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**Biostratigraphy of the Lias section at Tilton Railway Cutting,
Leicestershire**

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Palaeontology & Biostratigraphy Report



Geographical index

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Foraminifera & Ostracoda
Early Jurassic (Pliensbachian-early Toarcian)
Stratigraphy/Biostratigraphy

British Geological Survey, Keyworth, Nottinghamshire, UK

Biostratigraphy of the Lias section at Tilton Railway Cutting, Leicestershire (National Grid Reference SK 761 055)

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1. Introduction

A suite of samples from the upper part of the Dyrham, Marlstone Rock and the basal Whitby Mudstone formations of the Tilton railway cutting were examined for calcareous microfaunas (Foraminiferida and Ostracoda). Macrofossils (ammonites, gastropods, brachiopods, bivalves were also noted). Biostratigraphical conclusions can be drawn from the faunas recovered.

2. Samples

Micropalaeontological samples:

MPA49935	IPW1	SK 7615 0557
MPA49936	IPW2	SK 7617 0555
MPA49937	IPW3	SK 7624 0545
MPA49938	IPW4	SK 7635 0530
MPA 49939	IPW5	SK 7635 0530
MPA31042		SK 761 055
MPA31043		SK 761 055

Macrofaunal samples:

IPW6	SK 7635 0530
IPW7	SK 7635 0530
IPW8	SK 7635 0530

Thin sections (for slide numbers, see Lott, 2001):

- Thin section 1 Tilton 1: "Basal limestone"
- Thin section 2 Tilton 1: "Sandrock"
- Thin section 3 Tilton 1: "Lower Marlstone"
- Thin section 4 Tilton 1: "Marlstone"
- Thin section 5 Tilton 2: "Below Marlstone"
- Thin section 6 Tilton 2: "Base Marlstone"
- Thin section 7 Tilton 3: "Top Marlstone"

3. Previous biostratigraphical research

The stratigraphy of the section was first described by Wilson & Crick (1889) and it was further discussed in some detail in Whitehead *et al.* (1952). The "Marlstone Rock-bed" was divided into two, the lower "sandrock" and the upper "ironstone". The sequence has been outlined a number of times (e.g. Hallam, 1955, 1968; Howarth, 1980; Cox, unpublished note held in the BGS Biostratigraphy file for 1:50k sheet 156, 1989) and minor variations in the interpretation of the beds has resulted (Text Figure 1). The section is placed into the lithostratigraphical framework as presently understood by reference to Cox *et al.* (1999). The Dyrham Formation comprises sandy and silty mudstone with a thin, hard sandstone bed, overlain by massive sandstones (the 'Sandrock' of previous authors). This 'Sandrock' has often been assumed to have formed the lower part of the Marlstone Formation and has been mapped as such in the past. The Marlstone Rock Formation *sensu stricto* (the ironstone of earlier workers) is overlain by the Whitby Mudstone Formation.

Several collections of macrofossils have been made and published since the railway cutting was opened in 1879. Ager (1954) and Hallam (1955) discussed the brachiopods in detail, showing the biostratigraphical importance of the genus *Gibbirhynchia*. Some parts of the Dyrham and Marlstone formations are composed of great numbers of brachiopods, notably "Band A", which contains huge numbers of *Tetrahynchia tetrahedra* and *Lobothyris punctata*, often grouped in "nests". It has been assumed that this represented a period of virtually no sedimentation and that the firm sea-bed provided an ideal substrate for the brachiopod community. Two other, although less developed, brachiopod-rich horizons occur near the base of the 'Sandrock' and in the middle part of bed 5, toward the top of the formation.

Another brachiopod-rich bed ("Band B") occurs at the base of the Marlstone Rock Formation, the fauna being dominated by *Lobothyris punctata*, but *Gibbirhynchia tiltonensis* and *Zeillera subdigona* together with belemnites and bivalves were recorded by Ager (1954) and Hallam (1955).

Bivalves are common and diverse in the section, particularly in the upper part of the Marlstone Rock Formation (Wilson & Crick, 1889; Hallam, 1955); gastropods are not common below the top of the Marlstone Rock Formation; crinoid debris is also present, especially in the lower part of the Marlstone Rock Formation; and belemnites are moderately common in the Tilton section.

The "Marlstone Rock-bed" in its original sense, has traditionally been placed within the *Pleuroceras spinatum* ammonite Zone, although evidence is weak and Hallam (1955) was obviously puzzled by the presence of Toarcian species in the upper part, but maintained the *status quo*. This was also advocated by Howarth (1958 pages x-vi).

Howarth (1958) recorded several specimens of *Pleuroceras*, including *P. spinatum*, from the "sandrock" of Central England (although none from Tilton). It was on this evidence that the whole of the "Marlstone Rock-bed", as then understood, was placed into the Spinatum Zone (the "Sandrock" was placed in the Apyrenum Subzone and the "Ironstone" was considered to be Hawskerense Subzone). However, judging from the later evidence presented by Howarth (1980), the "sandrock" (at the top of the Dyrham Formation in modern terms) and the base of the Marlstone Formation (basal bed a of Howarth, 1980) are assigned to Spinatum Zone and the rest of the Marlstone Rock Formation is of Tenuicostatum zonal age.

Ammonites are not common in the Tilton Railway Cutting, with the exception of the top of the Marlstone Rock Formation (in what has previously called the "Transition Bed"). *Tiltoniceras acutum* has been recorded here in large numbers (Hallam, 1955), together with common *Dactylioceras (Orthodactylites) semicelatum* (Howarth, 1980). The identification of the latter species, and the comparison of faunas elsewhere in England, proves that the top of the Marlstone Rock Formation is of Semicelatum subzonal age, Tenuicostatum Zone (Lower Toarcian) (Howarth, 1980). The upper part of the Marlstone in Harston, Leicestershire has yielded rare *Dactylioceras tenuicostatum* and *D. crosbeyi*, characteristic of the *D. clevelandicum* Subzone, although the subzonal index was not found. Unfortunately these species have not been found at Tilton. It would appear, therefore, that although only the Semicelatum Subzone can be recognised at Tilton, the whole of the Marlstone Rock Formation, except of the basal part, can be placed into the Tenuicostatum Zone (earliest Toarcian).

During collection for the present study, sample MPA 49938 (collector's Number IPW4) from the "Transition Bed" was found to contain abundant fragments of *Dactylioceras*, tentatively identified as *D. semicelatum*, in the micropalaeontological preparation. This same sample (IPW4) also yielded *Harpoceras* sp. (?*H. serpentinum*) (IPW6), *Dactylioceras* sp. (?*D. semicelatum*) (IPW7) and bivalves

(IPW8). Cephalopod hooks (MPA49939) were recovered from the mudstones (Whitby Mudstone Formation) immediately above the "Transition Bed".

4. Calcareous microfaunas from the Tilton section

The distribution of samples and the calcareous microfossils present in the Tilton section are shown in Text-Figure 2.

4.1 Dyrham Formation

A foraminiferal association was recovered from a sandy mudstone just below the sandstone rib in the upper part of the silty mudstones of the Dyrham Formation, below the 'Sandrock'. It comprised mainly of long-ranging species, including the abundant *Lenticulina subalata* and frequent *L. varians*. However, the presence of *Lingulina tenera* subsp A of Copestake & Johnson (1989) is biostratigraphically significant as it first appears in the Margaritatus Zone in the 'Midlands Basin' and East Midlands Shelf as well as the Cleveland Basin, and in the last named region it also extends up into the Spinatum Zone. The species is accompanied by *Dentalina matutina*, which is a long-ranging species, but one that becomes extinct at the top of the Margaritatus Zone in the North Sea (Viking Graben), Southern North Sea Basin, Cleveland Basin, Midlands Basin and East Midlands Shelf, Wessex Basin and the Fastnet-Celtic Sea-Cardigan basins. There is little doubt that the fauna below the sandstone rib is from either foraminiferal zones JF10 (stokesi Subzone) or possibly JF11 (subnodosus-gibbosus subzones) and the Margaritatus Zone can be inferred. The absence of *Frondicularia terquemi* subsp B and common *Lenticulina muensteri acutiangulata*, suggests the former rather than the latter foraminiferal zone, but this may be due to sample failure.

Immediately above the sandstone rib (MPA49936), in a pebbly siltstone, the foraminifera are rare and comprised of agglutinating taxa. It is almost monospecifically *Ammodiscus siliceus*. This may be due to near-shore, marginal marine conditions precluding haline taxa. However, immediately below the base of the 'Sandrock', haline foraminifera are again present (MPA49937). *Lenticulina muensteri acutiangulata* is rare, but biostratigraphically important as it indicates foraminiferal zone JF11 (Copestake & Johnson, 1989) and the Subnodosus-Gibbosus subzones of the Margaritatus Zone.

The Sandrock proved too indurated to disaggregate for microfaunal analysis. However, thin sections cut for sedimentological purposes were examined to ascertain whether foraminifera or ostracods were present. Two samples from the upper sandrock (Bed 5), the upper part of the Dyrham Formation, contained indeterminate species of *Lingulina*, *Lenticulina*, *Nodosaria* and *Planularia*, together with *Ophthalmocythere* cf. *northamptonensis* a long ranging early Jurassic species. No biostratigraphical conclusions can be drawn from this association.

4.2 Marlstone Rock Formation

The Marlstone Rock Formation also proved too indurated to be disaggregated. The thin section from the basal bed (Band B) contains *Rheinholdella* sp. This is probably *Rheinholdella macfadyeni*, and although it is difficult to be certain, there are no other species of the genus of late Pliensbachian-early Toarcian age in Britain. *Rheinholdella macfadyeni* is rare in the *hawskerense* Subzone of the Cleveland Basin, but in the early Tenuicostatum Zone it becomes very common and abundant, and it is at this level that the species is also becomes more geographically widespread (Southern North Sea Basin, Cleveland Basin and the 'Midlands Basin'-East Midlands Shelf). This acme event is very characteristic of the Tenuicostatum Zone and its presence in the present sample is interpreted as being indicative of that age.

It is only the uppermost part of the Marlstone Rock Formation, where it is weathered to form the "Transition Bed", that disaggregation is possible and calcareous microfaunas can be removed (MPA49938). *Citharina colliezi* appears for the first time at the base of the Tenuicostatum Zone in the 'Midlands Basin' and East Midlands Shelf. *Lenticulina varians* subspecies D of Barnard also appears for the first time at the base of the Tenuicostatum Zone in the 'Midlands Basin' and East Midlands Shelf, but it has also been recorded from the Spinatum Zone in the Fastnet-Celtic Sea-Cardigan basins. These species suggest the base of foraminiferal zone JF12b (Tenuicostatum Zone)

Ostracoda were recovered from the "Transition Bed" (sample MPA 49938) in the Tilton section. *Kinkelinella sermoisense* is abundant and *Kinkelinella intrepida* is very rare, but these two species are characteristic of the eponymous ostracod zone of Bate & Coleman (1975). This zone extends from the ?Tenuicostatum Zone through to the basal Bifrons Zone. Lord (1979) shows that the first appearance of *Trachycythere verrucosa* is within the lower part of the Tenuicostatum Zone in the

Mochras Borehole (North Wales) and Bate & Coleman (1975) show it ranges from the Tenuicostatum to the early Bifrons Zone in Britain (in Germany this species ranges from the late Spinosum to Tenuicostatum zones). *Cytheropteron gwashense* and *Macrocypris liassicus* are unknown below the Falciferum Zone so that its presence here extends its range into the Semicelatum Subzone. *Eucytherura* sp of Bate & Coleman (1975) is unknown above the Tenuicostatum Zone and although its full range is not clear, it may prove to be biostratigraphically useful.

4.3 Whitby Mudstone Formation

The basal Whitby Mudstone Formation (sample MPA 49939), a dark brown mudstone, contains only very rare calcareous microfossils, of no stratigraphical significance. This horizon appears to be at a horizon in which foraminifera zone JF13 should occur, but it is not recognisable at Tilton.

A little higher (MPA31043) a rich, low diversity, fauna comprises mainly long-ranging species, but includes frequent *Reinholdella macfadyeni* and rare *Ophthalmidium macfadyeni* and *Nubeculinella tibia*. The last named is generally rare and patchily distributed, but it is common in the Falciferum Zone in Britain. *Reinholdella macfadyeni* is common in foraminiferal zones JF12b and JF14 (Tenuicostatum Zone and Late Falciferum to Early Bifrons zones)

Immediately above the belemnite-rich "hard band" (MPA31042), *Vaginulina clathrata* appears for the first time in the section. This species appears in Britain in the upper part of the Falciferum Zone (at the base of the Falciferum Subzone) and ranges through the rest of the Toarcian. It forms a characteristic part of the JF14 foraminiferal zone (Falciferum Subzone through to the early Fibulatum Subzone of the Bifrons Zone) Copestake & Johnson, 1989).

Ostracoda are also present in and immediately above the 'hard band'. *Kinkelinella sermoisensis* and *Kinkelinella intrepida* are again present confirming the continuation of the eponymous zone. *Cytheropteron gwashense*, which ranges from the Falciferum to early Bifrons zones is present above the 'hard band'. *Cytheropteron alafastigatum* and *Cytherella toarcensis* also occur, from which it is concluded that the assemblage is no older than the highest part of the Falciferum Zone (they seem to appear in the upper part of the Falciferum Subzone, at least in the English Midlands) (Bate & Coleman, 1975). Finally, *Isobythocypris ovalis*, which is confined to the Falciferum Zone, occurs for the first time in the 'hard band'.

5 Conclusions

1. The Dyrham Formation, below the 'Sandrock', near the cutting floor can be placed in foraminiferal zone JF10 which equates with the Margaritatus Zone, stokesi Subzone, and although indices are missing there is a possibility that it should be placed in JF11 (Margaritatus Zone, subnodosus-gibbosus subzones).
2. The very highest part of the sandy and silty mudstone, immediately below the 'Sandrock' (Dyrham Formation) at Tilton can be placed in foraminiferal zone JF11 (Margaritatus Zone, subnodosus-gibbosus subzones).
3. It is not possible to place the 'sandrock' at Tilton into a biostratigraphical scheme, but evidence from elsewhere in the English Midlands, indicates it is of Spinatum zonal age.
4. Much of the Marlstone Rock Formation is placed into foraminiferal zone JF12, subzone JF12b (Tenuicostatum Zone). However, the basal part of 'bed a' is placed into the Spinatum Zone, Hawskerense Subzone, according to Howarth (1980).
5. Macrofossils collected from the top of the Marlstone Rock Formation ('Transition bed') places it in the Semicelatum Subzone (latest Tenuicostatum Zone) and the *Kinkelinella sermoisense/Kinkelinella intrepida* ostracod Zone can also be recognised (the base is uncertain, but the zone ranges from within the Tenuicostatum through to early Bifrons zones).
6. Foraminiferal Zone JF13 (=Exaratum Subzone, Falciferum Zone) was not recognised in the section.
7. The *Kinkelinella sermoisense/Kinkelinella intrepida* ostracod zone extends up to the highest sample examined, immediately above the belemnite-rich 'hard band', 3.5m above the base of the Whitby Mudstone Formation. Based on the ostracods, there is some indication that the 'hard band' and the mudstone immediately above, are of Falciferum Subzonal age (Falciferum Zone).
8. The JF14 foraminiferal zone (Falciferum Subzone through to the early Fibulatum Subzone of the Bifrons Zone) can be recognised in the sample from immediately above the 'hard band' in the Whitby Mudstone Formation

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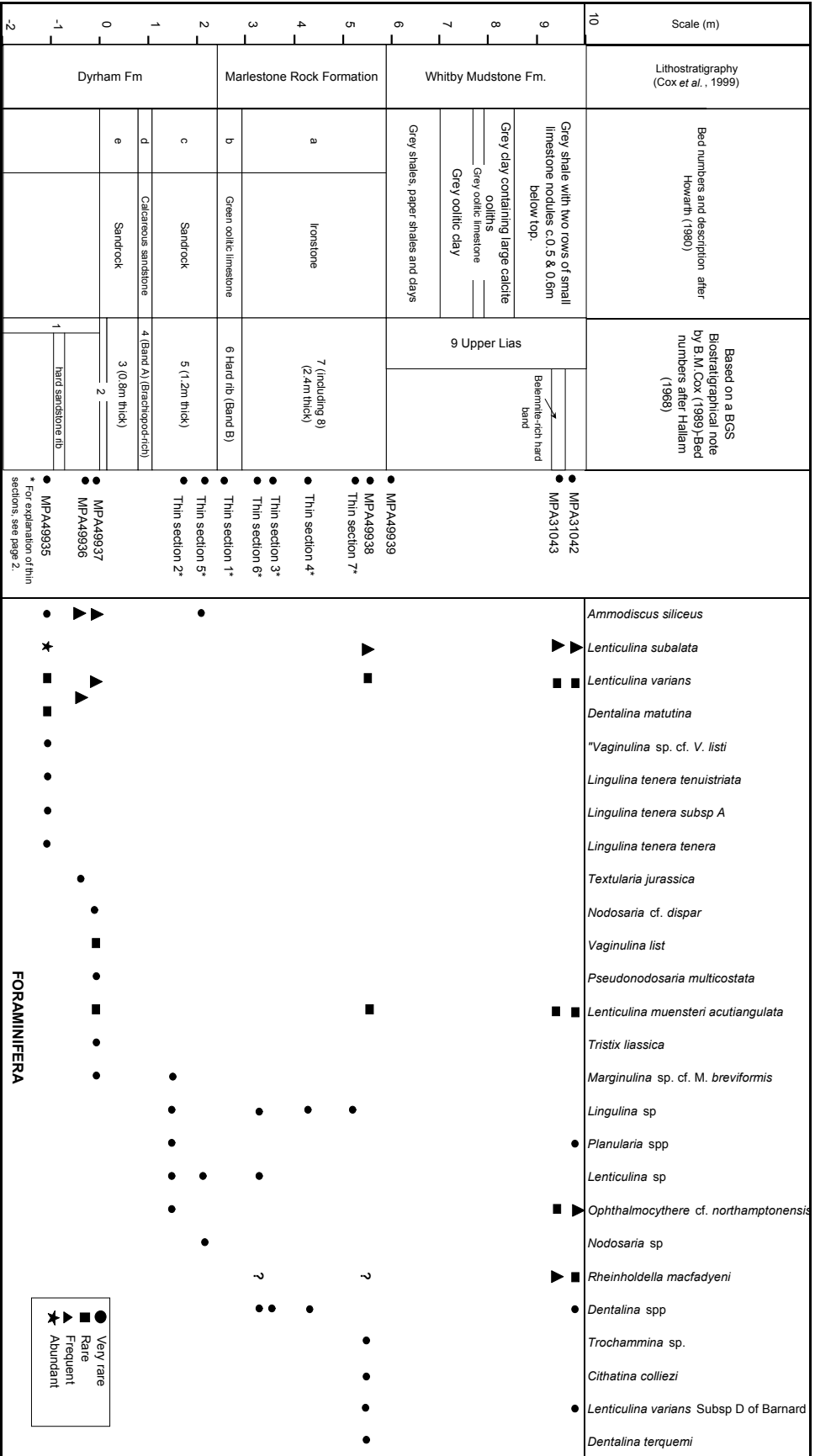
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Scale (m)	Lithostratigraphy (after Cox <i>et al.</i> , 1999)	Bed numbers and descriptions after Hallam (1955)		Bed numbers and descriptions after Hallam (1968)		Bed numbers and description after Howarth (1980)		Based on a BGS Biostratigraphical note by B.M.Cox (1989)-Bed numbers after Hallam (1968)	Ammonite zones	Ammonite subzones	
9	Whitby Mudstone Fm. (pars)	9 (pars)	Upper Lias shales	9 (pars)	Upper Lias clays (pars)	Grey shale with two rows of small limestone nodules c.0.5 & 0.6m below top.		9 Upper Lias	Falciferum	Falciferum	
8						Grey clay containing large calcite ooliths					Belemnite-rich hard band
7						Grey oolitic clay					
6						Grey oolitic limestone					
6						Grey shales, paper shales and clays					
5	Marlestone Rock Formation	8	'Transition bed'	8	'Transition bed'					Semicelatum	
4		7	Ironstone (finely oolitic limestone)	7	oolitic ironstone	a	Ironstone	7 (including 8) (2.4m thick)	Tenuicostatum	?	
3		6	Band B (hard rib)	6	Band B (hard rib)	b	Green oolitic limestone	6 Hard rib		Hawskerense	
2	Dyrham Fm. (pars)	5	Massive sandrock	5	Massive green-grey calcareous sandstone	c	Sandrock	5 (1.2m thick)	Spinatum	?	
1		4	Band A	4	Band A	d	Calcareous sandstone	4 (Band A) (Brachiopod-rich)			
0		3	Massive sandrock	3	Massive sandstone	e	Sandrock	3 (0.8m thick)			?Apyrenum
-1		2	Thin-bedded sandrock with nodules		2	Thin-bedded sandstone with numerous mudstone fragments				Margaritatus	Gibbosus-Subnodosus
-1		1 (pars)	Shales etc	1 (pars)	Clays etc			hard sandstone rib	?		
-2										?Stokesi	

Text Figure 1. The Lias section in Tilton Railway Cutting after Hallam (1955, 1958), Howarth (1980) and Cox (1989, MS)



● Very rare
 ■ Rare
 ▲ Frequent
 ★ Abundant

FORAMINIFERA

Text Figure 2. Distribution of Foraminifera and Ostracoda in the Tilton Railway Cutting



Text Figure 2. Distribution of Foraminifera and Ostracoda in the Tilton Railway Cutting

Lithostratigraphy	Lithology	Foraminifera		Ostracoda	Ammonites	
		Zones/subzones		Zones	Zones	Subzones
Whitby Mudstone Fm.	Grey oolitic shale	JF14		<i>Kinkelinella sermoisensis</i> - <i>Kinkelinella intrepida</i>	Falciferum	Falciferum
	Belemnite-rich hard band	?JF13				Exaratum
Grey shales & clays, oolitic in part						
Marlestone Rock Formation	oolitic limestone ('ironstone')	JF12	b		Tenuicostatum	Semicelatum
	brachiopod-rich oolitic limestone			Tenuicostatum to Paltum		
Dyrham Fm	massive sandstone	?a		Spinatum	Apyrenum	
	brachiopod-rich sandstone					
	massive sandstone					
	thin bedded sandstone	JF11		Margaritatus	Gibbosus-Subnodosus	
	sandy & silty mudstone (pebbly)	?				
	hard sandstone rib	JF10(?JF11)			?Stokesi	

Text Figure 3. Lithostratigraphical, lithological biostratigraphical relationships of the Tilton Railway Cutting section.