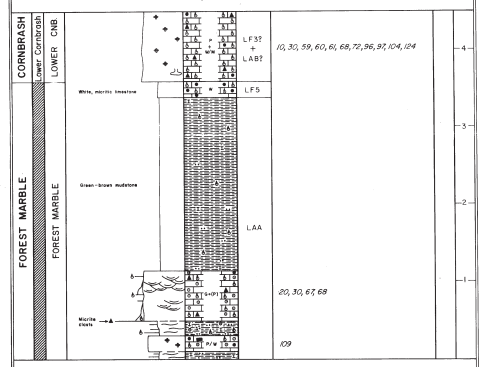


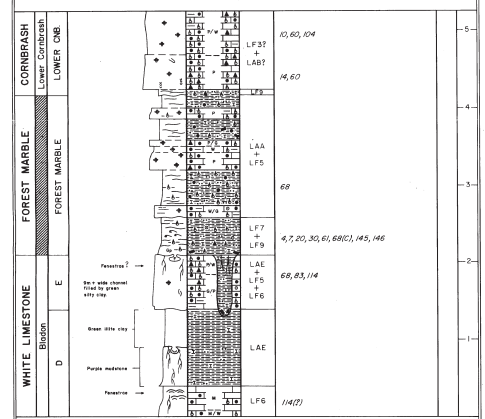
41 BROOMHILL



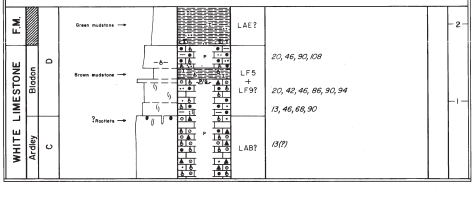
42 BLACKTHORN HILL ROAD CUTTING



44 STRATTON AUDLEY



51 CALVERTON



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Enc. A-7

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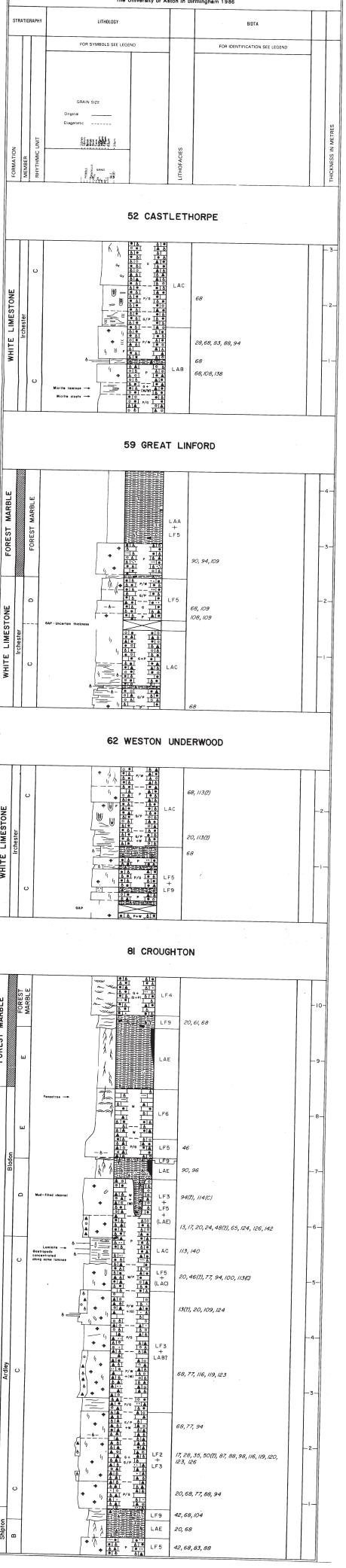

Enc. A-8

A FACIES ANALYSIS OF THE UPPER GREAT OOLITE GROUP IN CENTRAL AND EASTERN ENGLAND

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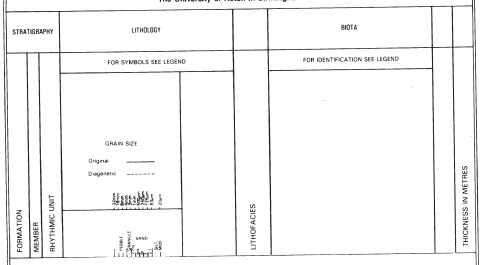
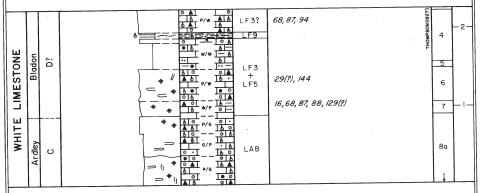
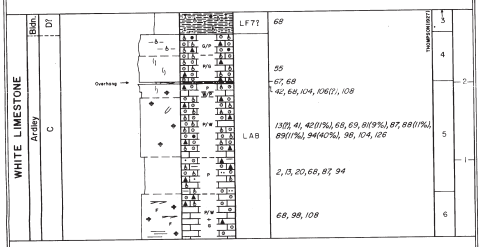


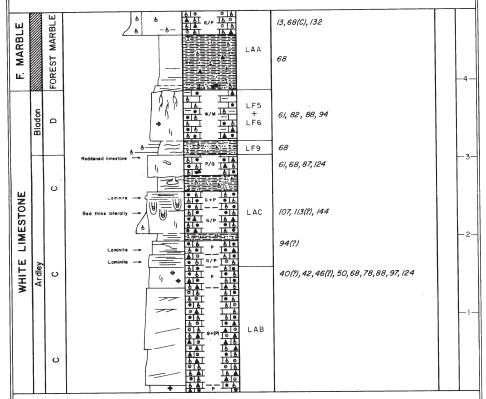
94 MAIDFORD



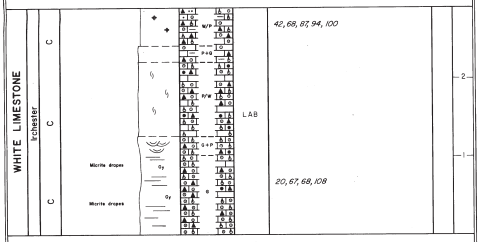
95 STOWE-IX-CHURCHES



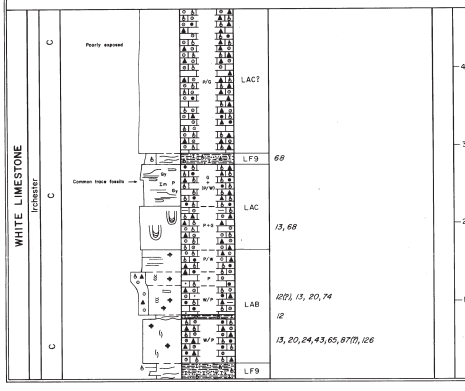
96 PURY END



97 LORD PENRHYN'S PIT, DEANSHANGER



100 COSGROVE



Enc. A-9

A FACIES ANALYSIS OF THE UPPER GREAT OOLITE GROUP IN CENTRAL AND EASTERN ENGLAND

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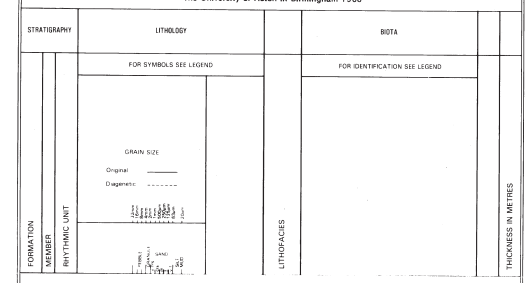
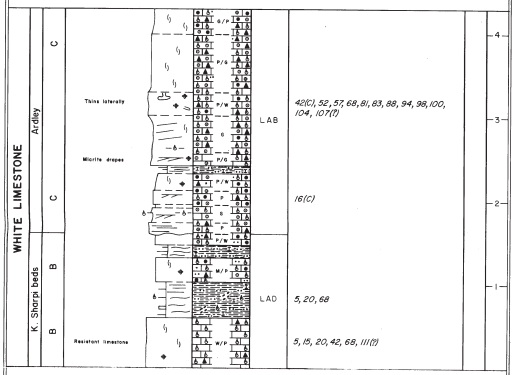
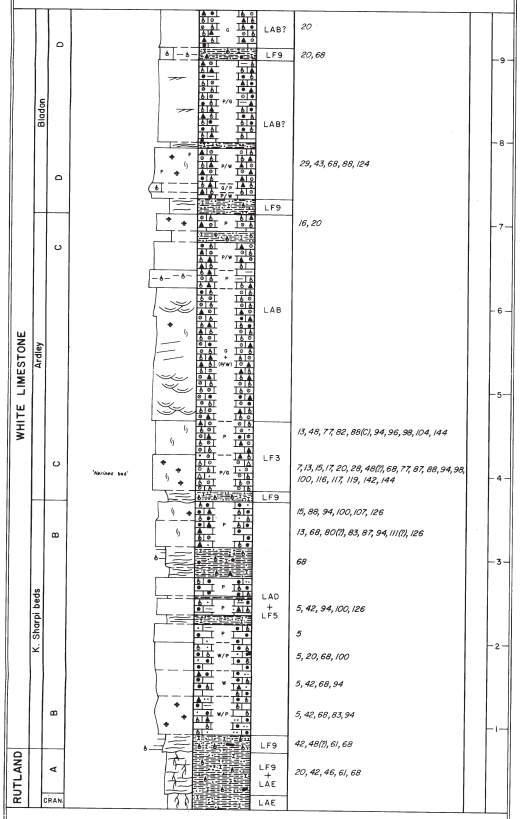


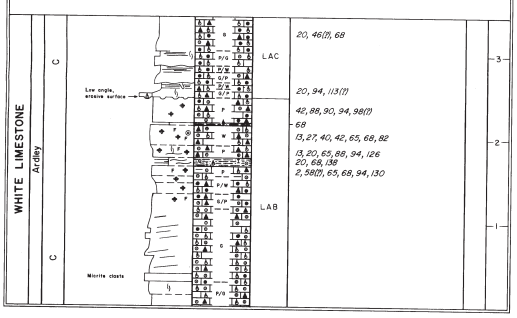
104 ROADE SOIL FERTILITY QUARRY



105 ROADE RAILWAY CUTTING



107 BLISWORTH EAST



Enc. A-10

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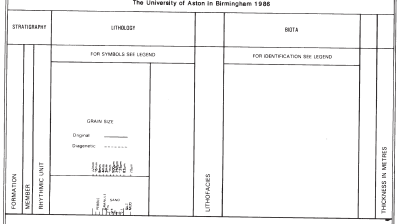
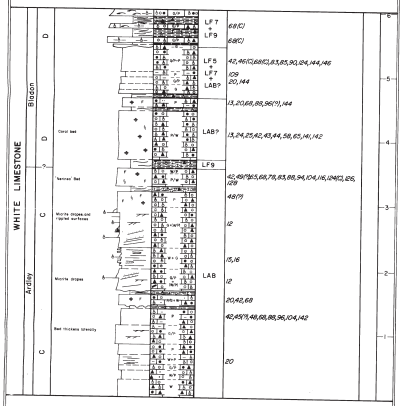
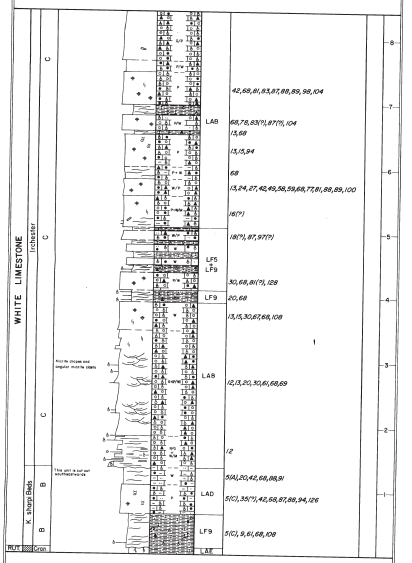


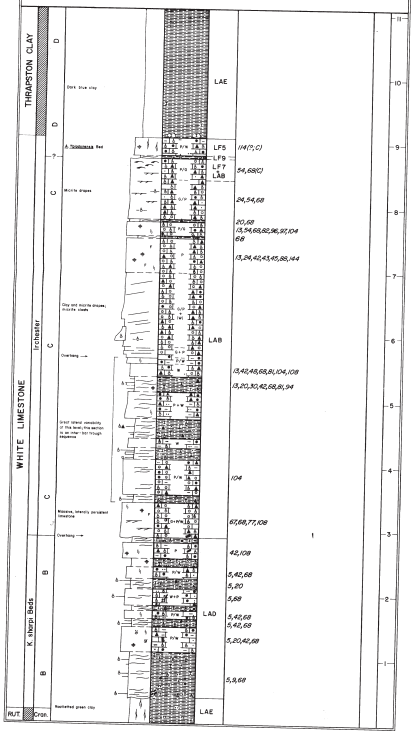
108 BLISWORTH RECTORY FARM QUARRY



121 IRCHESTER NEW LODGE PIT



122 IRCHESTER OLD LODGE PIT



Enc. A-11

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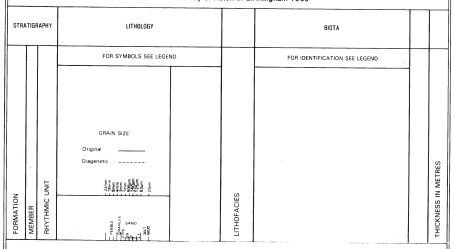
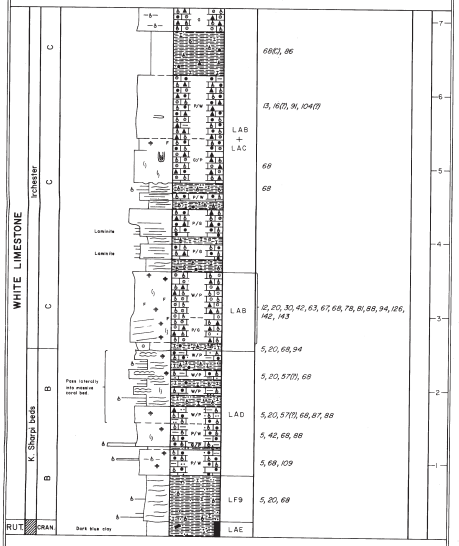
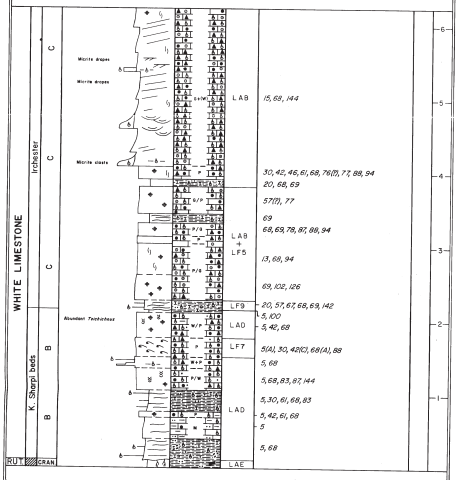


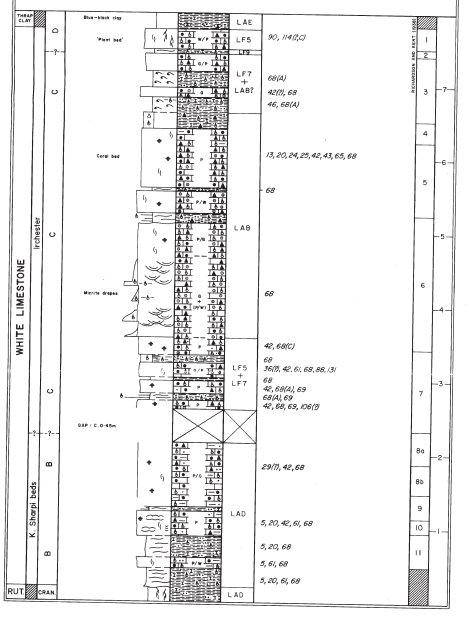
123 IRCHESTER NORTH PIT



124 WELLINGBOROUGH No.5 PIT



127 IRTHLINGBOROUGH



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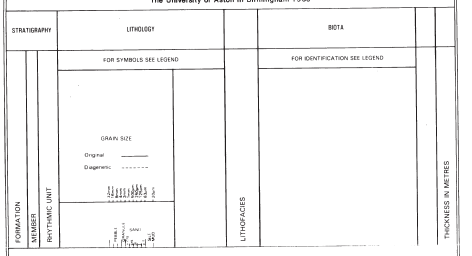
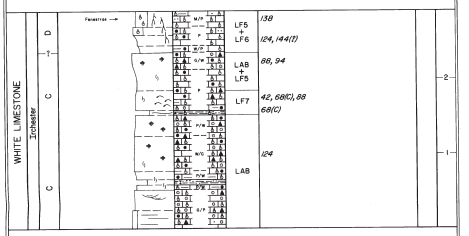
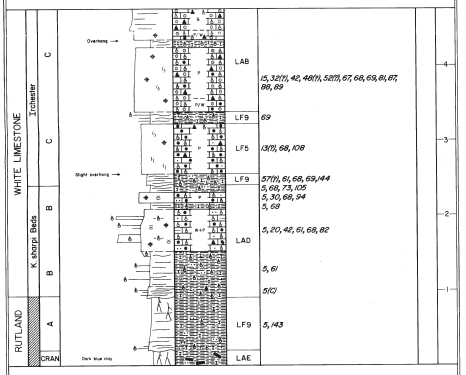


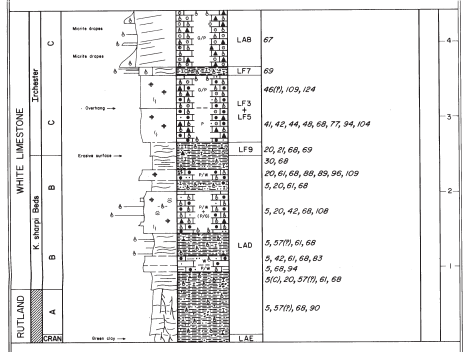
129 STANWICK



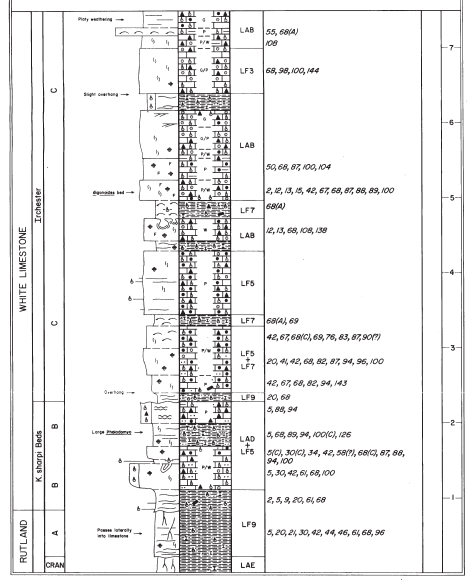
133 GLEBE QUARRY, FINEDON



134 BUCCLEUCH QUARRY, FINEDON



139 CRANFORD SOUTH PIT



Enc. A–13

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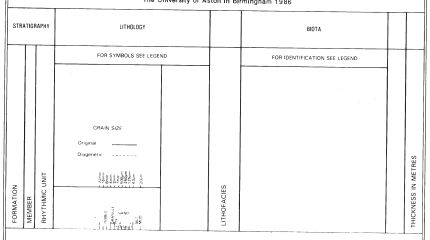
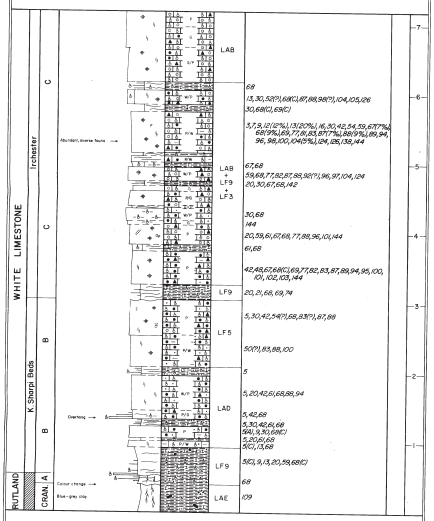
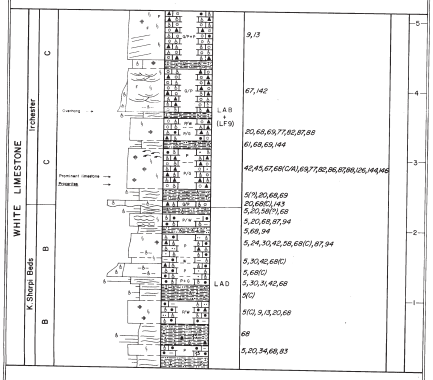


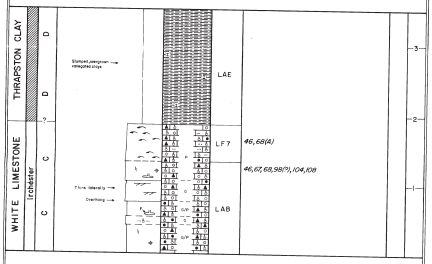
140 CRANFORD NORTH PIT



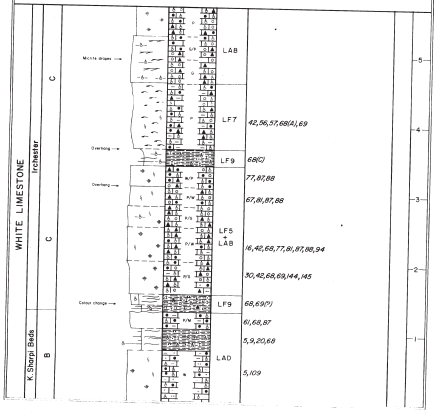
141 TWYWELL IRONSTONE PIT



142 TWYWELL LIMESTONE PIT



143 CARGO FLEET PIT, TWYWELL



Enc. A – 14

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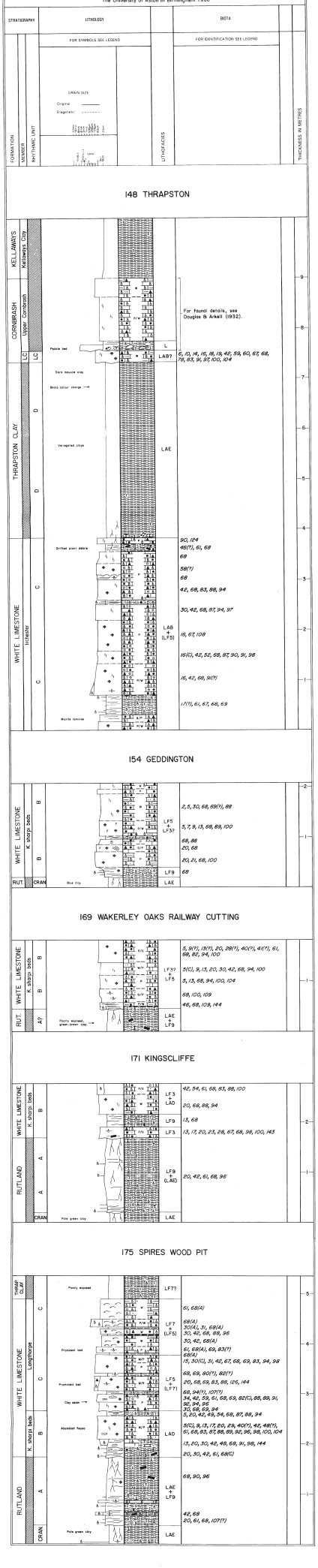

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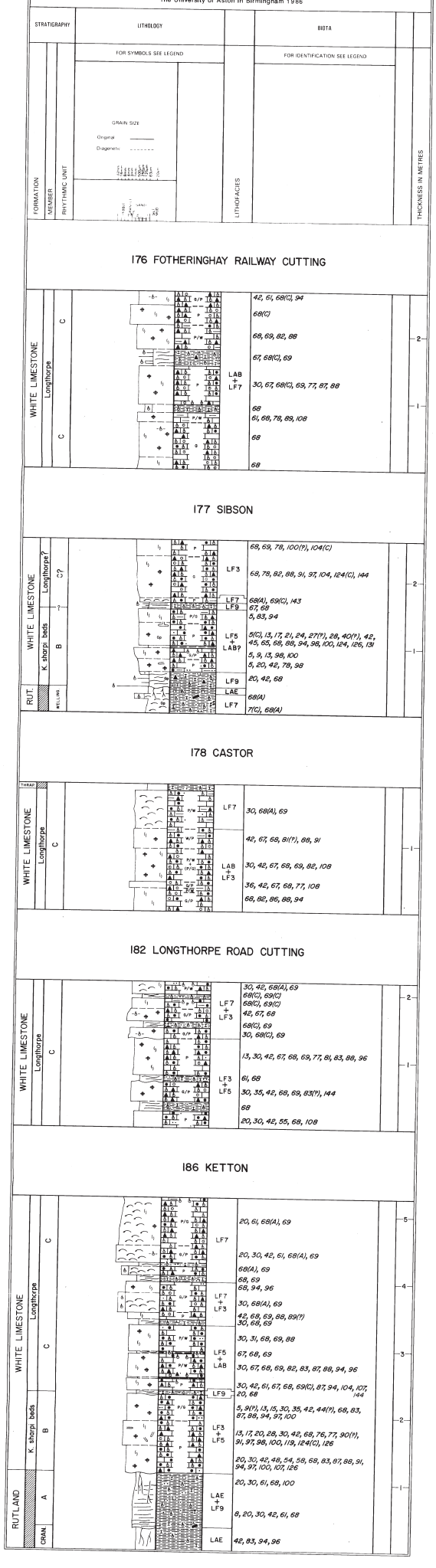

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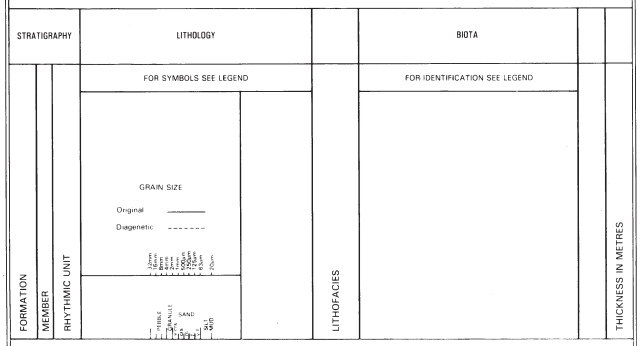
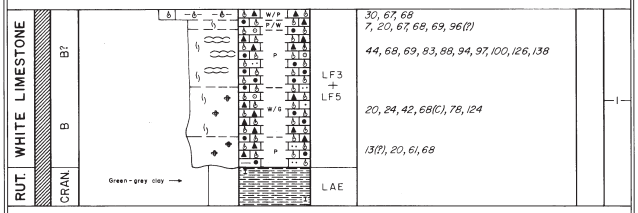
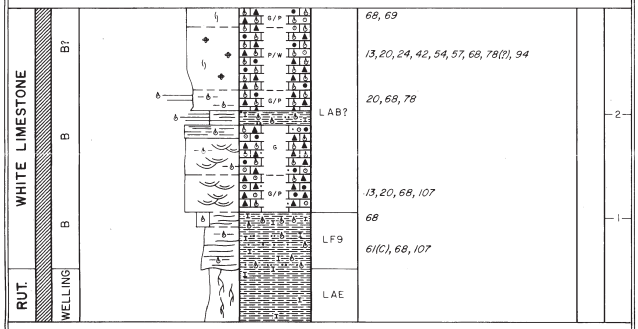


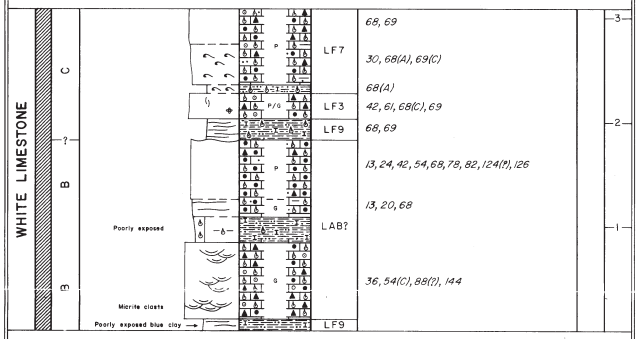
190 CLIPSHAM



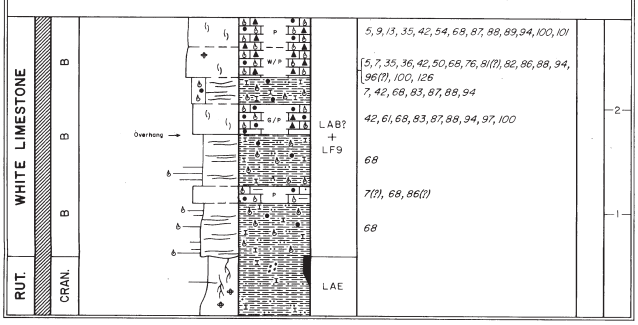
193 ADAMANTINE CLINKER AND FIRECLAY PIT, LITTLE BYTHAM



194 RAILWAY CUTTING, LITTLE BYTHAM



198 THOMPSON'S PIT, ANCASTER



Enc. 2.1

A FACIES ANALYSIS OF THE UPPER GREAT OOLITE GROUP IN CENTRAL AND EASTERN ENGLAND

THE UNIVERSITY OF ASTON IN BIRMINGHAM
1986

GREAT OOLITE GROUP ISOPACH MAP

SCALE

10 0 10 20 Miles
10 0 10 20 Kilometres

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LEGEND

Contour Interval	10 metres
Borehole	•
Borehole Location	B152
Thickness in Metres	85

Great Oolite Group outcrop based on the Geological Map of Great Britain, Sheet 2. Prepared by the Geological Survey, 2nd edition, 1957