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The Biostratigraphy of the Albian and Cenomanian succession in the Ventnor No. 2 Borehole, Isle of Wight

Internal Report IR/04/078

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Summary

This report describes the foraminifera found in the uppermost part of the Gault, Upper Greensand, Glauconitic Marl and West Melbury Marly Chalk of Ventnor No.2 Borehole (the "Carstone of the Isle of Wight" was barren of calcareous microfaunas). Albian foraminiferal zones followed those defined by CARTER & HART (1977), HART et al. (1989, 1990) and HART (2000). Cenomanian zones are those described by WILKINSON (2000). Albian foraminiferal zones 3 to5 were recognised in the Gault and foraminiferal zone 6 and questionable 6a were observed in the Upper Greensand Cenomanian foraminiferal zones BGS1 was present in the Glauconitic Marl and BGS2 and BGS3 were present in the West Melbury Chalk.

1 Introduction

The Ventnor no.2 Borehole was sited at N.G.R. 55666 77576 at an altitude of 101.36m above O.D. to the west of Ventnor, Isle of Wight (Figure 1). The cored borehole penetrated 17.17 m of Cenomanian chalk before entering the Albian-Aptian succession and terminated at a depth of 144.06m.

Lithostratigraphical unit	**Depth (m)**
West Melbury Chalk Formation	0.0-15.05m
Glauconitic Marl Member	15.05-17.17m
Upper Greensand Formation	17.17- 51.50m
'Passage Beds'	c. 42.43-51.50m
Gault Fornation	51.50-96.64m
"Carstone" Formation	96.64-100.84
Sandrock Formation (base not seen)	100.84-144.06m

Table 1. Stratigraphy of Ventnor no. 2 Borehole.

The Sandrock has not been examined for calcareous microfossils for this report, but faunas were recorded through the remainder of the borehole. Ostracoda were extremely rare throughout the borehole and biostratigraphical conclusions, were drawn predominantly from the Foraminiferida.

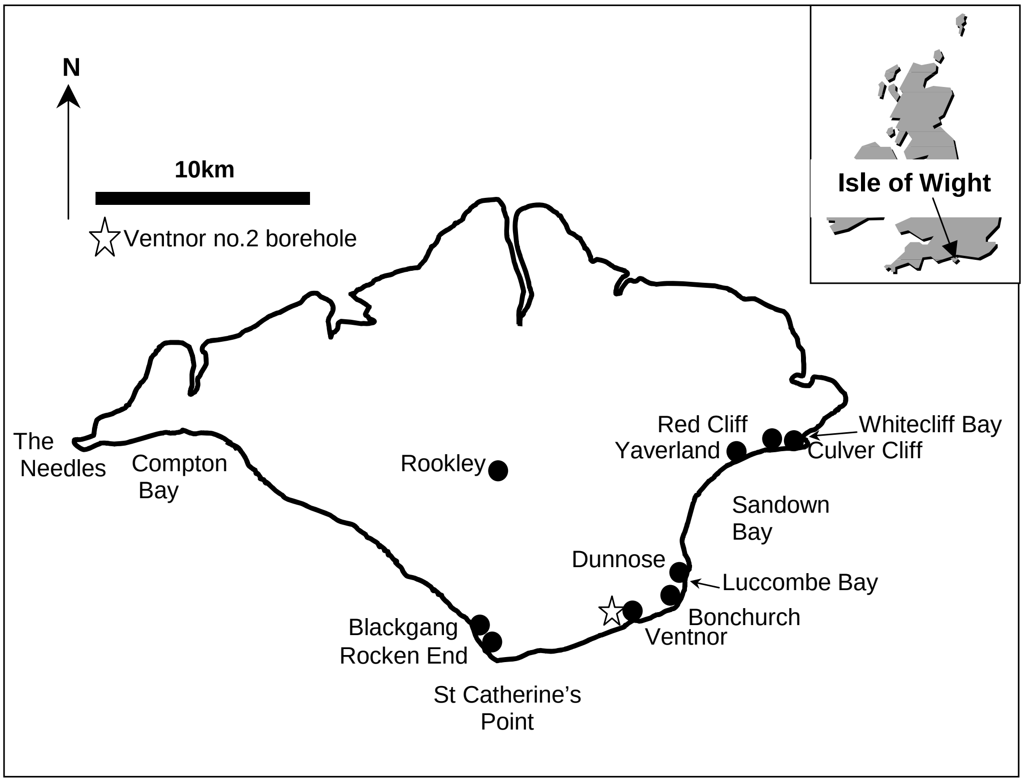


Figure 1. Sketch map of the Isle of Wight showing the localities mentioned in the text.

2 Stratigraphical framework

The Albian ('Carstone', Gault and Upper Greensand formations) and Cenomanian (West Melbury Marly Chalk Formation) successions crop out across the central part of the Isle of Wight from Compton Bay to Sandown Bay and in the Blackgang-Ventnor-Luccombe Bay area, where strata occur in badly slipped cliffs (Figure 1).

The 'Carstone' is a formation that, *sensu stricto*, is found no further south than East Anglia, yet the term has long been used for a similar unit in the Isle of Wight. The formation found in these two areas cannot be traced continuously across the intervening region and use of the same lithostratigraphical name for East Anglia and the Isle of Wight is unfortunate. A revision of nomenclature seems appropriate. The 'Carstone' of the Isle of Wight consists of ferruginous, medium to coarse-grained, often bioturbated sandstone, with occasional pebble beds. It varies considerably in thickness from 2 m at Compton Bay, 22 m at Red Cliff and 4.2 m in Ventnor no.2 Borehole. The lower boundary is placed at an erosion surface with pebble bed resting on fine-grained, sometimes cross-bedded sandstones of the Sandrock Formation. It becomes more finely grained up sequence and passes transitionally into the overlying Gault. In Ventnor no. 2 Borehole, the 'Carstone' comprises 2.64 m of dark green, silty, medium to coarse grained sandstone with occasional 'coal' chips, overlain by 1.56 m of dark grey, orange-brown mottled, fine- to medium-grained sandstone with layers and lenses of dark grey clay and pockets of coarse sand and gravel.

The Gault Formation comprises a sequence of medium and dark grey, often bioturbated silts and clays, up to 30 m thick. The lower boundary is transitional with the 'Carstone', and the boundary usually picked is at the top of the uppermost brown sandstone. The upper boundary is also transitional, the silty Gault passing up into the fine sands at the base of the Upper Greensand. The boundary has usually been placed at the base of the first brown silt or fine-grained sandstone. Minor variations in lithology have been recorded by GALE et al. (1996) where alternations of silt, fine sand and clay rich units occur in the east of the island, but a more arencaeous siltsone occurs throughout the succession in the west. INSOLE et al (1998) also add that lithological variations occur in the distribution of glauconitic and brown phosphatic seams.

The Upper Greensand, which attains a thickness of 45 m on the Isle of Wight, comprises glauconitic siltstones and fine-grained sandstones with thin bands of limestone and chert concretions. The transitional lower boundary has been described above, and the upper boundary is placed at an erosion surface where pale, weakly glauconitic siltsone (Upper Greensand) is overlain by dark green, glauconite-richcalcareous sands tone (Glaconitic Marl at the base of the Chalk Group.

The Upper Greensand was divided into six lithological divisions by JUKES-BROWNE & HILL (1900); the units are best regarded as facies, rather than formal subdivisons. They were also recognised by Osborne White (1921):

Facies A (or 'Passage Beds'): Bluish sandy clay or micaceous silt

Facies B: Rough Sandstones with irregular concretions

Facies C: Sandstones with Phosphatic nodules and courses of large calcareous doggers

Facies D: Firestones and Freestones

Facies E Chert Beds

Facies F: Sands with layers of calciferous concretions, often partly phosphatised

Subdivision was slightly modified by Insole et al (1998) who recognised three divisions:

'Passage Beds' (Facies A): an alternation of of grey and pale brown, micaceous sandy siltstones and fine-grained, argillaceous buff sands (the latter become thicker up sequence)

'Malm Rock' (equates with Facies B to D): grey or buff, glauconitic, fine-grained sands and sandstones with irregular bands of large calcareous concretions and small phosphatic nodules.

'Chert Beds' (Facies E and F) grey and buff, glauconitic siltstones and fine-grained sandstones with bands of grey, siliceoous and calcareous concretions.

The chert of the 'Chert Bed' appears to have been derived from solution of sponge spicules and radiolaria. The latter organisms were found frequently in the Upper Greensands of the Selbourne area (WOODS et al., 2001), but are absent in the Ventnor Borehole. INSOLE et al;. (2998) suggested that the chert nodules formed at an early stage of diagenesis and prior to compaction.

Only the lower part of the Chalk (the lower part of the Grey Chalk Subgroup) is considered here, that part penetrated by Ventnor no. 2 Borehole. The Cenomanian chalk of the Isle of Wight comprises the West Melbury Marly Chalk Formation, with, at its base, the Glauconitic Marl Member. The West Melbury Marly Chalk Formation comprises buff, grey and off-white, soft, marly chalk and hard grey limestone arranged in couplets. At its base, the Glauconitic Marl Member consists of bioturbated, glauconitic, calcareous sandstone and siltstone with phosphatic pebbles. The lower boundary is an erosion surface, frequently bored, at the base of the Glauconitic Marl Member. The upper boundary is placed at the erosional base of the overlying Cast Bed Member of the Zig Zag Chalk Formation. This mid-Cenomanian erosional break marks the change from well-defined limestone marl couplets below to chalks with marls above GALE

(1995). However, the Cast Bed and Zigzag Chalk were not recognised in Ventnor no. 2 Borehole. The Cenomanian succession in the Ventnor no. 2 Borehole (Figure 2) appears to correlate well with that at Compton Bay (Mortimore *et al*., 2001).

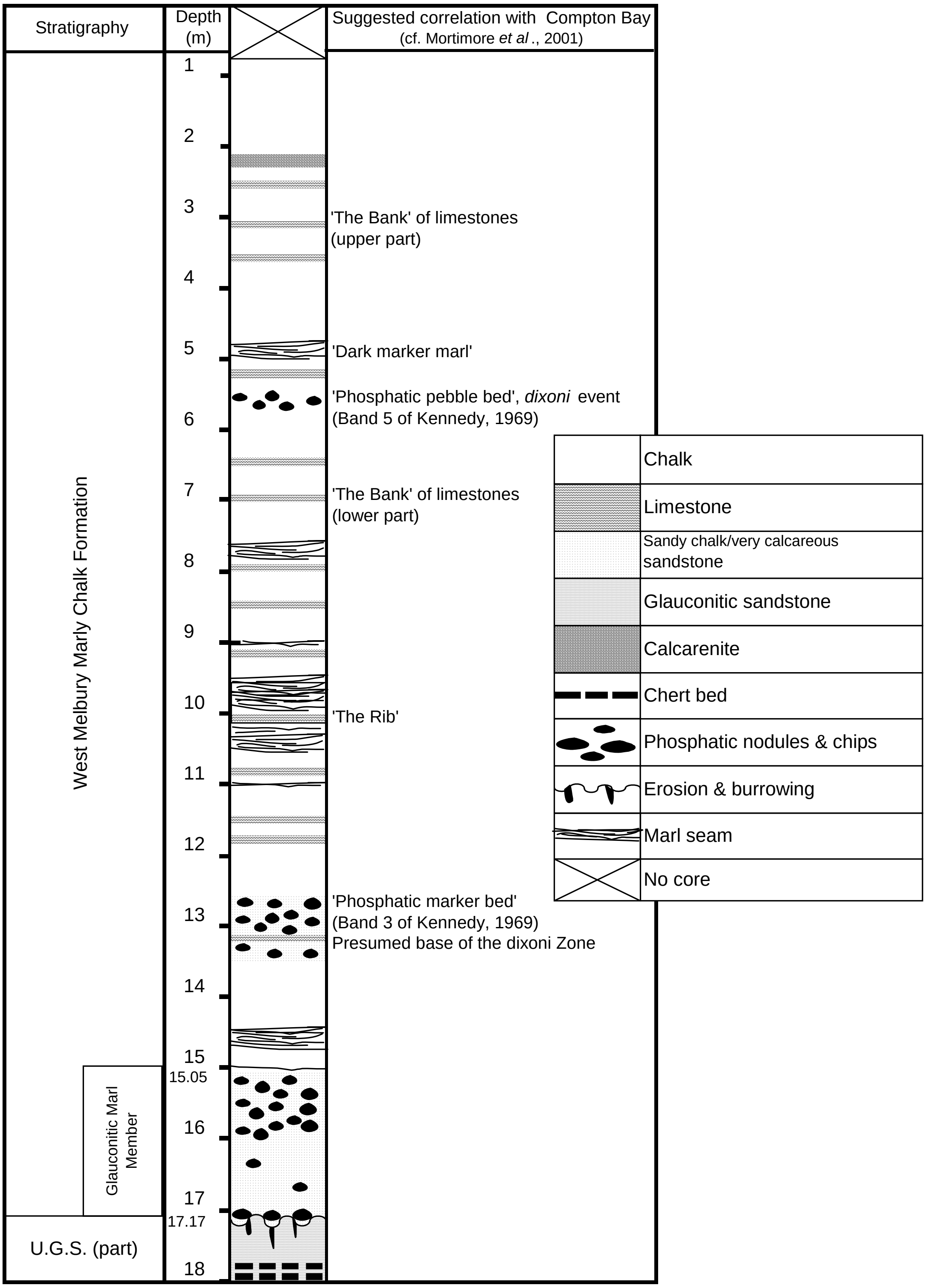


Figure 2. Stratigraphy of the Cenomanian Chalk in the Ventnor no. 2 Borehole and its suggested correlation with the Compton Bay Succession.

3 History of biostratigraphical research in the Isle of Wight

Despite the fact that microfossils such as foraminifera have been widely used as biostratigraphical tools to subdivide and correlate Albian and Cenomanian successions of mainland Britain(Price, 1977, Carter & Hart, 1977; Hart et al., 1989; Hart , 2000, 2003; and references), the mid Cretaceous succession of the Isle of Wight, has received little attention. Although few details were given, foraminifera from the Albian and Cenomanian of Compton Bay and Cenomanian of Culver Cliff and Rocken End were outlined by Carter & Hart (1977), who indicated that microfaunal dating was generally inconclusive . The Upper Greensand was shown to straddle the 5/6 foraminiferal zonal boundary and this facies was shown to continue up into the Cenomanian (foraminiferal zone 8 and basal zone 9). The Zone 9/10 boundary was placed at a phosphate bed, which marks a diachronous non-sequence.

The Dinoflagellate cysts of the Middle Cretaceous of the Isle of Wight are known principally from two, essentially systematic, studies. Clarke & Verdier (1967) described the mikroplankton assemblages from Cenomanian to Campanian outcrops, and principally from Compton Bay and Culver Cliff, and Duxbury (1983) described the Aptian and early Albian microfloras from the Lower Greensand in the coastal sections at Atherfield and Redcliff. Other microfossils, such as coccoliths, have not been studied in detail from the Isle of Wight.

4 Stratigraphical distribution of Foraminiferida in Ventnor no. 2 Borehole

The distribution of Foraminiferida and Ostracoda within Ventnor no. 2 Borehole is shown in figures 3, 4 and 5.

4.1 ALBIAN

4.1.1 Sandrock

The upper boundary of the Sandrock is placed at a pebble bed and erosion surface at 100.84m depth. The single sample examined for calcareous microfaunas, from 101.5m, proved to be barren.

4.1.2 "Carstone"

The 2.64m of dark green, silty, medium to coarse grained sandstone and overlain by 1.56m of dark grey, orange-brown mottled, fine- to medium-grained sandstone were examined for calcareous microfaunas. All samples proved to be barren of Foraminiferida and Ostracoda.

4.1.3 Gault

Medium to dark grey, micaceous silts and clays of the Gault formation extend from 96.64m through to 51.50m. Both boundaries are difficult to place in the borehole. The "Carstone"/Gault contact is gradational from fine sandstone to micaceous siltstone. The upper boundary passes up from micaceous siltstone to slightly sandy, micaceous siltstone of the "Passage Beds". The distribution of foraminifera is shown in Figure 3.

Foraminifera are not common in the lower part of the Gault and entirely agglutinated forms. *Tritaxia singularis*, *Cribrostomoides nonionoides angulata* and *Haplophragmoides chapmani* dominate the faunas. These long ranging forms have their origins in the early Albian and extend through much of the stage. Species characteristic of the lower Albian and the earliest part of the Mid Albian (*dentatus* Zone), as described by PRICE (1977 a, b) and MAGNIEZ-JANNIN (1975) were not encountered, although the rare specimens of *Saccammina* sp might be synonymous with *Saccammina* sp.1 of Price. *Haplophragmoides chapmani* is, however, rare in the lower Albian of Europe (PRICE, 1977 a) and was not recorded from the UK until the *Lyelli* Subzone (*dentatus* Zone) Its first up-section occurrence in the basal Gault of Ventnor no. 2 Borehole is interpreted as being indicative of the basal dentatus zone and equivalent to foraminiferal zone 3 of CARTER & HART (1977). *Arenobulimina macfadyeni* is a good marker for the Middle Albian where it is generally frequently found, but it extends into the *cristata*

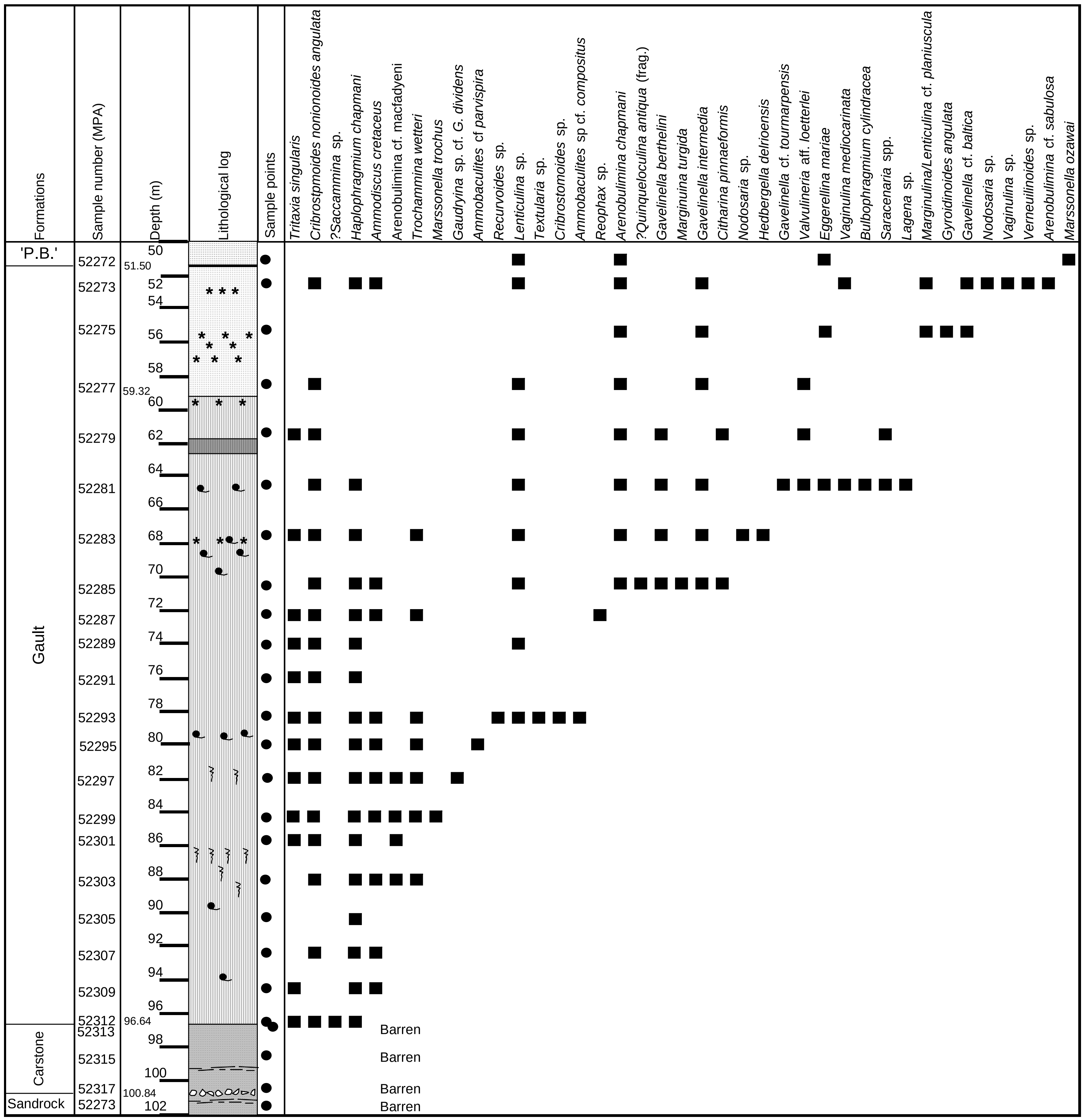
Subzone (basal Upper Albian). The species has a very patchy distribution between 88.0m and 82.0m and is probably indicative of the foraminiferal zones 3 or 4 of CARTER & HART (1977) and PRICE (1977 a, b), although species of *Hoeglundina*, which is characteristic of these zones elsewhere, were not present.

Foraminifera with a calcareous, rather than an agglutinated, test appeared at 78.15m with *Lenticulina rotula*, a species that is consistently present throughout the remainder of the Albian. This is a long ranging taxon with no biostratigraphical importance. However, it does appera to indicat a switch in lithological or palaeoenvironmental conditios such that, for the first time, hyaline species survive.

A more characteristic fauna appears for the first time at 70.6m This include *Arenobulimina chapmani, Gavelinella intermedia, Gavelinella berthelini* and *Citharina pinnaeformis*. The last named was used by CARTER & HART (1977) as the zonal indicator for 4a and 5, species of *Hoeglundina* (absent in the present borehole, unlike the Selborne boreholes described by WOODS et al., 2001) separating the former from the latter zone. PRICE (1977 a) indicated that the species becomes extinct at the top of the *varicosum* subzone (*inflatum* Zone) and HART et al., 1990 and Hart (2000) indicates its extinction at the top of Bed XI (*auritus* Subzone). In the Ventnor No.2 Borehole the species is not common, but was recorded at 70.6 and 61.65m, the highest record being immediately below the silt between the depths 59.32 and 51.50m. This is very similar to the situation at Copt Point, Kent, where the last specimens of *Citharina pinnaeformis* are immediately underneath the silty Gault Bed XII.

The first appearance of *Eggerelina mariae* at 64.65m is also stratigraphically useful in that it is known to evolve in the upper part of foraminiferal zone 5 or close to the zone 5/5a boundary (of range given by CARTER & HART, 1977, differs slightly from that given by PRICE, 1977 a). Carter & Hart's range seems more appropriate because they show a concurrent zone with *Citharina pinnaeformis* (PRICE, 1977 a) shows them to be mutually exclusive) as is the case at Ventnor No.2 Borehole. A number of species appeared at the same time as *Eggerelina mariae*.

Other species that appear for the first time at 64.5m include *Valvulineria aff loetterlei*, *Vaginulina mediocarinata* and *Bulbophragmium cylindracea*. *Valvulina* aff. *loetterlei* (*sensu* JANNIN, 1967) first appeared in the lowest *inflatum* Zone (*cristatus* Subzone), disappeared from the record within the same Zone, although the scarcity in the latest part of its range means the exact extinction level is not fully understood and varies considerably locally. In Ventnor No.2 Borehole, *Valvulina* aff *loetterlei* ranges from a depth of 64.65 to 58.65m, but is not seen in the highest Gault. *Vaginulina mediocarinata* first appeared in Europe in the *loricatus* Zone according to PRICE (1977 a), and HART et al. (1989) shows its early distribution in the uppermost



'P.B.' 'Passage Beds' (part.)

Figure 3. The distribution of foraminifera through the Gault of Ventnor no. 2 Borehole.

dentatus and *lautus* zones to be patchy. However, in southern England it is consistently present in zone 4a of CARTER & HART (1977) (*cristata* macrofaunal Subzone) and through to the top of the Gault. Clearly is not represented in the lower part of its range in the Ventnor No.2 Borehole. *Bulbophragmium cylindracea* (or possibly *Cribratina cylindracea*, the generic assignment is unclear) first appeared in the varicosum Subzone (*inflatum* Zone) and ranges through into the Cenomanian. Its presence here is thus useful biostratigraphically.

The upper part of the Gault in Ventnor No.2 Borehole is a siltstone. The lowest sample examined contained only long ranging taxa, but *Gyroidinoides angulata* appeared at 55.1m depth. Originally placed in *Valvulineria*, this species shows an intermediate position with *Gyroidinoides praestans*, and its overall morphology is closer to that species than *Valvulina* aff *loetterlei* from which it apparently evolved in the upper part of the *inflatum* Zone. *Gyroidinoides angulata* is confined to the upper part of the inflatum Zone judging from the information given by JANNIN (1967) and MAGNIEZ-JANNIN (1975), although zonal data are not abundant.

Diminutive specimens of *Arenobulimina* cf *sabulosa* appeared at 52.55m, in the highest sample of Gault examined. This species has its inception in the *dispar* Zone (i.e. at the base of Gault Bed XII according to Hart et al., 1989) and at the base of foraminiferal zone 6l (HART et al., 1990; HART 2000). PRICE (1977 a, b), however, places its inception at the base of the *auritus* Subzone, at the base of his foraminiferal zone 7(i). The problem arises with the interpretation of the macrofaunal subzonal scheme across the inflatum/dispar zonal boundary, for that of OWEN (1975) and subsequently followed by a number of authors, is incorrect as reworking was not recognised (MORTER & WOOD, 1983; BRISTOW et al., 1995). The rare specimens of *Arenobulimina sabulosa* recovered from the highest Gault, therefore, indicate a dispar Zone, *rostratum* subzonal age and a stratigraphical position equivalent to Gault Bed XII.

4.1.4 Upper Greensand

Despite the fact that the distribution of Foraminifera through the Gault of southern England has been studied in detail, faunas from the Upper Greensand are not well known, the most detailed analysis being that on the BGS Selborne boreholes (Woods et al., 2001). Figure 4 details the distraibution of fanas throughout the Upper Greensand of the Ventnor no. 2 borehole.

4.1.4.1 FACIES A ("PASSAGE BEDS")

The position of the Gault/Upper Greensand "Passage Beds" boundary in the borehole is difficult to place as it is transitional in nature. The lithological log shows the top of the "Passage Beds" between 51.50 and 43.96m. OSBORNE WHITE (1921) described the unit "sandy clays and marls". INSOLE et al. (1998) placed the Gault/Upper Greensand boundary "at the first buff silt or fine-grained sand", and describe the "Passage Beds" as "alternations of grey and buff silts and micaceous sandy muds and fine grained muddy sands". JUKES BROWNE & HILL (1900) and OSBORNE WHITE (1921) subdivided the Upper Greensand as shown in Table 1.

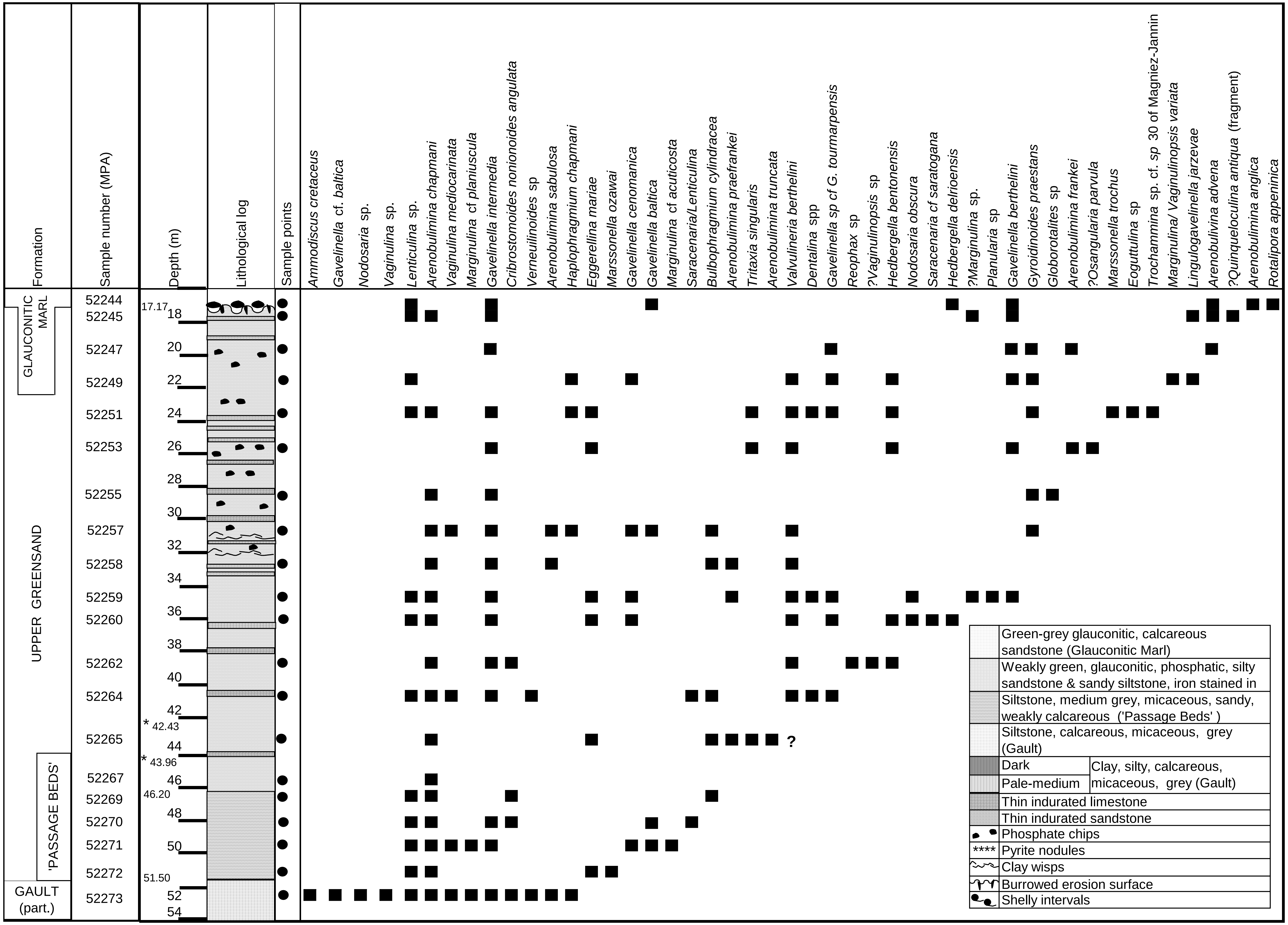
The Gault passes up via a transitional contact into "Passage Beds" which comprise, in Ventnor no. 2 Borehole, medium grey, micaceous, sandy siltstone in the lower part. Foraminifera are generally less diverse than in the Gault and in general they are long-ranging. *Marssonella ozawai*, which was recovered from the basal "Passage Beds", at a depth of 51.05m, is characteristic of the *dispar* Zone, its inception being in Beds XII of Copt Point Gault succession (HART et al., 1990; HART, 2000), and it ranges into the Cenomanian. At 49.4m *Gavelinella cenomanica* was recorded for the first time. It is rare and rather patchily distributed throughout the more arenaceous Upper Greensand of the Ventnor Borehole. This species is rare in the *varicosum* Zone of Europe, but becomes more frequent and consistently present in the Gault of the auritus Subzone and above (PRICE, 1977 a, b). HART et al. (1989, 1990) however, show that in south-eastern England *Gavelinella cenomanica* first appears in foraminiferal Zone 6, within the *dispar* macrofaunal zone, and HART (2000) use its first occurrence to mark the base of Subzone 6m. The species becomes more numerous above 36.05m (where it accompanies *Hedbergella bentonensis*), possibly indicating subzone 6m at that level (see below).

4.1.4.2 FACIES B-F

Above Facies A (JUKES BROWNE & HILL, 1900; OSBORNE WHITE, 1921), five further facies were recognised at Undercliff and Gore Cliff. These appear to be represented in the Ventnor no.2 Borehole and preliminary examination suggests the subdivision shown in Table 1.

Facies	Description (Jukes-Browne & Hill, 1900; Osborne White, 1921)	Ventnor no. 2 Borehole	
		Top	Base
F	Sands with layers of calciferous concretions, often partly phosphatised	17.17	17.90
E	Chert Beds	17.90	23.97
D	Firestones & freestones	23.97	27.73(?)
C	Sandstones with phosphatic nodules & courses of large calcareous doggers	27.73(?)	33.25
B	Rough Sandstone with irregular concretions	33.25	43.96
A	Grey sandy clay and micaceous silt ('Passage Beds')	43.96	51.50

Table 2. Preliminary subdivision of the Upper Greensand in Ventnor no. 2 Borehole, based on definitions by Jukes-Browne & Hill (1900) and Osborne White (1921).



sition of the top of the 'Passage Beds' (Facies A of Jukes-Browne, 1900) according to soil mechanics log. The top is here
base of the siliceous limestone situated at 43.78-43.96m (seeJukes-Browne, 1900; White, 1921, p. 50).

Figure 4. The distribution of foraminifera through the Upper Greensand of Ventnor no. 2 Borehole.

At 43.2 m, *Arenobulimina praefrankei*, *Tritaxia singularis* and *Valvulineria berthelini* appear for the first time in the borehole, although all are long ranging. *Arenobulimina praefrankei*, for example, first appears in the auritus subzone and extends up to the top of the Albian (and into the Cenomanian according to some authors, as discussed by FRIEG & PRICE, 1982). *Valvulineria berthelini* evolved from *V*. aff *loetterlei* within the upper part of the *inflatum* Zone (?*varicosum* Subzone) and then ranges through to the top of the Albian (MAGNIEZ-JANNIN, 1975).

The biostratigraphy of the lower part of the Upper Greensand (and "Passage Beds") is difficult to determine due to the dominance of long ranging taxa. However, at 38.85 the first specimens of planktonic foraminifera were found. They comprised entirely of *Hedbergella bentonensis*, a species that is particularly characteristic of foraminiferal Zone 6 and which, in the Gault facies, may occur in flood proportions (particularly in 6m) (HART et al., 1990; HART, 2000). Although not forming a flood occurrence in the greensand facies as it does in the Gault, their sudden appearance is taken to reflect the zone 6 incursion in the arenaceous facies. Further north in the Selbourne boreholes, Wilkinson (in WOODS et al., 2001) noted the absence of planktonic foraminifera in the Upper Greensand, although those boreholes yielded common radiolaria which were not encountered in the Ventnor No.2 Borehole. *Gyroidinoides praestans* entered the record at 30.9m, although it first appeared in France in the *inflatum* ZONE (MAGNIEZ-JANNIN, 1967, 1975).

In the upper part of the Upper Greensand, *Arenobulimina frankei* makes its first appearance at a depth of 21.55m in the Ventnor No. 2 Borehole. This species has been misunderstood in the past, but FREIG & PRICE (1982) clarified the taxonomic position of the species. It apparently evolved from Arenobulimina praefrankei in the in the late dispar zone and HART et al (1990) and HART (2000) show it to be a good marker for foraminiferal Subzone 6u. It is often accompanied by *Lingulogavelinella jarzevae*, a species that was present between from 21.55m and 17.70m depth, a little below a bored and bioturbated surface at 17.17 m. The species is known from foraminiferal zone '6 (middle)' of HART *et al*. (1990), but more consistently present from the upper part of '6 (upper)' and through to their Foraminiferal Zone 9 (=UKB3 of HART *et al.*, 1989; BGS2 of WILKINSON 2000). Its first uphole appearance is a useful proxy for the upper part of the *dispar* macrofaunal zone.

The presence of *Arenobulimina chapmani* in the sample from 17.70m proves the biostratigraphical age is no younger than foraminiferal zone '6 (upper)'. According to HART *et al.* (1989, 1990) it is not present in zone '6a', however, PRICE (1977 a, b) showed that it is also present in the lowest part of 6a, which he places into foraminiferal Subzone '9(i)'. HART *et al*. (1989, 1990) place it no younger than the "*substuderi"* macrofaunal Subzone (*dispar* Zone) and PRICE (1977 a, b) extends it to that part of the Upper Albian that lack macrofaunal subzonal indicators.

MPA52245, from a depth of 17.70m also contained the first specimens of *Arenobulimina advena*. This is essentially a Cenomanian species, but HART *et al.* (1989, 1990) show that its first occurrence is within their zone 6a and PRICE (1977 a, b) shows it is a characteristic element of foraminiferal subzones 9(ii) and 9(iii). Foraminifera zone 6a falls within that part of the highest *dispar* Zone of Gault Bed XIII, that lacks macrofaunal subzonal indicators. The results of these authors is therefore more or less consistent. However, they show that *Arenobulimina chapmani* and *Arenobulimina advena* are mutually exclusive. The presence of both in the present sample may be the result of bioturbation and burrowing.

4.2 CENOMANIAN

The distribution of foraminifera in the Cenomanian of the Isle of Wight is poorly known compared to the higher chalks and depends primarily on the discussion of Carter & Hart (1977). The distribution in the Ventnor borehole is shown in Figure 5.

4.2.1 West Melbury Chalk Formation: Glauconitic Marl Member

The foraminiferal faunas from the base of the Glauconitic Marl Member (at the base of the West Melbury Marly Chalk Formation) lack many of the characteristic species associated with Upper Cretaceous foraminiferal Zone BGS1. *Arenobulimina anglica* is present in the sample from 17.1 m (MPA52244) indicating the Cenomanian. *Rotalipora appeninica*, the first keeled planktonic species to enter the British area was also recorded. The latter species appears later in the British succession compared to the Tethyan province, and although it is known to occur in the Cenomanian of south east England, for which it is useful local marker, there is a possibility that it first appeared in the UK during latest Albian, as there is an unconfirmed occurrence in the upper part of Bed XIII of the Gault in Kent (HART et al., 1989). The fauna at 16.6m is essentially similar to that at 17.1 m, and although diversity is increased at this depth, the additional taxa are generally long ranging Late Albian to Cenomanian taxa.

4.2.2 West Melbury Chalk Formation: "Chalk Marl Member"

The first specimens of *Pseudotextulariella cretosa* was encountered in the sample from 15.3m (MPA52242). This species is characteristic of foraminiferal Zone BGS2. The top of the zone can be placed at a depth of 7.0 m (MPA52231) where the last *Marssonella ozawai* was recorded. The Base of BGS2 is placed by HART *et al.* (1989) at approximately the base of the *M. saxbii* macrofaunal zone, although this should be lowered into the top of the *carcitanense*

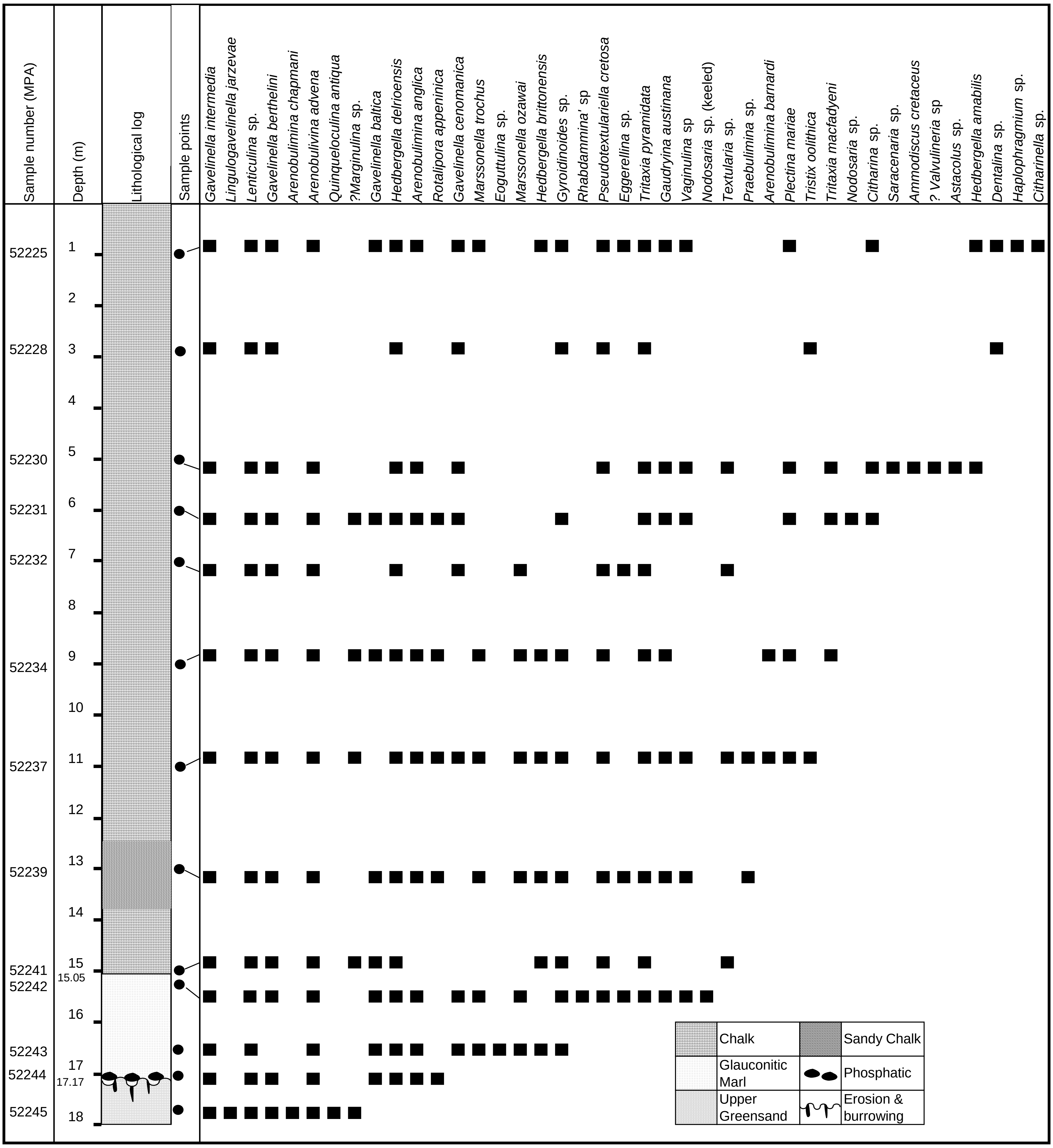


Figure 5. The distribution of foraminifera through the Chalk Marl and West Melbury Chalk in the Ventnor no. 2 Borehole.

Subzone. CARTER & HART (1977) placed their foraminiferal zone 8/9 boundary in the upper part of their "Upper Greensand with Stone Bands" at Compton Bay and Culver Cliff (Isle of Wight). They place the boundary at an erosion surface in the former locality and at a stone band at the latter. The log of the Ventnor No.2 Borehole does not show erosion or stone horizons in the upper part of the Glauconitic Marl, so the base of BGS2 may be at the marl seam at 15.40 m or associated with the 15.5-15.95 m interval which contains phosphatic chips

CARTER & HART'S (1977) zone 9/10 zonal boundary is above an interval with abundant sponges and immediately below a bed of phosphatic nodules at Compton Bay and Culver Cliff (Isle of Wight) and at the top of the "Popple Bed" in Wiltshire. In Ventnor No.2 Borehole, phosphatic nodules occur at about 5.6m depth and sponges are logged between 4.75m through to the top of the core. This is difficult to interpret because Foraminiferal Zone BGS2 (i.e. CARTER & HART'S zone 9) cannot be recognised above 7m depth.

The top of the borehole is difficult to date biostratigraphically. The base of Foraminiferal zone BGS3, which is defined by the extinction of *Marssonella ozawai*, is placed between 6.0 and 7.0 m (between the samples MPA 52231 and 52232). A convenient lithological marker for the BGS2/3 boundary, would be the limestone at a depth 6.40m. The inception of *Flourensina mariae* and *Plectina cenomana* defines the base of foraminiferal zone BGS4, but these taxa were not encountered in Ventnor No.2 Borehole. The stratigraphically highest specimens of *Rotalipora appeninica* was found at 6 m depth (MPA52231). This species is rare throughout much of its range, thus reducing their usefulness somewhat, but its presence indicates an age no younger than foraminiferal Subzone BGS4ii. The presence of *Arenobulimina anglica* through to the top sample (MPA52225) at 1.0m depth, also proves an age no younger than the top of foraminiferal subzone BGS4ii. Although based on the absence of diagnostic species rather than their presence, it is suggested that the upper 6 m to 7 m is within foraminiferal Zone BGS3.

Comparison with other Isle of Wight successions shown in Table 1 indicates consistency with the interpretations for the Culver Cliff and Compton Bay successions given by CARTER & HART (1977).

Foraminiferal zones			Thicknesses (m) in the Isle of Wight		
Wilkinson (2000)	Hart et al. (1989)	Carter & Hart (1977)	Compton Bay	Culver Cliff	Ventnor No.2 Borehole
BGS3	UKB4	10	c. 10.4 m	c.8.8 m	6.40+ m (top not seen)
BGS2	UKB3	9	c. 5.75 m	c.7.0 m	c. 9.0 m
BGS1	UKB2	8	c. 1.5 m	c. 1.7 m	c. 1.77 m

Table 3. Comparison of the thickness of foraminiferal zones in three localities in the Isle of Wight (data for Compton Bay and Culver Cliff from Carter & Hart, 1977).

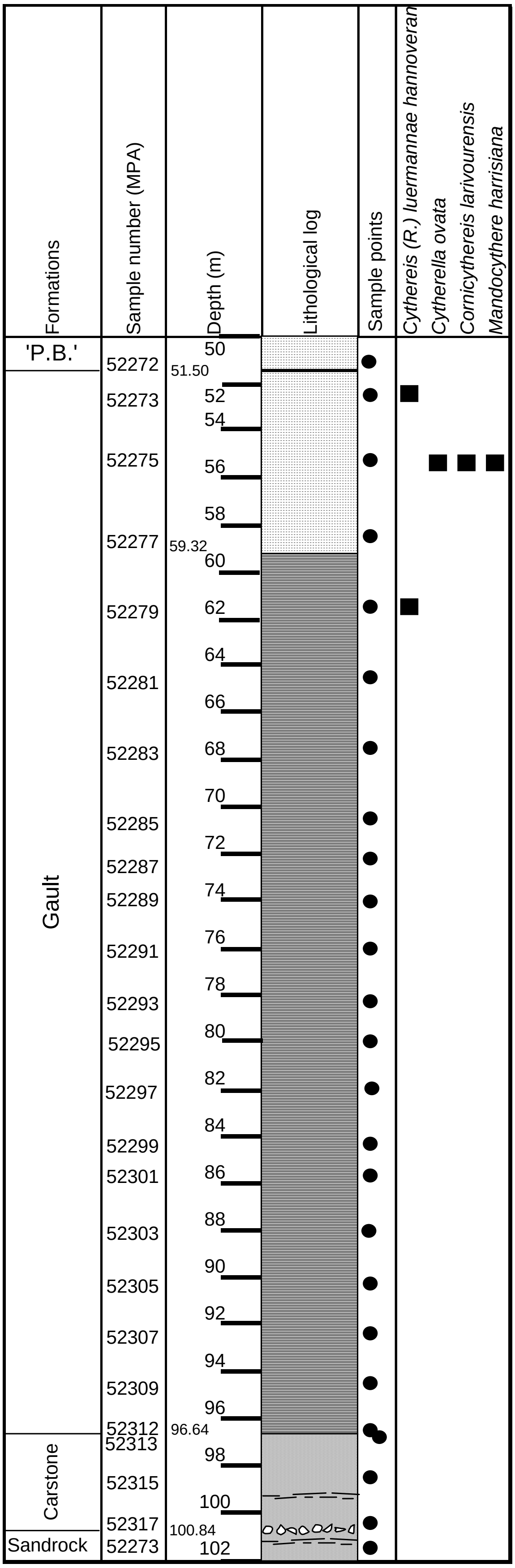
5 Stratigraphical distribution of Ostracoda in the Ventnor no. 2 Borehole

Ostracoda are very rare in the Middle Cretaceous of the Ventnor no. 2 Borehole (Figure 5) and comprise predominantly of long-ranging species. Although the Upper part of the Gault and the Upper Greensand part of the succession yielded small numbers, only a single specimen was found in the Cenomanian Chalk.

The lower part of the Gault Formation of the Ventnor no. 2 Borehole is devoid of calacreous microfaunas, although rare, agglutinated foraminifera are present. Ostracods appear at 61.65 m, with the first occurrence of *Cythereis* (*Rehacythereis*) *luermannae hannoverana*. This species is found in the Gault of mainland England as well as Germany where it appears in the upper part of the *varicosum* Zone and ranges through into the Cenomanian. It is accompanied by *Cytherella ovata*, which ranges through from the Aptian into the late Cretaceous; *Mandocythere harrisiana*, a species that is very common throughout the Mid and Late Albian and also extends through into the late cretatceous; and *Cornicythereis larivourensis*, which ranges through the Late Albian and into the Late Cretaceous. These long-ranging taxa are, therefore of little use in detailed biostratatigraphical subdivision of the Gault, although it is clear from the presence of *C.*(*R.*) *luermannae hannoverana* (an ostracod zonal idex of WILKINSON & MORTER, 1981; WILKINSON 1988, 1990), that the upper part of the Gault is no older than *varicosum* Subzonal age.

The 'Passage Beds', at the base of the Upper Greensand Formation, yielded similar faunas to the upper Gault, although Schuleridea jonesiana, a mid Albian-Cenomanian species is also present. The remainder of the Upper Greensand contains rare, scattered specimens including *Cytherelloides stricta* (*cristata* Subzone through to the Cenomanian); *Bairdia pseudoseptentrionalis* (Albian-Cenomanian) and *Cythereis paranuda* (?highest *rostratum* and *perinflatum* subzones of the *dispar* Zone and through to the Cenomanian). The zonal age of the Upper Greensand is, therefore, poorly constrained using ostracods, but the fauna from 34.75 m is unlikely to be older than the *perinflatum* Zone (WILKINSON, 1988), so that the assumed *dispar* zonal age for this unit is, in part, confirmed.

It is not possible to draw any conclusions regarding the zonal age of the Cenomanian Chalk based on ostracods. Only a single, poorly preserved, specimen of *Neocythere* cf *vanveenae* was found (at 2.9 m depth).



'P.B.' 'Passage Beds' (part.)

Figure 6. The distribution of Ostracoda through the Albian succession in the Ventnor no. 2 Borehole.

6 Conclusions

Much of the Albian succession of the Ventnor no.2 Borehole was subdivided into the foraminiferal zones recognised in the Gault of southern England and elsewhere in Europe.

1. The Carstone was barren of foraminifera and no biostratigraphical conclusions are possible.

2. The lower part of the Gault yielded only long-ranging taxa but the appearance of consistently occurring *Haplophragmium chapmani* suggests base of the Mid Albian and foraminiferal zone 3 (of CARTER & HART, 1977; PRICE, 1977 a). The presence of *Arenobulimina* cf. *macfadyeni* between 88.0 and 82m confirms foraminiferal zone 3 or 4. However, the absence of species of *Hoeglundina* precludes further subdivision of the lower part of the Gault.

3. The first evidence of Foraminiferal zone 5 was at a depth of 70.6m, with the inception of *Citharina pinnaeformis*. The top of the zone is placed at 61.65 m. In south eastern England, the top of Zone 5 equates with the top of Gault Bed XII.

4. The silty part of the Gault above 59.32m is tentatively equated, at least in part, with Bed XII of Kent. This is based on the last appearance of *Citharina pinnaeformis* (foraminiferal zone 5) and the first appearance of *Arenobulimina sabulosa* (foraminiferal zone 6) towards the top of the unit, at a depth of 52.55m. There is some confusion in the micropalaeontological literature whether Bed XII is of auritus or *rostratum* subzonal age, but this report follows MORTER & WOOD (1983) and BRISTOW et al., (1995) in placing Bed XII in the base of the dispar Zone.

5. 'The Passage Beds' fall within Foraminiferal Zone 6l. The remainder of the Upper Greensand is placed in Foraminiferal Subzone 6m, which appears to have its base at about 40m and Subzone 6u, which was recognised at 25.75m with the appearance of *Arenobulimina frankei* and *Lingulogavelinella jarzevae*. Foraminiferal Zone 6a appears to be represented at 19.7m with the appearance of Arenobulimina advena, although there is a possibility that bioturbation and burrowing is the cause for the apparent presence of zone 6a

6. A BGS 1 assemblage, including *Arenobulimina anglica* and *Rotalifera appeninica* was found in the lower part of the Glauconitic Marl (17.1-15.40m depth). The facies controlled foraminiferal subzone BGS 1i, which equates with UKB1 of HART et al. (1989), was not recognised

7. BGS 2 faunas, including *Pseudotextulariella cretosa*, were encountered between 15.3 and 7m depth. The top of the zone was recognised by the last record of *Marssonella ozawai*.

8. The remainder of the borehole could assigned to foraminiferal zone BGS 3.

9. Ostracoda are too rare and patchily distributed to be of biostratigraphical significance in the present succession. However, *C.*(*R.*) *luermannae hannoverana* implies the presence of the eponymous ostracod Zone, suggesting that the upper part of the Gault is no older than *varicosum* Subzonal age, and the presence of *Cythereis paranuda* suggests the Upper Greensand at 34.75 m is unlikely to be older than the *perinflatum* Zone.

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