

CORRELATION OF THE MIDDLE-UPPER BATHONIAN (MIDDLE JURASSIC) SUCCESSION BETWEEN BATH AND SHERBORNE

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Correlation of the Middle-Upper Bathonian succession between Bath and Sherborne is reviewed in the light of a recently-published lithostratigraphical revision of this sequence. A critique of this revision forms the basis for re-establishing a lithostratigraphical interpretation which has been widely accepted for many years.

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INTRODUCTION

Correlation of the Middle-Upper Bathonian succession between Bath and Sherborne for long proved to be somewhat intractable and controversial. Until the late 1960s, restricted exposure, especially in the mudstone-dominated parts of the sequence, the paucity of stratigraphically diagnostic faunas at most levels, and the availability of only a few cored borehole sequences precluded an assured interpretation. Nevertheless, by then Kellaway and Wilson (1941) had clearly identified the pinch-out of the Fuller's Earth Rock Member south of Sherborne, and demonstrated that brachiopod-rich beds, named by them the Wattonensis Beds, were a discrete unit at a higher stratigraphical level. Also, Sylvester-Bradley and Hodson (1957) had recognised a threefold division of the Fuller's Earth Rock at Whatley, near Frome, naming the uppermost unit the Rugitela Beds and the underlying middle unit the Ornithella Beds. They equated the former with the Wattonensis Beds further to the South.

Subsequent researches were directed particularly at the problems of correlating the Bathonian succession between Bath and Frome. Initially, Green and Donovan (1969, Fig.2.) presented a revised interpretation of the relationship between the Great Oolite Formation at Bath and the corresponding mudstone sequence at Frome, which represent carbonate shelf and basinal facies respectively. Later, Penn and Wyatt (1979, Fig.2), enabled by several cored boreholes, refined this work and introduced the term Frome Clay Formation for the basinal mudstones (formerly included in the Upper Fuller's Earth

Member). In consequence, the 28 m of Upper Fuller's Earth at Bath, which underlie the Great Oolite, were shown to thin progressively to less than 1 m at Frome, over the Mendip Axis. Penn and Wyatt (1979) also inferred the correspondence of the basal Forest Marble Formation shell bed at Bath, which contains a Bradford Clay fauna, with the well-known basal Boueti Bed south of the Mendips. Torrens (1980) designated the 9 m or so of mudstones separating the Ornithella Beds (Fuller's Earth Rock) and the Wattonensis Beds in the Sherborne area as Middle Fuller's Earth Clay and correlated the Wattonensis Beds with the Rugitela Beds of the Frome area, following Sylvester-Bradley and Hodson (1957). This correlation, which was based on an interpretation of a section recorded by Torrens (1980, p.27) at West Cranmore, near Frome, conflicted with Penn and Wyatt's (1979, Fig.14) inferred equivalence of the Wattonensis Beds with the lower 'smithi limestone' at the base of the Frome Clay north of the Mendips. This latter interpretation implied that the 'Middle' Fuller's Earth Clay of Torrens (1980) is in fact Upper Fuller's Earth.

Penn (1982, Fig.4), Whittaker (1985, Fig.9.1), Green (1992, Fig.30), Barton *et al.* (1993, Fig.9), Bristow *et al.* (1995, Fig.25, Table 4), Callomon and Cope (1995, Fig.13) and Bristow *et al.* (in press) all broadly follow Penn and Wyatt (1979), some admittedly with a measure of caution, thus providing a consensus on Middle-Upper Bathonian correlation between Bath and Sherborne; none however, re-evaluated the critical section at West Cranmore (see below).

The whole matter was put back in the melting pot by Page (1996, Fig.3) who proposed a revised lithostratigraphical interpretation stemming from his introduction of a Standard Sub-Mediterranean Ammonite Zonation. The present paper uses a critique of Page's account to re-establish the lithostratigraphical status quo, in the course of which the basis for an assured correlation is set out.

CRITIQUE

The observations on the succession of Bathonian ammonite faunas of south-west England (Page, 1996) is a commendable and welcome attempt to further integrate the Bathonian ammonite faunas there with the well-established Sub-Mediterranean Standard Zonation (see also Mangold, 1991; Callomon and Cope, 1995, Fig.13). Page rightly emphasizes that the relatively impoverished British Bathonian ammonite faunas do not belong to a separately identifiable biogeographical province; thus one Standard Zonal Scheme should suffice for most of Europe. Although certain of the Sub-Mediterranean zones and subzones are as yet poorly attested in south-west England, future discoveries of age-diagnostic ammonites

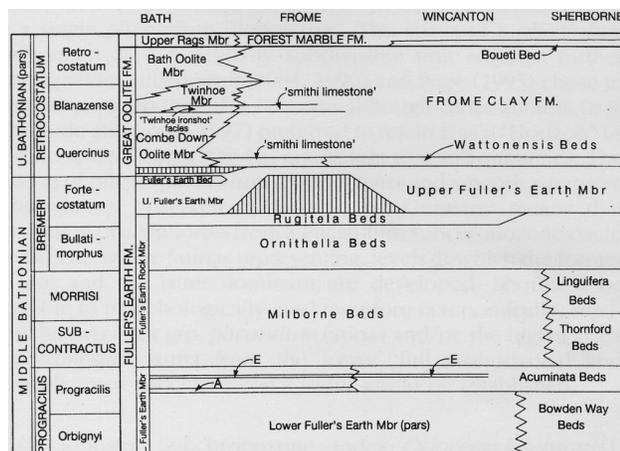


Figure 1. Correlation of the Middle - Upper Bathonian of S. W. England between Bath and Sherborne, excluding the Discus Zone (modified from Page, 1996, Fig 3). [A = Acuminata Bed; E = Echinata Bed]

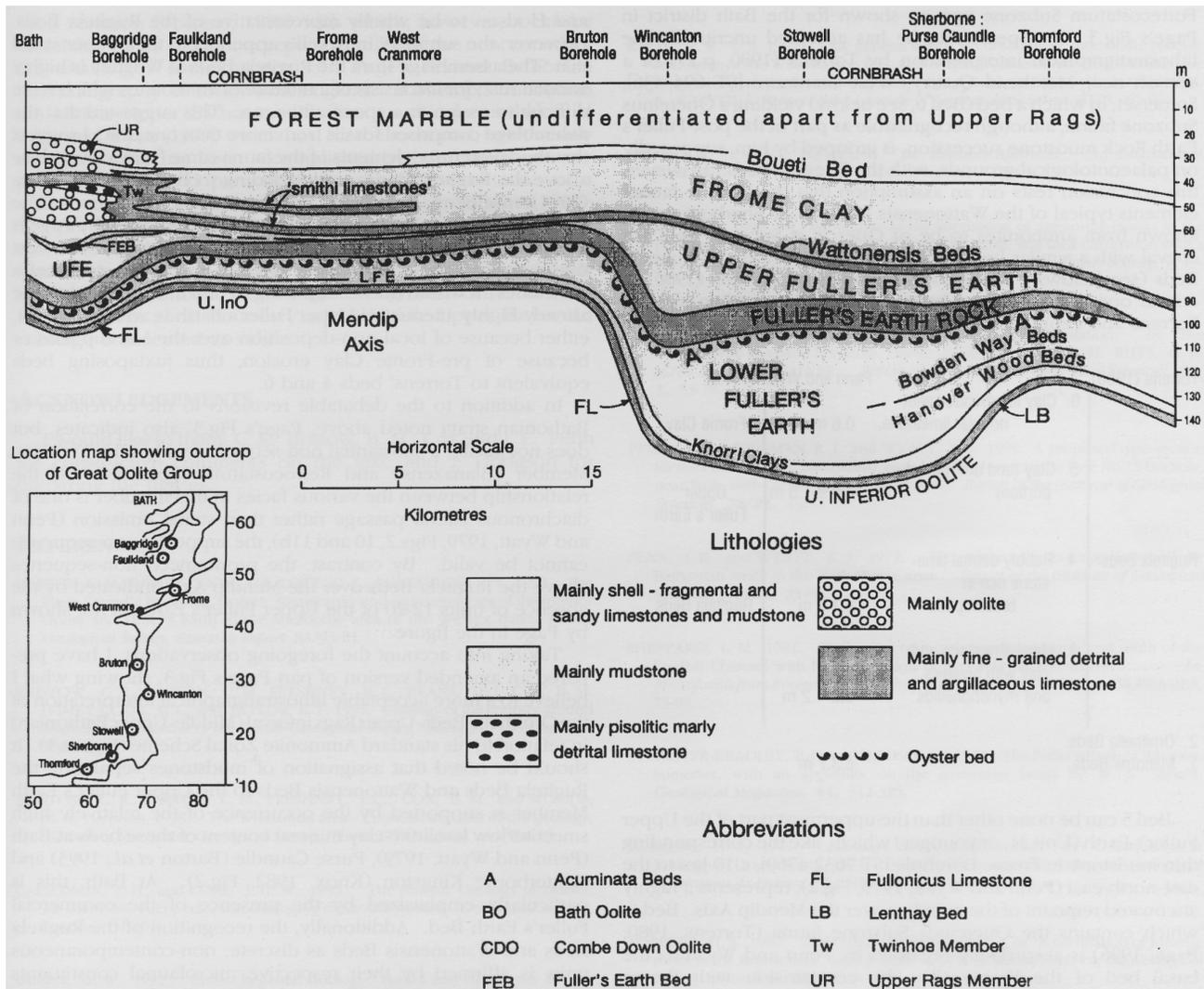


Figure 2. Diagrammatic section to show lithostratigraphy of the Bathonian succession between Bath and Sherborne, excluding Lower Cornbrash (modified from Green, 1992, Fig 30)

hopefully should improve correlation with this Standard Zonal Scheme. A significant feature of the new scheme is the correspondence of the Bremeri-Retrocostatum zone boundary with a major regressive unit boundary between the Frome Clay/Great Oolite formations and the Upper Fuller's Earth Member established by Penn (1982) and Wyatt (1996, Figs. 2 and 8, base regressive unit 3), which Page identifies as the Middle-Upper Bathonian substage boundary. This identity was presaged by Penn *et al.* (1979, Fig.1), who divided Torren's (1974) Retrocostatum Zone into lower and upper parts, which clearly correspond to the Bremeri and Retrocostatum zones respectively.

Page (1996) demonstrates the utility of his zonation by proposing a revised correlation of the Bathonian lithostratigraphy of the district, as shown in his Fig.3. Unfortunately, little or no explanation of the lithostratigraphical revisions in this figure is provided, particularly that of the status of the non-ammonitiferous units. Some of the revisions conflict with existing, well-established interpretations based on field observations and studies of cored borehole sequences, which have relied on a variety of stratigraphical indicators, including ammonites related to an externally derived standard zonation (Torrens, 1980). Such an holistic approach has been followed by Penn *et al.* (1979), Penn and Wyatt (1979), Penn (1982) and Whittaker (1985, Fig.9.1). Page's revisions to the Upper Bathonian Bremeri-Retrocostatum interval, which encompasses the Ornithella Beds-Upper Rags succession, are questionable.

Several assumptions made in Sections 6(b) and 7(a) of Page's paper are misleading. Firstly, in Section 6(b) (p.50, column 2, para.1) the ammonites from the Fuller's Earth Bed (Unit 20 of Penn and Wyatt, 1979) are, justifiably, assigned to the Fortecostatum Subzone. However, the suggestion that the Fuller's Earth Bed passes laterally into a level corresponding to the lower part of the Rugitela Beds (Unit 11b) is incorrect, since up to 15 m of the Upper Fuller's Earth (Units 12-19) separate the latter from the Fuller's Earth Bed at Bath, as shown by Page. The absence of these beds in the Frome area does not invalidate this conclusion. Page's suggested passage seems to be based on a misunderstanding of Figs. 7 and 15 in Penn and Wyatt (1979) which, from an analysis of the lithological and rhythmic units observed in borehole cores, actually show that successively higher beds of the Upper Fuller's Earth overlap southwards onto the Fuller's Earth Rock, such that at Frome only the uppermost 0.5 m of the member (Unit 21, or younger) is present, resting non-sequentially on the Rugitela Beds. There, bearing in mind the evidence of ammonites cited by Page, most of the Fortecostatum Subzone must be unrepresented (Units 12-20 at least being absent), probably because of erosion associated with positive movement on the Mendip Axis (Penn and Wyatt, 1979). Later in Section 6(b), it is claimed that, south of Bath, the upper part (implied) of the Rugitela Beds yields a fauna representative of the Quercinus Subzone. This seems unlikely, because the overlying Upper Fuller's Earth, including the Fuller's Earth Bed, is of older Fortecostatum Subzone age, as shown for the

Bath district in Page's Fig.3. It appears that he has accepted uncritically the lithostratigraphical interpretation by Torrens (1980, p.27) of a section near Merehead Quarry, West Cranmore [ST 694 436], Somerset, in which a bed (Bed 6, see below) yielding a Quercinus Subzone fauna, although recognisable as part of the post-Fuller's Earth Rock mudstone succession, is grouped by him, supposedly on palaeontological grounds, with the Rugitela Beds. However, this conclusion rests on an assumption that the benthic faunal elements typical of the Wattonensis Beds of the Sherborne area, known from ammonites to be of Quercinus Subzone age, are coeval with a similar benthic fauna associated with the Rugitela Beds (see below). The section recorded by Torrens (1980), a critical one, is reproduced below, classified according to both Torrens and Penn and Wyatt (1979).

Torrens (1980)	Penn and Wyatt (1979)	
6. Clay interbedded with nodular limestone.	0.6 m +	} Frome Clay
5. Clay (and unexposed portion)	c.0.9-1.5 m	
Rugitela Beds		} Upper Fuller's Earth
4. Rubbly detrital limestone rich in brachiopods	c.1.8 m	
		} Rugitela Beds
3. Marly limestone and clay with bivalves and rhynchonellids	0.9-1.2 m	
2. Ornithella Beds		
1. Milborne Beds	c.3.7 m	

Bed 5 can be none other than the uppermost part of the Upper Fuller's Earth (Unit 21, or younger) which, like the corresponding thin mudstone in Frome Borehole [ST 7632 4769], c.10 km to the east-north-east (Penn and Wyatt, 1979, Fig.2), represents a highly attenuated remnant of the member over the Mendip Axis. Bed 6, which contains the Quercinus Subzone fauna (Torrens, 1980; Page, 1996) is accordingly regarded by Penn and Wyatt as the basal bed of the Frome Clay, by comparison with Frome Borehole. It corresponds to the basal 'smithi limestone'- base of the Frome Clay between Bath and Frome, which passes into the base of the Great Oolite Formation at Bath; the latter rests on Unit 23 of the Upper Fuller's Earth (Penn and Wyatt, 1979, Fig.2) and is separated from the Rugitela Beds by 28 m of strata there. Thus, far from demonstrating the equivalence of the upper part of the Rugitela Beds with the Wattonensis Beds, the newly determined Quercinus Subzone fauna from Bed 6 at West Cranmore actually confirms the correlation presented by Penn and Wyatt (1979) and subsequent authors (Barton *et al.*, 1993, Fig.9; Bristow *et al.* 1995, Fig.25). Furthermore, Bristow *et al.* (in press) cite geophysical evidence to support this correlation. Thus, Page's assertion in para.4 that the Wattonensis Beds are the lateral equivalent of the Rugitela Beds (Fortecostatum Subzone) in North Somerset following Sylvester-Bradley and Hodson (1957) and Torrens (1980), cannot be substantiated, because the latter comprises only Beds 3 and 4 at West Cranmore, whereas the Wattonensis Beds are equivalent to Bed 6 (Quercinus Subzone). Although the benthic faunas of the Wattonensis and Rugitela Beds are comparable, they may be regarded as repetitions of a non age-diagnostic facies fauna.

Reference is made by Page (in section 7(a), p.51, column 1, para.2) to a varied ammonite fauna collected by Sylvester-Bradley and Hodson (1957) from spoil excavated from a cutting at Whatley [ST 735 475], near Frome, which includes *Procerites bodsoni* Arkell and *P. ex gr. quercinus* (Terquem and Jourdy), suggestive of the Quercinus Subzone. The fossils came from a 2.5 m-long, no-longer

visible section, assumed by Sylvester-Bradley and Hodson to be wholly representative of the Rugitela Beds. However, the summary in Arkell's appendix to their paper states that "The assemblage from the Rugitela Beds at Whatley is highly anomalous", for it consists of a mixture of ammonites which were difficult to assign to a specific horizon. This suggested that the assemblage comprised fossils from more than one unit. I suggest that the *quercinus'* elements of the fauna came from a level close above the Rugitela Beds, corresponding to Bed 6 (basal Frome Clay *sensu* Penn and Wyatt, 1979) at West Cranmore. The provenance of the "*Wagnericeras fortecostatum*" cited by Page is probably the Rugitela Beds *sensu stricto* (i.e. Beds 3 and 4 at West Cranmore). This interpretation offers a resolution of Arkell's difficulties. It would not be surprising to find that, at Whatley, the already highly attenuated Upper Fuller's Earth is actually absent, either because of local non-deposition over the Mendip Axis or because of pre-Frome Clay erosion, thus juxtaposing beds equivalent to Torrens' beds 4 and 6.

In addition to the debatable revisions to the correlation of Bathonian strata noted above, Page's Fig.3. also indicates, but does not justify, a substantial non-sequence within the Twinhoe Member (Blanazense and Retrocostatum subzones). If the relationship between the various facies in this member is one of diachronous lateral passage rather than stratal omission (Penn and Wyatt, 1979, Figs.2, 10 and 11b), the supposed non-sequence cannot be valid. By contrast, the pronounced non-sequence above the Rugitela Beds over the Mendip Axis, indicated by the absence of units 12-20 of the Upper Fuller's Earth, is not shown by Page in the figure.

Taking into account the foregoing observations, I have prepared an amended version of part Page's Fig.3, showing what I believe to a more acceptable lithostratigraphical interpretation of the Ornithella Beds-Upper Rags interval (Middle-Upper Bathonian) in relation to his standard Ammonite Zonal Scheme (Figure 1). It should be noted that assignation of mudstones separating the Rugitela Beds and Wattonensis Beds to the Upper Fuller's Earth Member is supported by the occurrence of the relatively high smectite/low kaolinite clay mineral content of these beds at Bath (Penn and Wyatt, 1979), Purse Caundle (Barton *et al.*, 1993) and Winterborne Kingston (Knox, 1982, Fig.2). At Bath, this is particularly emphasized by the presence of the commercial Fuller's Earth Bed. Additionally, the recognition of the Rugitela Beds and Wattonensis Beds as discrete, non-contemporaneous units is affirmed by their respective microfaunal constituents (Penn and Wyatt, 1979; Sheppard, 1981). The former note that the Rugitela Beds are characterised by a Faunule B2 foraminiferal assemblage, whilst the Wattonensis Beds yield a faunule C3 assemblage: and Sheppard indicates that the *confossa-polonica* ostracod zonal boundary lies within the Rugitela Beds, and that the base of the overlying *blakeana* Zone lies close above the base of the Wattonensis Beds, which is largely characterised by the *blakeana* assemblage. Although the microfaunas provide a less refined basis than ammonites for correlation, in the basinal succession south of Bath, where the lithological succession is relatively uniform and persistent, they may be considered reliable and useful, in contrast to the mainly facies-controlled microfaunas of the shelf facies (Wyatt, 1996, p.303). Figure 2 illustrates the stratigraphical relationships between Bath and Sherborne, which are confirmed by this analysis.

Contrary to Bristow *et al.* (1995), I place the base of the Middle Bathonian (=base of Progracillis Zone) in Figure 1 at the base of the Bowden Way Beds (Lower Fuller's Earth Member) in the Sherborne area, i.e. equivalent to the base of Unit 4 at Bath and Frome (Wyatt, 1996, Fig.8), which level is marked by an oyster shell bed north of Bath. This interpretation accords with Penn (1982, Fig.5).

SUMMARY

Unlike the bulk of the outcrop of Bathonian rocks in England, sufficient ammonites have been collected in south-west England to enable Callomon and Cope (1995) and Page (1996) to apply a Sub-Mediterranean Standard Zonation in place of the previously used

(Torrens, 1980) with which, however, it can be correlated. This account accepts the utility of the new zonation, but challenges some aspects of Page's revised Bathonian lithostratigraphy of south-west England. It attempts to confirm the Middle-Upper Bathonian lithostratigraphical correlation of Penn and Wyatt (1979) which has, for the most part, been widely accepted. This has been accomplished by reference to already published data and particularly by the re-interpretation of a critical section recorded at West Cranmore by Torrens (1980). The principal amendments have been the determination of the true status of the Rugitela Beds and confirmation of the equivalence of the Wattonensis Beds south of the Mendips to the lower 'smithi limestone' to the north. Page's designation of the Bremeri-Retrocostatum zonal boundary as the Middle-Upper Bathonian substage is accepted as valid.

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