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Geology of the Cranborne Chase district (Dorset)

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Preface

This account describes the geology depicted on 1:10 000 sheets ST90NE (Witchampton), ST91SE (Chettle), ST91NE (Sixpenny Handley), SU00NW (Horton), SU01SW (Wimborne St Giles) and SU01NW (Pentridge), which form part of the 1:50 000 scale Ringwood (314) Geological Sheet. The original geological survey on the one-inch scale was by H W Bristow and J Trimmer and published on Old Series Sheet 15 in 1856. The district was geologically surveyed on the 1:10 560 scale by F J Bennett 1896–1899, E E L Dixon 1899–1890 and C Reid in 1894 and 1899. The 1:63 360 scale Ringwood Sheet 314 was first published with drift in 1902 and reprinted in 1948. The sheet was reconstituted from the one-inch scale without geological revision and reprinted on to a 1:50 000 scale base in 1976 and reprinted in 1990.

The 1:10 000 scale revision survey was carried out by C R Bristow in 1997 and 1998.

Cretaceous macrofossils have been identified by M A Woods, Cretaceous micropalaeontology by I P Wilkinson and Palaeogene palynolog by J A Riding.

Contents

Preface ..... **i**

Contents ..... **i**

1 Introduction **1**
1.1 Geographical setting 1
1.2 Previous work 1
1.3 Geological sequence 3

2 Cretaceous **6**
2.1 New Pit Chalk Formation 6
2.2 Lewes Nodular Chalk Formation 6
2.3 Seaford Chalk Formation 6
2.4 Newhaven Chalk Formation 9
2.5 Culver Formation 9
2.6 Portsdown Chalk Formation 11

3 Palaeogene **24**
3.1 Reading Formation 24
3.2 London Clay Formation 25
3.3 Poole Formation 34
Broadstone Clay 36

4 DRIFT **38**
4.1 Clay-with-flints 38
4.2 Older Head 39
4.3 Head 39
4.4 River Terrace Deposits 39

4.5 Peat....40
4.6 Alluvium....40
4.7 Landslip....40
4.8 Swallow holes....40
4.9 Made Ground....41

Acknowledgements....41

References....41

FIGURES

Figure 1 Topographical map of the Cranborne Chase area.

Figure 2 Geological map of the Cranborne Chase area.

Figure 3 Gamma-ray and sonic log of the Cranborne Borehole.

Figure 4 Lithological markers in the Seaford Chalk of the Cranborne Chase area.

Figure 5 Section in the Newhaven Chalk, near Sixpenny Handley.

TABLES

Table 1 Geological succession in the Cranborne Chase area.

Table 2 Biostratigraphical subdivisions of the Newhaven, Tarrant and Spetisbury Chalk.

Table 3 Comparative chrono- and lithostratigraphy of the Campanian chalks.

1 Introduction

1.1 GEOGRAPHICAL SETTING

The Cranborne Chase, mainly falling in the County of Dorset, but with a small part in the north in Wiltshire, and an even smaller part in the north-east in Hampshire, is a rural area with several small scattered villages, but no major settlement. The area is mostly underlain by Chalk which is inclined towards the south-east to give extensive broad sloping surfaces on which are developed several subsequent streams. This gives an overall grain of north-west/south-east trending ridges and valleys, which join the consequent, south-westward, flowing River Allen (Figure 1). The ridges tend to have large, well-drained, fields developed upon them giving rise to an open landscape. By contrast, in the south-east of the area, where Palaeogene deposits overlie the Chalk, the strata are more varied and both well-drained sandy and heavy clay soils occur in close proximity giving a much smaller-scale field-pattern to the land.

The highest ground, some 220 m OD, is in the north-west north of Woodcutts [ST 960 200]; the lowest ground, about 28 m OD, is to the south adjacent to the River Allen. Agriculture is the main industry of the region, with arable farming predominating on the Chalk, and pasture farming on the Palaeogene deposits. There are some extensive tracts of woodland, with the larger ones being mainly coniferous, but with a scatter of broad-leaved deciduous woods. Remnants of the formerly widespread Dorset heaths, commonly developed on the Palaeogene sands occur in places (Holt Heath [SU 060 040] is one of the larger remnants).

The Cranborne Chase area of this report comprises the 1:10 000 sheets ST90NE, ST91SE, ST91NE, SU 00NW, SU 01SW and SU 01NW. In addition, for completeness, reference is made to localities on sheets SU 00NE and SU 01SE, drawing on the manuscript notes of Mr E E L Dixon on his fieldslips.

Figures in square brackets are National Grid references; places within the Cranborne Chase area fall in the 100-km squares ST and SU. The grid letters precede the grid numbers.

1.2 PREVIOUS WORK

The original geological survey of the area at the 1:63 360 scale was by H W Bristow and J Trimmer, and published on Old Series Sheet 15 in 1858. The resurvey at the 1:10 560 scale was by Mr J Bennett, mainly on the Cretaceous strata, between 1896 and 1899, by Mr C Reid, mainly on the Palaeogene strata in 1894 and 1899, and Mr E E L Dixon around Cranborne village, Horton and Verwood in 1899 and 1900, and published on New Series Sheet 314 in 1902. The accompanying memoir by C Reid was published in 1902. The map was reprinted, without revision in 1948. In 1976, the map was reconstituted without geological revision and reprinted on to 1st Series 1:50 000 base. The map was reprinted, again with no revision, in 1900.

The area was resurveyed at the 1:10 000 scale by C R Bristow in 1997 (a small area only) and 1998.

The Water Supply of the area is covered by *Wells and Springs of Dorset* (Whitaker and Edwards, 1926).

Chalk macrofossils were collected by C Reid and E E L Dixon during the original geological survey. Mr S C A Holmes, as a research student at Cambridge University, collected an extensive suite of Chalk fossils during the 1930s. These were donated to the BGS before the completion of his research. All these chalk fossils, together with ones collected by the author have been re-examined and re-determined by M A Woods, who has also carried out some extensive collecting in the field. The determinations and biostratigraphical conclusions of this work are included in

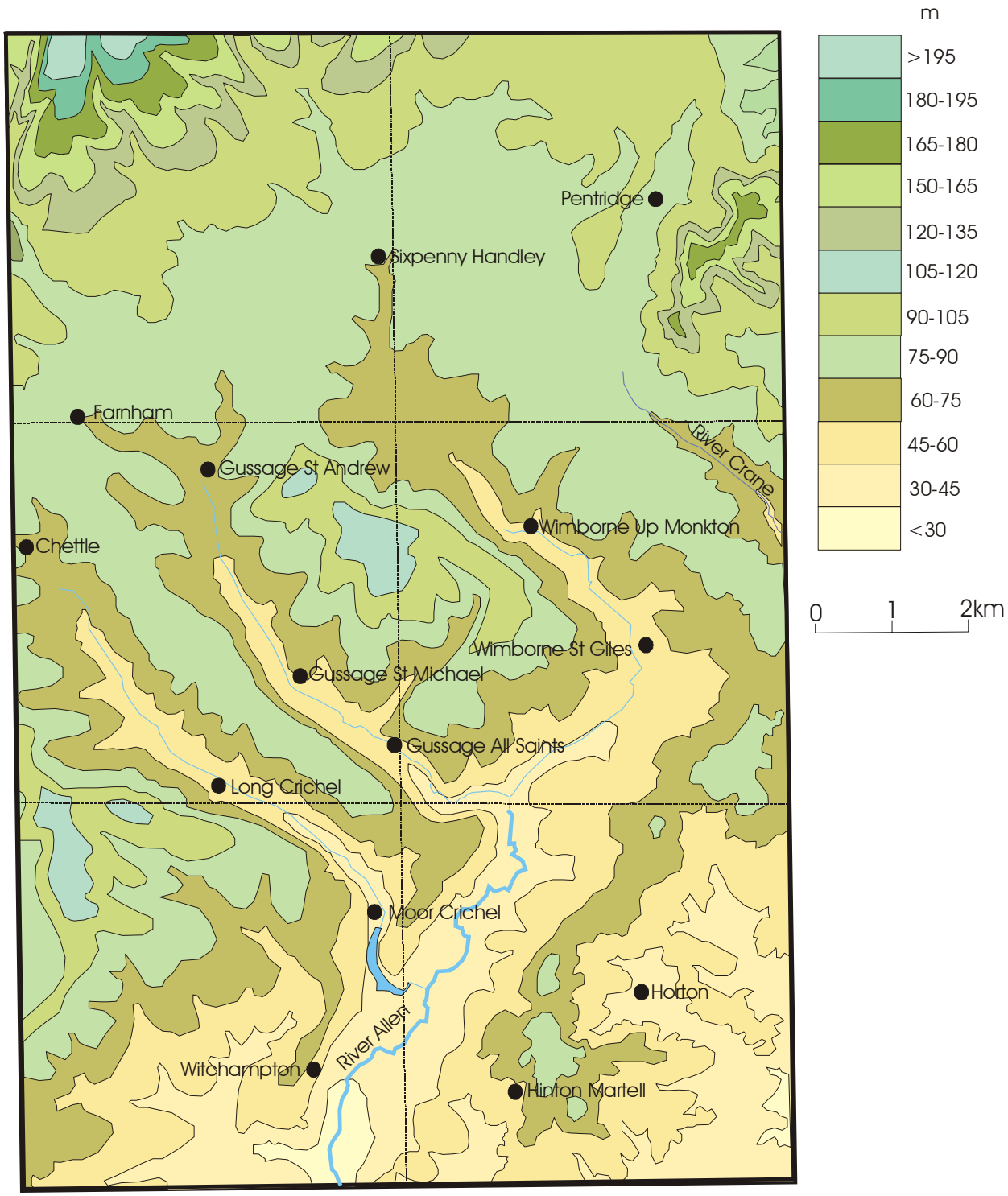


Figure 1. Topographical map of the Cranborne Chase area

several unpublished BGS reports (Woods, 1997; 1998a; 1998b). Foraminifera from spot samples of chalk collected from sections and soil brash have been identified by I P Wilkinson (1998; 1999). J A Riding has examined two samples of Broadstone Clay from just outside the present area for dinoflagellates and pollen (Riding, 1999).

1.3 GEOLOGICAL SEQUENCE

The solid formations (see Figure 2) and drift deposits mapped during the survey for geological sheets ST90NE, ST91SE, ST91NE, SU 00NW, SU 01SW and SU 01NW are listed in Table 1. For completeness, two of the higher units (Parkstone Clay and Branksome Sand) which are mentioned in the text, but do no occur in the Cranborne Chase area, are included. Additionally, the Cretaceous strata proved in the Cranborne Borehole [SU 0341 0907] which do not crop out are included in Table 1, but the older Mesozoic strata are omitted.

Table 1 Geological succession in the Cranborne Chase area

System	Group		Formation	Member	Lithology	Thickness
PALAEOGENE	Bracklesham		Branksome Sand		Sand, fine- to coarse grained	>16
			Poole	Parkstone Clay	Clay	3–5
				Parkstone Sand	Sand	16–20
				Broadstone Clay	Clay, commonly carbonaceous	5–15
				Broadstone Sand	Sand	5–15
	Unconformity					
			London Clay	Holt Woodr	Clay, fine-grained sandy	5
				Lytchett Matravers Sand	Sand, fine-grained	5
				Holt	Clay, fine-grained sandy	12
				Warmwell Farm Sand	Sand, fine-grained, pebbly	5–10
				West Park Farm	Clay, locally red-stained	5
			Reading		Clay, locally red-stained, and sand	10–15
Unconformity						
CRETACEOUS	Chalk Group	White Chalk Sub-group	Portsdown Chalk		Chalk, marl seams near base, flinty	60
			Culver Chalk	Spetisbury Chalk	Chalk, flinty	25–36
				Tarrant Chalk	Chalk, flinty	25–72
			Newhaven Chalk		Chalk, common thin marl seams	40–60
			Seaford Chalk		Chalk, flinty	60–75
			Lewes Nodular Chalk		Chalk, hard, nodular, flinty	27–30
			New Pit Chalk		Chalk, firm, flinty	18
			Holywell Nodular Chalk		Chalk, hard, nodular, common *Mytiloides* shells	18
		Grey Chalk Sub-group	Zig Zag Chalk		Chalk, blocky, off white.	40
			West Melbury Marly Chalk		Chalk, marly	24–29
			Upper Greensand		Sand and sandstone, glauconitic with common chert nodules at top;	37
			Gault		Mudstone, fine-grained sandy	37

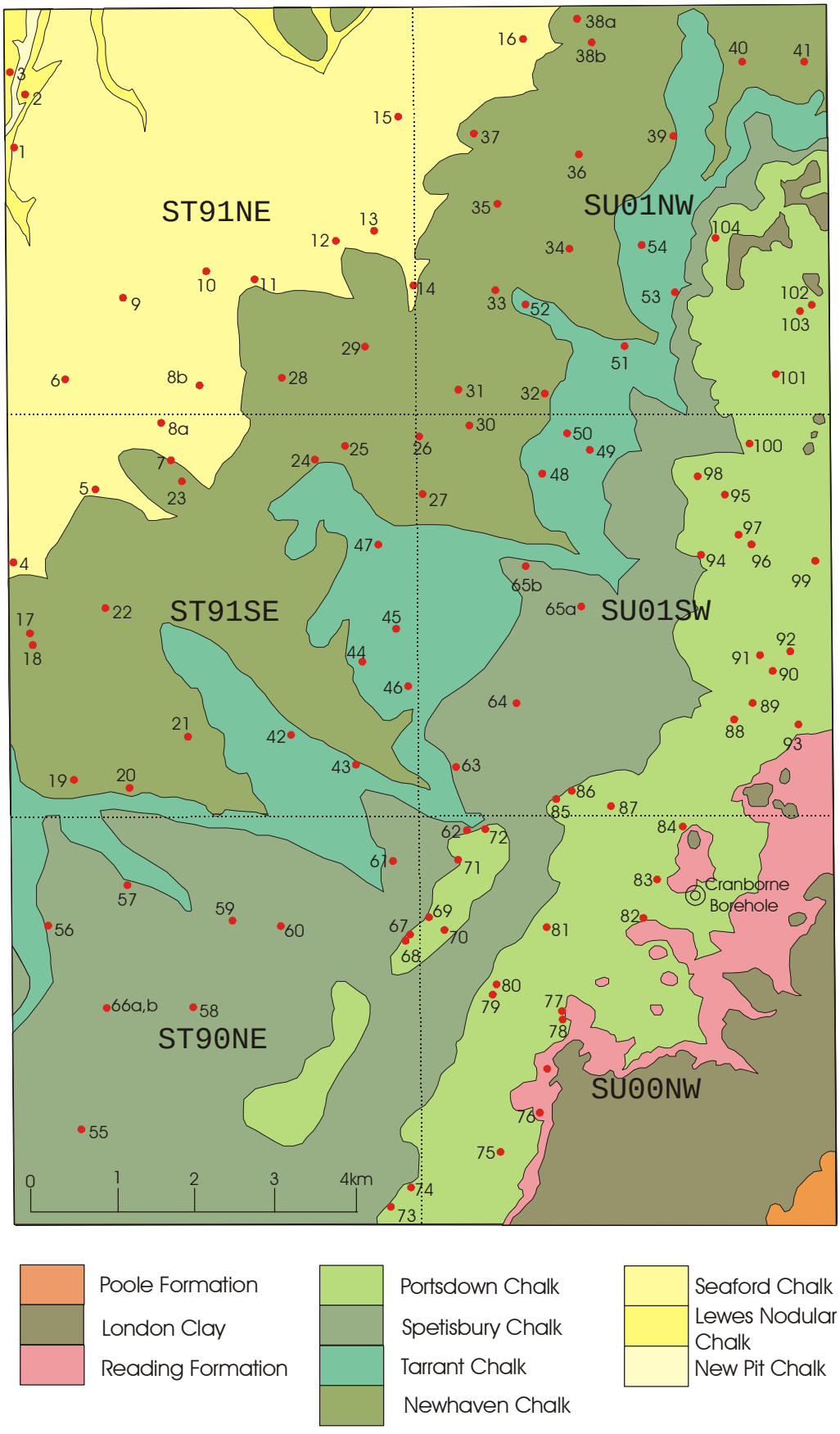


Figure 2. Geological map of the Cranborne Chase area

2 Cretaceous

2.1 NEW PIT CHALK FORMATION

The New Pit Chalk Formation only crops out on the sides of Rotherly Bottom in the north-west of the area. There is no exposure. The formation is about 18 m thick in the Cranborne Borehole [SU 0341 0907] (Figure 3). On regional considerations, the formation consists of firm, white, slabby chalk with common *Mytiloides hercynicus*; flints may be locally developed.

2.2 LEWES NODULAR CHALK FORMATION

The Lewes Nodular Chalk Formation crops out on the valley sides on the northern margin of the area where it is about 30 m thick. At depth in the Cranborne Borehole in the south of the area, it is about 27 m thick (Figure 3).

For the most part, the formation consists of hard, locally porcellanous and splintery, nodular and flinty chalk. It is the incoming of hard nodular, flinty chalk which distinguishes the Lewes Nodular Chalk from the underlying New Pit Chalk. The glauconitic, nodular **Chalk Rock** which occurs close to the base of the formation has only been seen at one locality [ST 9519 1868] (Reid, 1902, p.5).

Micraster cortestudinarium preserved in hard nodular chalk is a common component of the fauna in the higher part of the formation. Because of its hardness, it is often found in brash. Foraminiferal zones BGS11 (pars) to BGS13 have been recorded in the Lewes Nodular Chalk Formation of southern England (Wilkinson, 2000).

2.3 SEAFORD CHALK FORMATION

The Seaford Chalk Formation has a broad outcrop in the north of the district (essentially north of the A354) (Figure 2). It is 60 m thick in the Cranborne Borehole (Figure 3).

The formation consists of firm white chalk with common flints. Possible correlatives of named flints of Sussex and Kent have been identified in several places (Figure 4; Localities 8a, 9, 11 and 15). Fragments of the inoceramid *Platyceramus* are common in brash and sections. Less commonly, *Micraster coranguinum*, the eponymous echinoid of the *coranguinum* Zone, is found. In two places [ST 9575 1550 and SU 9980 1865], *Cladoceramus undulatoplicatus*, indicative of a position close to the basal Santonian, within the *coranguinum* Zone, was found. Foraminifera are common in the Seaford Chalk Formation and can be used to divide the unit into zones BGS 14 to BGS 17 (Wilkinson, 2000).

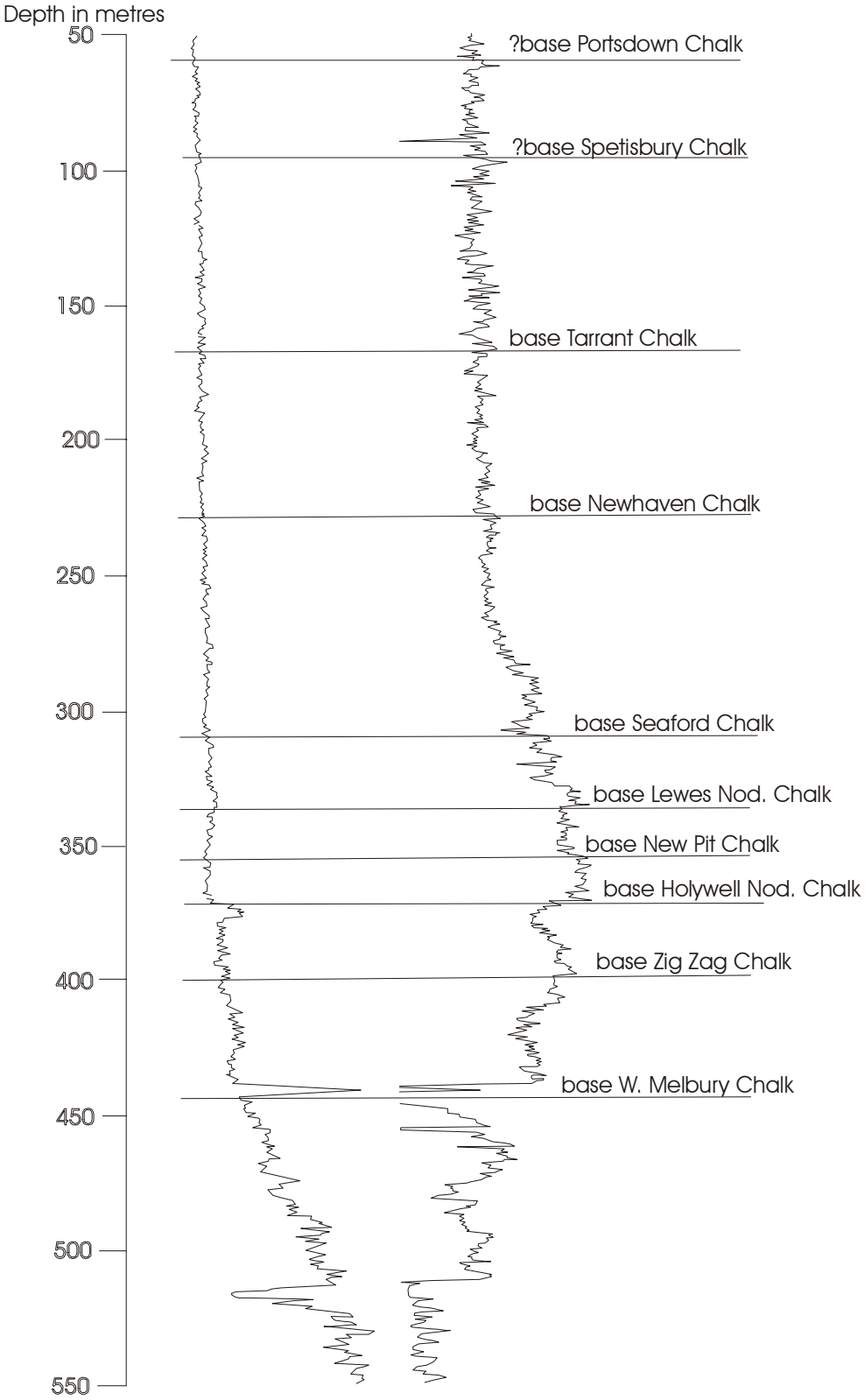
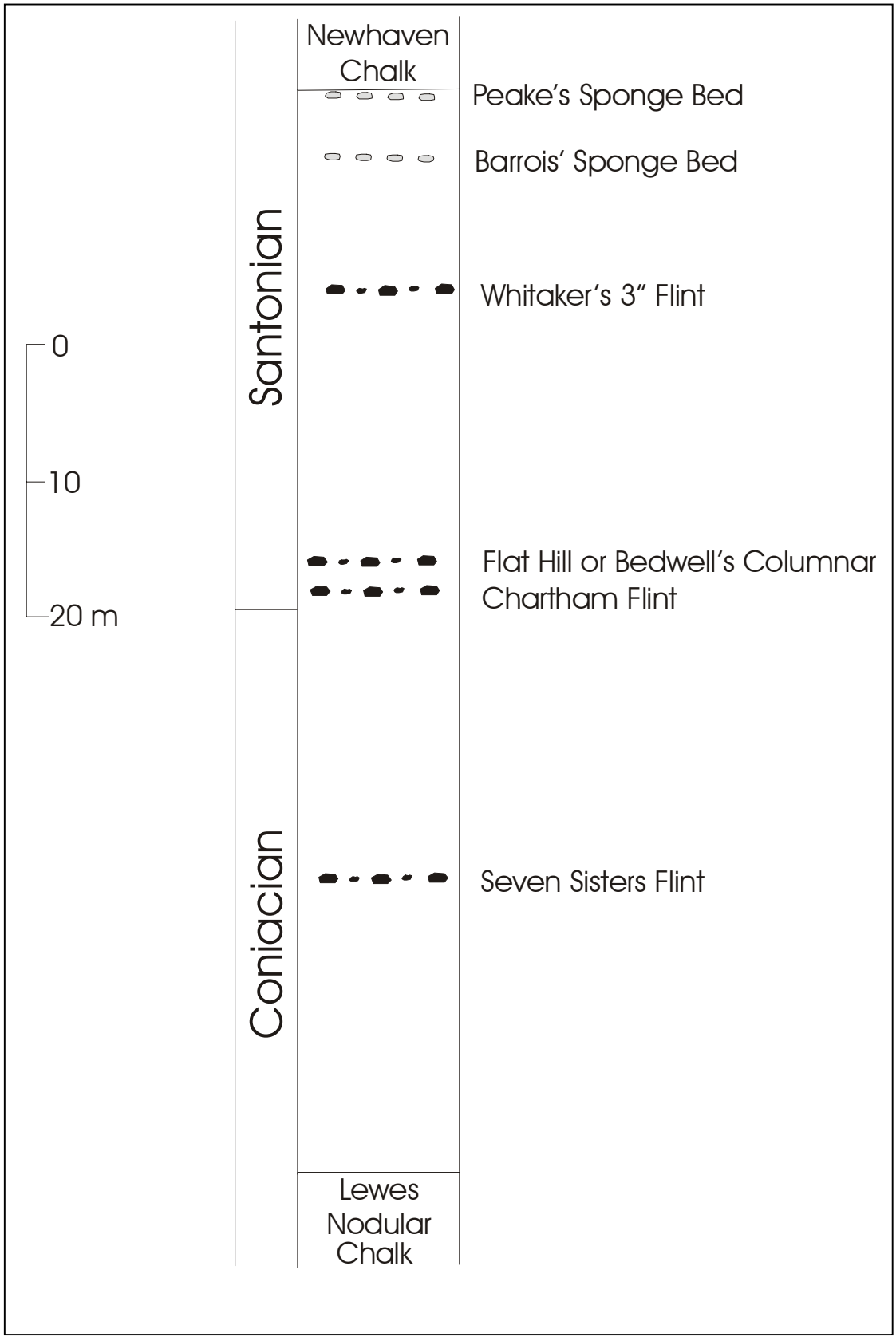


Figure 3. Gamma-ray and sonic log of the Cranborne Borehole

Figure 4 Lithological markers in the Seaford Chalk of the Cranborne Chase area.



2.4 NEWHAVEN CHALK FORMATION

The Newhaven Chalk occurs as a broad band across the central part of the area (Figure 2). The formation consists of some 40 to 60 m of firm, white, flinty chalk with common flints. It is about 60 m thick in the Cranborne Borehole (Figure 3). It differs from the Seaford Chalk by the occurrence of thin marl seams throughout the sequence.

The formation spans the *socialis, testudinarius, anglicus* and *pilula* macrofossil zones (Table 2). The *testudinarius* Zone has been proved in several places by the occurrence of the eponymous crinoid *Marsupites testudinarius*. Because of the small size of their zone fossils, the *socialis* and *anglicus* zones are easily overlooked. The *pilula* Zone can be subdivided by the relative abundance of the eponymous fossil *Offaster pilula*, as well as by the presence of various morphitypes of *Echinocorys scutata:* in approximate ascending sequence var. *tectiformis, depressula, truncata, cincta* and the large and small morphs of *Echinocorys* spp. of Gaster (1924)). Although not seen in the present area, Bailey et al. (1983) noted that the acme of *M. testudinarius* is associated with *Gonioteuthis granulata*, and Mortimore and Pomerol (1991a) recorded a *Zoophycos* event at this level, extending down into the *socialis* Zone. The formation has been divided into foraminifera zones BGS 18 and 19 and several subzones (Table 2).

2.5 CULVER FORMATION

The Culver Chalk consists of firm white chalk with common flint nodules. The base is well defined at the prominent feature break at the top of an escarpment developed in the Newhaven Formation. A similar well-developed feature break is used to subdivide the formation into two members, a lower Tarrant Chalk, and an upper Culver Chalk.

2.5.1 Tarrant Chalk Member

The Tarrant Chalk, consisting of firm, white, flinty chalk, varies in thickness from about 25 m at outcrop in the north-east of the area, to 72 m in the Cranborne Borehole (Figure 3), but mostly falls in the range of 35 to 50 m thickness.

The base of the member, and also the base of the Culver Chalk, is taken at a prominent feature break which extends right across the area. Because of the lack of exposure, the exact stratigraphical position of this feature break has not been determined, and in detail is slightly equivocal. Macrofaunal and microfaunal evidence on Launceston Down just west of the present area suggests that it occurs towards the top of the *pilula* Zone (Bristow, 1991). Microfaunal evidence in the present area suggests a slightly higher level at about the level of the Arundel Sponge Bed in the basal *quadrata* Zone. Either position for the base of the member is slightly older than the base in Sussex (Mortimore, 1986, fig. 20). The belemnite *Gonioteuthis* occurs in the member, but there is a lack of diagnostic macrofossils that typify the unit. *Belemnitella mucronata*, which normally typifies the *mucronata* Zone, also occurs in low numbers with in the lower part of the Tarrant Chalk (more-or-less coincident with the *Gavelinella usakensis* Foraminiferal Biozone =BGS20i of Wilkinson (2000)). The member spans the *'Hagenowia* Horizon' of Bailey et al. (1983). The Tarrant Chalk falls in the top part of Wilkinson's (2000) microfaunal Zone BGS20i and almost the whole of BGS20ii (see Table 2)).

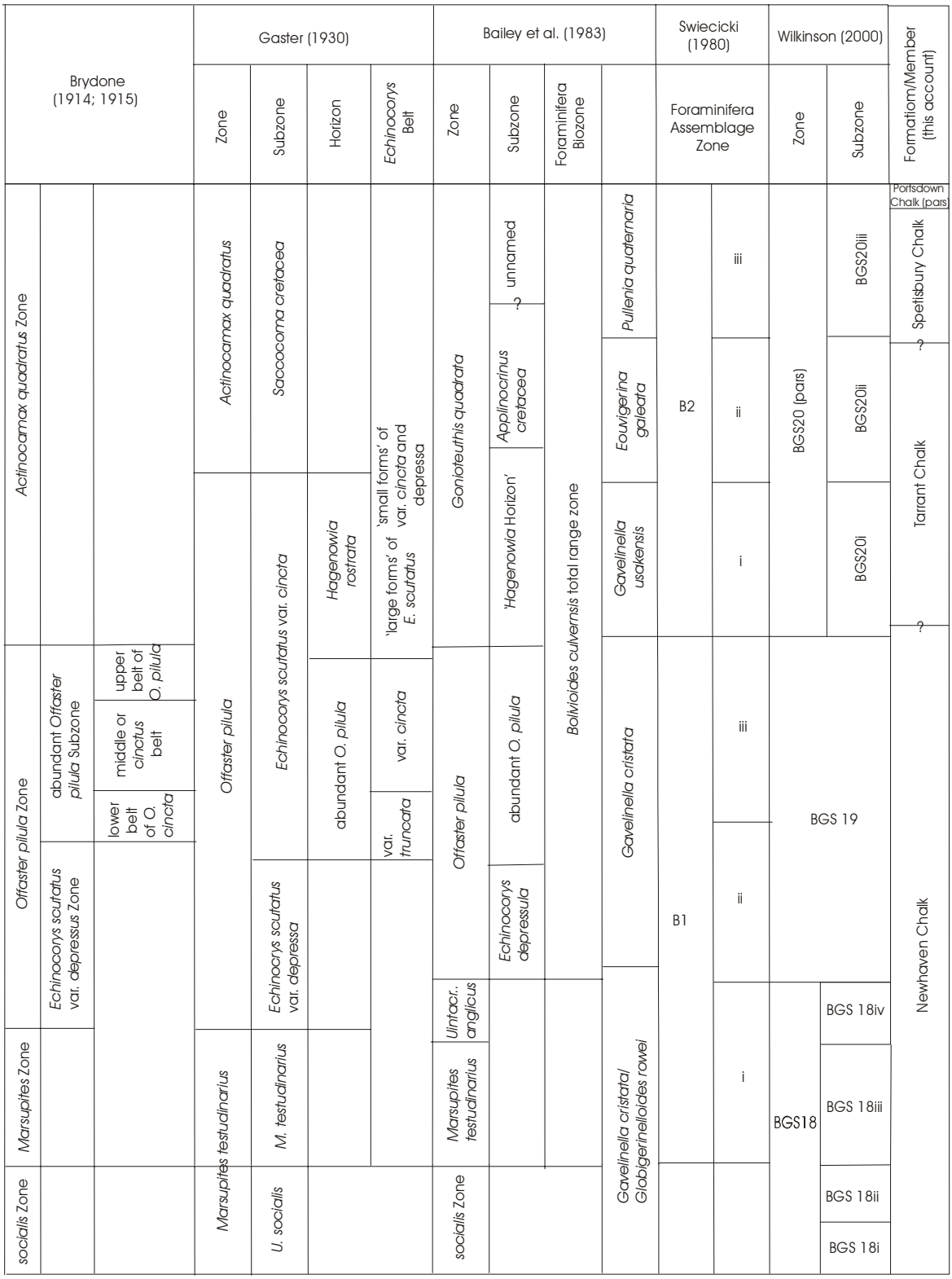


Table 2. Biostratigraphical subdivisions of the Newhaven, Tarrant and Spetisbury Chalk

2.5.2 Spetisbury Chalk Member

Lithologically, the Spetisbury Chalk is similar to the Tarrant Chalk. Farther south-west (see Portsdown Chalk below), the top 13 m at least of the member has large, regularly spaced flints throughout and which give rise to long dip slopes. A similar situation probably occurs in the Cranborne Chase area.

The thickness of the member varies from about 25 m in the north-east of the area to 36 m in the Cranborne Borehole (Figure 3). A prominent feature break defines its base, but, as with the Tarrant Chalk, its exact stratigraphical position has not been ascertained. Microfaunal evidence from near Amen Corner (see Details) suggests that the base of the member falls in the top of the *Applinocrinus cretaceus* Subzone of the *quadrata* Zone. The member is more-or-less coincident with the BGS 20iii foraminiferal zone of Wilkinson (2000) (see Table 2).

2.6 PORTSDOWN CHALK FORMATION

The base of the Portsdown Chalk is taken at a prominent negative feature break. In sections and boreholes in the Dorchester area it has been possible to determine the cause of the feature and to erect an outline stratigraphy for the lower 16 m of the Portsdown Chalk (Bristow et al., 2002). In particular, evidence in the Big Almer Wood Borehole [ST 9154 0016] suggests that the feature break coincides with the disappearance of regular-spaced, large, flints that occur in the top of the Spetisbury Chalk. Similar flint-free or only sparsely flinty Portsdown Chalk has been noted both in the present area and near Dorchester (Reid, 1899, 15). The maximum preserved thickness of the Portsdown Chalk in the area is about 60 m.

The basal 11 m of the Portsdown Chalk in the Big Almer Wood Borehole is full of broken inoceramid shells (these also continue downwards for a further 3.15 m into the flint-rich chalk where it forms a calcarenite). A similar inoceramid-rich chalk at the base of the Portsdown Chalk has been noted in the West Lulworth Borehole [SY 8225 8076], in exposures near Spetisbury (Bristow et al, 1997, p.10), and in the present area (see Details). This inoceramid-rich unit has been named the Big Almer Wood Member (Bristow et al., 2002).

The Big Almer Wood Borehole was drilled in the base of an old pit. Some 4 m above the base of the pit (i.e. about 14 m above the base of the Portsdown Chalk), occurs a prominent marl seam – the Almer Marl of Bristow et al. (1997, p.310) and a probable correlative of the Shide Marl. This marl seam appears to be widespread in the Dorchester area, but has not been noted in the Cranborne area.

Belemnitella mucronata is common, both above and below the marl seam. *B. mucronata* is typical of the lower 20 m of the Portsdown Chalk and is the eponymous fossil of the *mucronata* Zone. However, it does range down into the top part of the *quadrata* Zone (coincident with the base of the *Boliviniodes decoratus* Foraminiferal Biozone =BGS20iv Zone of Wilkinson (2000) (Mortimore, 1986b, fig. 24) (see Table 3). There is also, however, a much lower occurrence of *B. mucronata* in the *quadrata* Zone (more-or-less coincident with the *Gavelinella usakensis* Foraminiferal Biozone =B2i of Swiecicki (1980)) in the lower part of the Tarrant Chalk.

The B3i foraminiferal biozone has been subdivided by Wilkinson (2000) into a lower (BGS20iv Subzone) and upper (BGS21 Zone) unit (Table 3). The base of the BGS21 Zone is defined at the inception of common *Gavelinella monterelensis*, the extinction of *Boliviniodes culverensis* and the consistent occurrences of *B. decoratus*. The Big Almer Wood Member is more-or-less coincident with the BGS20iv Subzone.

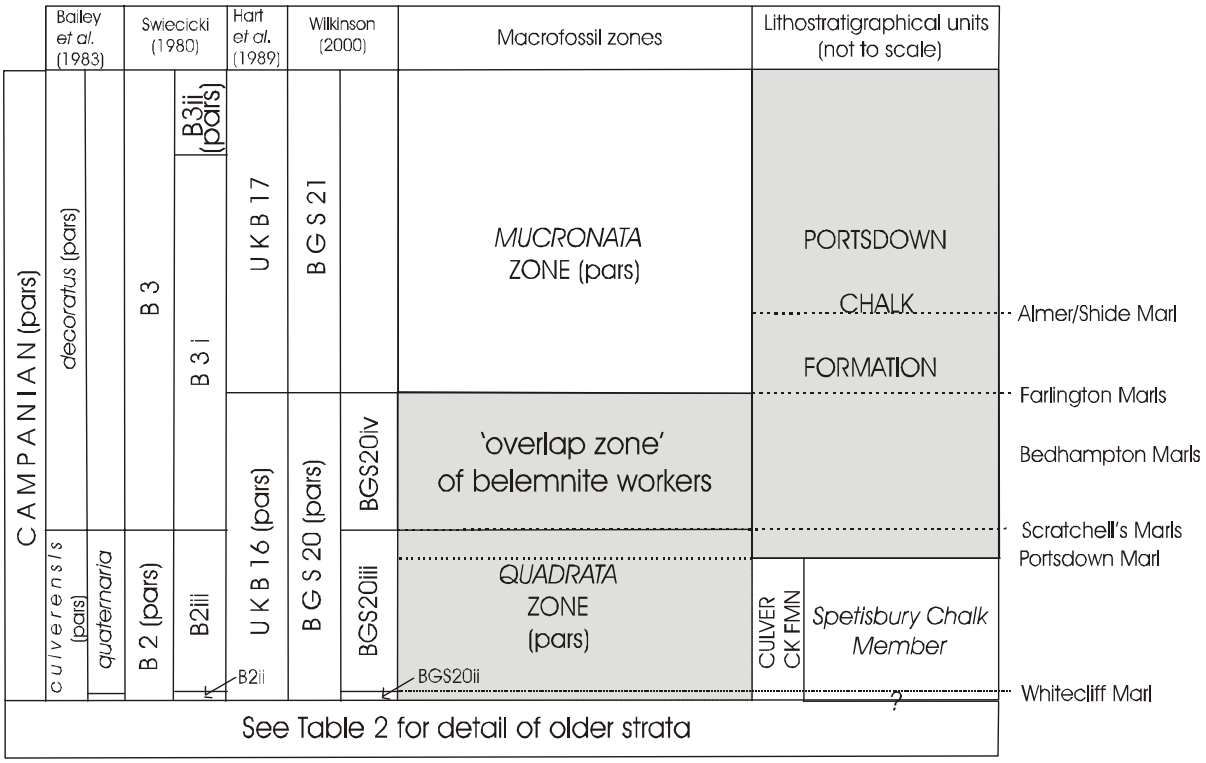


Table 3. Comparative chrono- and lithostratigraphy of the Campanian chalks

Echinocorys subconicula, common in the Portsdown Chalk, is characteristic of the lower part of the *B. mucronata* Zone (Wood, 1995).

At Big Almer Wood (Bristow, 1993) and Stinsford [SY7178 9168] (Woods, 1996), the Almer/Shide marl is underlain by small *Zoophycos* flints. At Bere Down Farm Pit [SY8436 9675] and Herringston Barrow Pit [SY6860 8835], which lie to the south-west of Big Almer, spectacular *Zoophycos* flints occur just above the marl (Westhead, 1993; Woods, 1996). At Higher Kingston Farm [SY7175 9305], *Zoophycos* flints occur both above and below the marl seam. A widespread and conspicuous *Zoophycos* acme occurs in the upper *quadrata* Zone and lower *mucronata* Zone (= Précy-Warren Farm Zoophycos Event), and the *Zoophycos* flints in the Dorchester area are assumed to be this event (Bristow et al., 1997, p.310). However, Mortimore and Pomerol (1991a) also recorded a *Zoophycos* acme in the lower *quadrata* Zone, overlapping with the lower acme of *Belemnitella* detailed by Bailey et al. (1983). *Zoophycos* flints have been widely noted in the Cranborne area (see details). Hitherto (Woods, 1998a), the record of common *Belemnitella* and *Zoophycos* flints has been taken as good evidence for the upper *quadrata* Zone or lower *mucronata* Zone. However, without good field control, the possibility of assignment to the lower *quadrata* Zone cannot be entirely excluded.

Details

2.6.1 Lewes Nodular Chalk Formation

Glauconitic, nodular Chalk Rock, 1.2 m thick, was seen by Reid (1902, p.5) just north-west of Rushmore School [ST 9519 1868] (Figure 2, Loc. 1). Just to the north, on the opposite side of a small tributary valley [ST 9520 1886], common specimens of *Micraster*, including *M. cortestudinarium* occur in the brash (Figure 2, Loc. 2). On the west side of Rotherly Bottom and a little farther north [ST 9510 1900 to 9517 1935], brash of hard nodular, porcellanous chalk with sponges is common on the valley slope and thrown out from badger setts. At one point

[ST 9514 1920], an internal mould of the ammonite *Lewesiceras mantelli* in chalkstone was found (Figure 2, Loc.3).

2.6.2 Seaford Chalk Formation

At Chettle, a sample from a trial pit [ST 9502 1323] yielded the following microfauna *Stensioeina exsculpta exsculpta, Reussella kelleri?, Neoflabellina rugosa* and *Cibicides beaumontianus* (Figure 2, Loc. 4). The presence of *C. beaumontianus* (which has its lowest record at the base of BGS17) and *R. kelleri?* indicates an age no older than the late *coranguinum* Zone; *S. exsculpta exsculpta* becomes extinct in the basal *pilula* Zone. There are insufficient biostratigraphically useful taxa to be more precise.

Just over 1 km north-east of Chettle, a brash sample [ST 9613 1406] (Figure 2, Loc. 5) yielded *Stensioeina granulata* cf. *perfecta, Gavelinella stelligera, Cibicides beaumontianus, C. ribbingi, Reussella kelleri* and *Stensioeina exscavata exscavata* indicative of an age no older than the late *coranguinum* zone.

At Farnham, a temporary exposure [ST 9575 1550] (Figure 2, Loc.6) in firm white chalk yielded brachiopod and inoceramid bivalve shell fragments, including *Cladoceramus undulatoplicatus* which the basal Santonian part of the formation. A microsample from this locality yielded *Stensioeina granulata* cf. *perfecta, Gavelinella stelligera, Cibicides beaumontianus, C. ribbingi, Reussella kelleri* and *Stensioeina exscavata exscavata* indicative of an age no older than the late *coranguinum* zone.

At Farnham, a small exposure [ST 9700 1449] (Figure 2, Loc.7) of firm white chalk in the upper part of the formation yielded common fragments of *Platyceramus*.

North-east of Minchington [ST 9693 1495] (Figure 2, Loc. 8a), a thick (c. 5 mm) shell fragment of *Platyceramus?* was found in brash. Thick-shelled specimens of *Platyceramus* occur in the lower *M. coranguinum* Zone, around the **Seven Sisters Flint**, and towards the top of the Zone, above the equivalent of **Whitaker's 3" Flint** in the North Downs (Woods, 1997). The Minchington occurrence is more likely to be associated with the equivalent of the Whitaker's 3" flint.

About 1.5 km east of Farnham, a brash sample [ST 9727 1532] (Figure 2, Loc. 8b) from high in the formation yielded sparse *Osangularia cordieriana, Gavelinella stelligera* and *Reusella szajnochae praecursor,* a fauna which gives no biostratigraphical information. Some 400 m south-west, a fragment of *Platyceramus* was found loose.

About 1.4 km north-north-east of Farnham, microfauna from a brash sample [ST 9642 1640] (Figure 2, Loc. 9) high in the formation yielded rare *Lingulogavelinella arnagerensis, Gavelinella lorneiana, Stensioeina granulata* and *Reussella kelleri*, indicative of the *Lingulogavelinella arnagerensis* foraminiferal zone. The presence of *granulata* indicates a position no older than BGS14, and *arnagerensis* becomes extinct in the base of BGS17ii in the upper part of the *coranguinum* Zone (a little above **Whitaker's 3" Flint**) in the upper part of the Seaford Chalk. *Stensioeina granulata* appears near the base of the *coranguinum* at the base of the Seaford Chalk.

A microsample [ST 9747 1681] from fairly high in the formation from an excavation behind Manor Farm (Figure 2, Loc. 10) yielded *Gavelinella arnagerensis, Stensioeina exsculpta exsculpta, S. granulata* and *Reussella kelleri,* together with a single, poorly preserved, specimen tentatively assigned to *L. arnagerensis*. If correctly identified, it would indicate an age no younger than the upper part of the *coranguinum* Zone. *Stensioeina exsculpta exsculpta* has it inception towards the base of the *coranguinum* Zone and ranges through to the base of the *pilula* Zone.

Some 650 m east-south-east of Manor Farm, another sample [ST 9807 1667] (Figure 2, Loc. 11) from high in the formation included rare and poorly preserved *Gavelinella lorneiana,*

Osangularia cordieriana and *Stensioeina polonica* indicative of the *polonica* foraminiferal zone of Bailey et al. (1983) and of BGS17 and, by implication, the upper part of the *coranguinum* macrofaunal zone. The upper part of the Seaford Chalk (above the **Chartham Flint** and equivalents) is inferred.

Just west of Sixpenny Handley, a brash sample [ST 9905 1712] (Figure 2, Loc. 12) from high in the formation yielded scarce *Gavelinella lorneiana, G. stelligera* and *Osangularia cordieriana* of limited biostratigraphical value.

The sparse fauna from a roadside excavation [ST 9953 1724] (Figure 2, Loc.13) south-west of Sixpenny Handley church, is dominated by inoceramid shell fragments (some thick), probably belonging to *Platyceramus*. *Echinocorys* sp. and *Micraster coranguinum* also occur. Locally, there is orange-yellow stained spongiferous chalk. *Micraster coranguinum* and *Platyceramus* are typical of the *coranguinum* Zone, but also occurs in the overlying *socialis* Zone (Mortimore, 1986). Thick-shelled *Platyceramus* and locally spongiferous chalk might favour the higher (Santonian) part of the *M. coranguinum* Zone, and thus the upper Seaford Chalk.

A brash sample [SU 0001 1646] (Figure 2, Loc. 14) from the highest Seaford Chalk just south of Sixpenny Handley yielded *Gavelinella stelligera, G. cristata, Cibicides beaumontianus* and *Reussella szajnochae praecursor*. The *Gavelinella cristata/G. rowei* Zone of Bailey et al. (1983) is recognised (BGS18). The very highest Seaford Chalk, immediately below **Peake's Sponge Bed**, or the very basal Newhaven Chalk a little above Peake's Sponge Bed (BGS18i), but below the inception of *S. granulata perfecta* (BGS18ii), is inferred.

A silage pit [ST 9980 1865] (Figure 2, Loc. 15) at Upwood Farm, near Sixpenny Handley, exposes a c. 2.6 m section of soft chalk with a very conspicuous semi-continuous nodular flint, locally with vertical protuberances which more than double the thickness of the flint. The fauna is dominated by the inoceramid *Cladoceramus undulatoplicatus*, both in the flint itself, and especially immediately above it. Two acmes of *Cladoceramus undulatoplicatus* typically occur at the base of the Santonian in the middle *coranguinum* Zone (Bailey et al., 1984; Mortimore, 1986). The higher of these acmes is usually associated with a conspicuous flint from which local columns are developed, named **Bedwell's Columnar Flint** in the North Downs (Robinson, 1986) and the **Flat Hill Flint** in Sussex (Mortimore, 1986). The equivalent flint is assumed to be that seen in the above section, and the section is assigned to the middle Seaford Chalk.

At Woodyates Manor, microfauna from a brash sample [SU 0135 1965] (Figure 2, Loc. 16) yielded rare and poorly preserved *Stensioeina exsculpta exsculpta, S. polonica*? and *Gavelinella stelligera*? Based on the rare fragmentary specimens tentatively identified as *G. stelligera* and *S. polonica*, a position between the between **Barrois Sponge Bed** and **Peak's Sponge Bed** might be suggested.

2.6.3 Newhaven Chalk Formation

Firm white chalk with *Zoophycos* flints occurs as brash [ST 9521 1230] (Figure 2, Loc. 17) on Tarrant Hinton Down. Nearby, brash [ST 9526 1218] (Figure 2, Loc. 18) yielded *Reussella kelleri, Gavelinella cristata cristata, G. cristata brotzeni, G. stelligera, Stensioeina granulata* cf. *perfecta* and *Reussella szajnochae praecursor*. The *Gavelinella* spp. indicate an age no older than the *coranguinum/socialis* boundary interval. The presence of *Stensioeina granulata* cf. *perfecta*, if correctly identified, implies that the sample is no older than the 'mid' *socialis* Zone (its incoming is diagnostic of foram zone/subzone BGS18ii). *Bolivinoides* is not present, suggesting an age older than the late *socialis* Zone.

Spoil from a trial pit [ST 9588 1061] (Figure 2, Loc. 19) on Launceston Down yielded *Gavelinella cristata cristata, G. cristata brotzeni, Stensioeina granulata perfecta, Stensioeina exsculpta exsculpta*, *Reussella kelleri, Reussella szajnochae praecursor* and *Bolivinoides culverensis*. The incoming of rare *Bolivinoides culverensis* takes place at the base of the *pilula* Zone and, the rare *Stensioeina exsculpta exsculpta* indicate that the age is unlikely to be younger

than the early *pilula* Zone. The concurrent range of these two species is restricted to the very base of foram zone BGS19 (Wilkinson, 2000), the lower part of B1ii benthonic zone of Swiecicki (1980).

Spoil of firm white chalk from a ditch [ST 9655 1032] (Figure 2, Loc. 20) west of Long Crichel yielded *?Offaster pilula planata* (internal mould), and a *Zoophycos* flint. Close by [ST 9659 1032 to 9669 1026], *O. pilula* and *O. pilula planata* were collected. *O. p. planata* indicates the top part of the *pilula* Zone (Subzone of abundant *O. pilula*, Upper belt of *O. pilula*).

A microsample [ST 9720 1104] (Figure 2, Loc. 21) from the opposite side of the Crichel valley included *Gavelinella cristata cristata, G. stelligera, Cibicides beaumontianus, Stensioeina exsculpta exsculpta, S. granulata perfecta* and *Reussella szajnochae praecursor; Bolivinoides* spp are absent. The assemblage is probably foram zone/subzone BGS18ii in the 'mid' *socialis* Zone (*perfecta* foraminifera zone of Bailey et al., 1983), the absence of *Bolivinoides* spp suggesting that it is not as high as18iii.

A flint internal mould of *Echinocorys scutata* (distinctive flat-topped form) was found as brash [ST 9622 1267] (Figure 2, Loc. 22) south-east of Chettle. The specimen is similar to *Echinocorys* morphotypes from the highest *coranguinum* Zone and the *socialis* Zone in the BGS Type and Stratigraphical Collection. The field context suggests the latter zone.

West of Gussage St Andrew, an old pit [ST 9710 1426] (Figure 2, Loc. 23) yielded a fragment of a *Micraster*. The morphology of the periplastron suggests assignment to a level at or above the *M. coranguinum* Zone (Drummond, 1983). The latter interpretation is supported by the microfauna which includes *Reussella kelleri, R. szajnochae praecursor, Gavelinella cristata cristata, G. cristata brotzeni, G. stelligera* and *Stensioeina granulata* cf. *perfecta*. The *Gavellinella* species indicate an age no older than the *coranguinum/socialis* boundary. The presence of *Stensioeina granulata* cf. *perfecta* suggests that the sample is no older than the mid-*socialis* Zone. The absence of *Boliviniodes* suggests an age older than the late *socialis* Zone, and probably BGS18ii.

In a slightly sunken green lane [ST 9878 1435 to 9887 1442] (Figure 2, Loc. 24) south-west of Canada Farm, near Sixpenny Handley, were collected: bryozoans, indeterminate inoceramid shell fragments, *?Pseudoperna boucheroni* (2), *Pycnodonte vesiculare* (4), *Spondylus* sp., *Bourgueticrinus* sp. (columnal) and *Echinocorys depressula.* The association of oysters (particularly *Pseudoperna boucheroni*) and *Echinocorys depressula* suggests assignment to the lower part of the *depressula* Subzone of the *pilula* Zone (Mortimore, 1986; Young and Lake, 1988), although Mortimore (1986) also recorded the subzonal index in the slightly older *testudinarius* Zone and *anglicus* Zone.

At Canada Farm [ST 9920 1465] (Figure 2, Loc. 25), *Marsupites* plates have been found in temporary excavations (Mr M Green, Down Farm, pers. commn. 1998). To the south-east of Down Farm, the upper 12 m of a Mesolithic shaft/flint mine [SU 0015 1473] (Figure 2, Loc. 26), over 25 m deep, has been recorded geologically by Prof. R Mortimore. He has kindly allowed his section to be incorporated in this report (Figure 5). The archaeology of the shaft has been published by Green and Allen (1997). *Marsupites* plates were found at a depth of 7.9 m, and *Echinocorys elevata* at 9.3 m. A brash sample [SU 0015 1405] (Figure 2, Loc. 27) some 670 m south of the shaft yielded sparse, poorly preserved *Gavelinella cristata, G. stelligera, Neoflabelinella rugosa* and *Stensioeina pommerana* indicative of the B1 Zone, and probably the B1iii Subzone of Swiecicki (1980). With *pomerana* present, it is unlikely to be lower than BGS19, i.e. *pilula*, and with *G. cristata* rather than *G. usakensis* it is no younger than BGS 19).

South of Chapel Down Farm, another brash sample [ST 9841 1538] (Figure 2, Loc. 28) yielded *Gavelinella cristata,* together with rare *Eouvigerina gracilis* and *Stensioeina pommerana* indicative of the B1iii Zone (of Swiecicki, 1980) (upper part of the *pilula* Zone). Some 900 m north-east of this sample, two fragments of thick-shelled *Platyceramus* were found on the surface [ST 9869 1612 and 9879 1621].

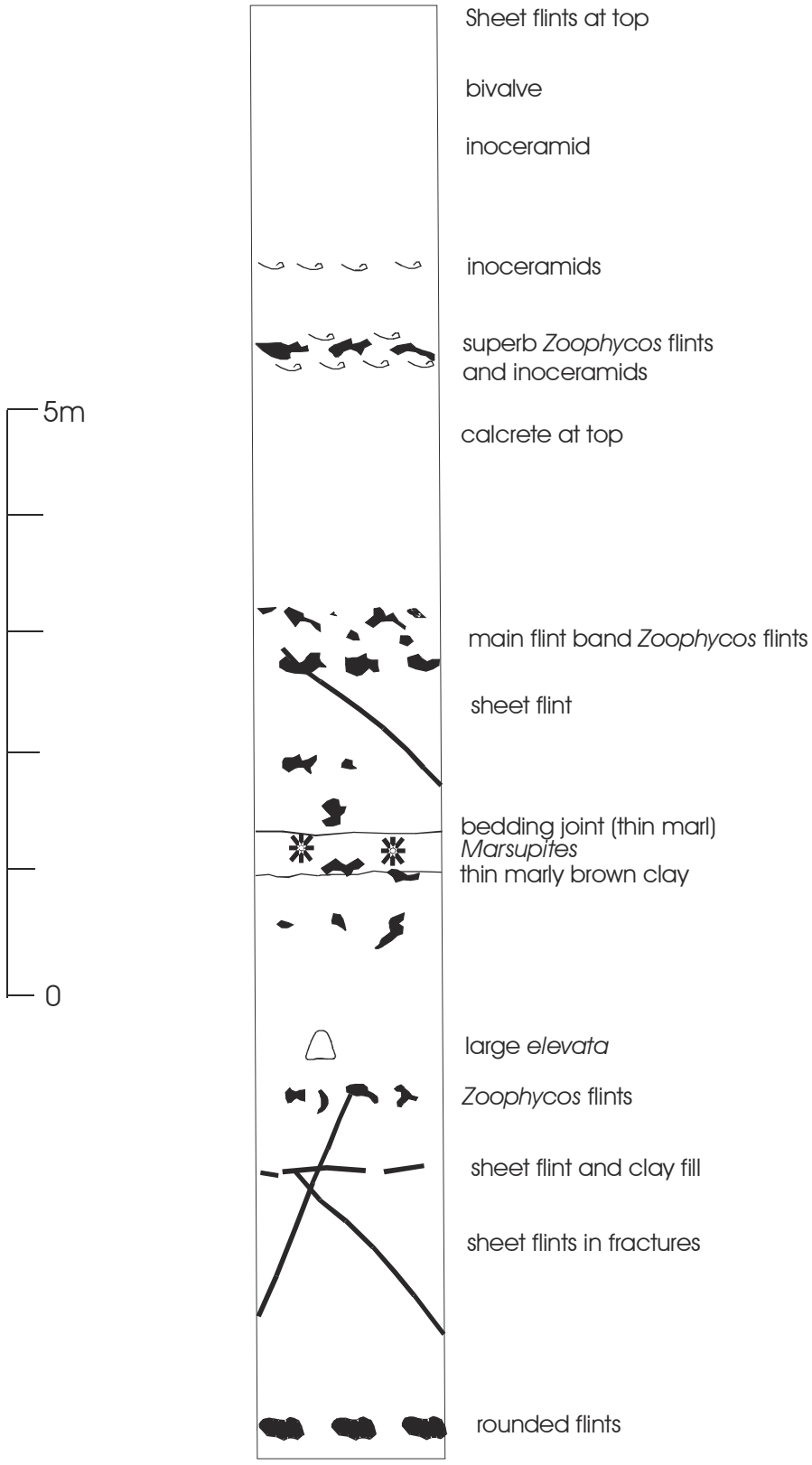


Figure 5. Section in the Newhaven Chalk, near Sixpenny Handley

About 1 km east-north-east of Chapel Down Farm, microfauna from a brash sample [ST 9943 1594] (Figure 2, Loc. 29) included rare and poorly preserved *Gavelinella lorneiana, G, stelligera, G. cristata, Stensioeina exsculpta exsculpta, S. granulata perfecta* and *Cibicides beaumontianus* indicative of the 'mid' *socialis* Zone, or, possibly, the basal *pilula* Zone. (BGS18ii–BGS18iii, but as there is no *Bolivinoides* present, this probably indicates 18ii – there is no evidence for 18iii. The upper limit is given on the basis of the extinction level of *exsculpta*)

A temporary exposure [SU 0065 1495] (Figure 2, Loc. 30) on Ackling Dyke, visited by Mr Holmes in 1936, yielded *Porosphaera nuciformis, Acutostrea incurva, Platyceramus?* (shell fragments in tabular flint) and *Pseudoperna boucheroni.* Although *Platyceramus* is most characteristic of the *coranguinum* Zone (Mortimore, 1986), it also occurs at slightly younger horizons. A rich oyster fauna, particularly characterised by *P. boucheroni*, occurs from the middle *testudinarius* Zone to the lower *pilula* Zone (Young and Lake, 1988), suggesting that the above *Platyceramus?* is from above its main acme in the *coranguinum* Zone.

Surface brash at an archaeological excavation [SU 0062 1522] (Figure 2, Loc. 31) c. 700 m at 068° from Down Farm, yielded *Orbirhynchia?,* inoceramid shell fragment, *Gonioteuthis* sp., *Marsupites testudinarius* (9 calyx plates), *Echinocorys* sp. (test fragment) and *Zoophycos* flints. Bailey et al. (1983) noted that the acme of *M. testudinarius* is associated with *Gonioteuthis granulata*, and Mortimore and Pomerol (1991a) recorded a *Zoophycos* event at this level, extending down into the *socialis* Zone. The lower Newhaven Chalk is therefore suggested.

A microsample [SU 0158 1516] (Figure 2, Loc. 32) from high in the member on the south side of Bottlebrush Down yielded *Gavelinella cristata, G. lorneiana, G. stelligera, Reussella szajnochae praecursor* and *Stensioeina pommerana*. The *G. cristata* Zone (BGS19 (B1ii-iii of Swiecicki) Subzone) (= high *pilula* Zone) is indicated; possibly just below the **Arundel Sponge Bed** and only a little above the **Telscombe Marls** and lateral equivalents.

Some 220 m south-west of the cross roads on Handley Hill [SU 0102 1648] (Figure 2, Loc. 33) was found a solitary *Belemnitella* sp. in brash. Normally, *Belemnitella* would indicate the upper *quadrata* Zone or *mucronata* Zone. However, in the Salisbury area, there is a lower acme of *Belemnitella* in the lower *quadrata* Zone (Bailey et al., 1983). The position of this specimen, some 10 m below the base of the Tarrant Chalk, suggests that it is not *in situ*.

On Ackling Dyke, 800 m north-east of the Handley Hill crossroads, microfauna from a brash sample [SU 0190 1703] (Figure 2, Loc. 34) yielded a few poorly preserved *Gavelinella stelligera, Osangularia cordieriana, Gavelinella cristata* and *Stensioeina pommerana*? (encrusted). The *cristata* Zone (B1 of Swiecicki) (and probably the *pilula* macrofaunal zone) (BGS19) is likely.

Brash on the north side, western part, of the public footpath [SU 0101 1756] (Figure 2, Loc. 35) which extends to either side of the track to Oakley Farm includes small crinoid brachials, questionably identified as *Uintacrinus*; some fragments of *Zoophycos* flints also occur. The possible *Uintacrinus* brachials suggest either the *socialis* or *anglicus* Zone. However, the possibility that the specimens might represent distal brachial plates of *Marsupites testudinarius* cannot be entirely excluded. In either case, the lower Newhaven Chalk is indicated.

Brash [SU 0207 1782] (Figure 2, Loc. 36) to the north-east of the above occurrence includes small- to medium-sized, smooth calyx plates of *Marsupites testudinarius*, and small crinoid brachials. The former is characteristic of the *testudinarius* Zone in the lower Newhaven Chalk. The smooth character of the calyx plates, and their rather small size, might suggest a level in the lower part of the Zone (Young and Lake, 1988). The crinoid brachials could be either *M. testudinarius* or *Uintacrinus*. In the North Downs of east Kent, Bailey et al. (1983) recorded *U. socialis* in the lower part of the *testudinarius* Zone as well as the underlying *socialis* Zone. Microfauna from brash close by (*Cibicides beaumontianus, Gavelinella stelligera, G. lorneiana, G. cristata, Reussella szajnochae praecursor* and *Bolivinoides culverensis*), yielded a slightly

younger, *cristata* foraminiferal Zone (B1ii or B1iii) (=*pilula* macrofaunal Zone), and presumably was collected from a slightly higher level.

Brash [SU 0081 1852] (Figure 2, Loc. 37) from north-west of Oakley Farm lies on a low rise about 10 m above the base of the Newhaven Chalk. The microfauna included rare *Gavelinella lorneiana, Reussella szajnochae praecursor, Lingulogavelinella arnagerensis* (one specimen only) and *Loxostomum eleyi*. The fauna is no older than the *coranguinum* Zone, on the basis of the presence of *L. eleyi* (inception at the Base BGS16) which has its inception at **Hope Point Marl** in the Kent succession. If the single specimen of *L. arnagerensis* is in situ, then the fauna is unlikely to be younger than the Seaford Chalk immediately overlying the **Whitaker's 3" Flint** (basal BGS17ii where it becomes extinct). However, it should be noted that this conclusion is tentatively drawn. Species characteristic of the Newhaven Chalk (such as *Gavelinella cristata* and *G. stelligera*) or the upper part of the Seaford Chalk (such as *Stensioeina polonica* and *Cibicides beaumontianus*), were not found.

A temporary section [SU 0197 1990] (Figure 2, Locality 38a) north-east of Woodyates Manor yielded a solitary *Conulus* sp. (Kate Royce, pers. commn.). A brash sample [SU 0221 1960] (Figure 2, Loc. 38b) from east of the Manor, an estimated 15 to 20 m above the base of the formation, yielded rare *Stensioeina exsculpta exsculpta, S. granulata perfecta* and *Gavelinella stelligera*. The presence of *S. g. perfect* indicates an age no older than the foraminiferal Zone BGS18ii (mid *socialis*), where it has its inception, and *S. exsculpta exsculpta* indicates that the youngest age is BGS18iii (earliest *pilula*), at which point, the latter species becomes extinct.

A sample [SU 0314 1834] (Figure 2, Loc. 39) from Peaked Post, Pentridge, yielded the following foraminifera *Gavelinella cristata, G. lorneiana, Cibicides beaumontianus* and *Stensioeina pommerana.* The *G. cristata* Zone can be recognised, and the presence of *S pommerana* suggests the B1iii Subzone of Swiecicki (1980) (BGS19). *Inoceramus* prisms are common in the sample.

A flat-topped morphotype of *Echinocorys* sp. was found on the surface at the top end of a moderately steep slope [SU 0394 1931] (Figure 2, Loc. 40) on the north side of Bokerley Down, some 4 m below the top of the Newhaven Chalk. This type of morphotype is normally characteristic of the lower part of the Newhaven Chalk (*socialis* and *testudinarius* zones). Such an assignment appears to be supported by the foraminifera from a brash sample at this locality which yielded *Gavelinella cristata, Cibicides beaumontianus, Stensioeina granulata perfecta* and *Reussella szajnochae praecursor*. *G. cristata* and *S. granulata perfecta,* and absence of *Bolivinoides* spp., indicate the BGS 18ii Zone (mid-*socialis* Zone). However, *Bolivinoides* species are rare at this horizon and the ranges of the recorded indices all extend up into the *pilula* Zone and the youngest possible age is basal *quadrata* (immediately below the **Arundel Sponge Bed**). From the field context, a *pilula* or *quadrata* date is more probable.

Some 800 m east of the last locality, another brash sample [SU 0473 1936] (Figure 2, Loc. 41) but an estimate 10 m lower in the sequence, included *Gavelinella cristata, G. lorneiana, G. stelligera, Reussella szajnochae praecursor* and *Stensioeina granulata perfecta*. Again, a *socialis* Zone is indicated, but the sample could be as young as the *pilula* Zone.

2.6.4 Culver Chalk Formation

2.6.4.1 TARRANT CHALK MEMBER

A brash sample [ST 9845 1105] (Figure 2, Loc. 42) on Sovell Down yielded *Gavelinella cristata cristata, G. cristata brotzeni, G. usakensis, G. stelligera, Stensioeina granulata perfecta, S.* cf. *pommerana* and *Eouvigerina* cf. *galeata*. The concurrent range of *G. cristata* and *G. usakensis* is in the basal *quadrata* Zone (in the lower part of BGS20i). *Reussella kelleri*, which becomes extinct at the very base of the *quadrata* Zone is not present. The fauna comes from a horizon equivalent to the **Arundel Sponge Bed** (see also next paragraph).

An old Chalk pit [ST 9930 1075] (Figure 2, Loc. 43) low down in the member on Ackling Dyke, Gussage All Saints, yielded to Mr Holmes in 1936: *Porosphaera globularis, Orbirhynchia* sp. and *Echinocorys* (?small form of Gaster, 1924). The possible record of the small *Echinocorys* morphotype of Gaster (1924) probably indicates the upper '*Hagenowia* Horizon', although it could indicate the lower part of the *A. cretaceus* Subzone in the *quadrata* Zone (Mortimore, 1986b). The above form is small and evenly domed, with a distinctively flat base, and quite unlike *E. depressula* and *E. cincta*, although the latter morphotypes can co-occur at this level (Gaster, 1924). A microsample [ST 9931 1067] from brash close by yielded *Gavelinella usakensis, G. stelligera, Stensioeina pommerana, Bolivinoides culverensis* and *Neoflabellina rugosa.* The common *G. usakensis* indicate an age no older than the basal *quadrata* Zone (*usakensis* foraminiferal Zone of Bailey (1983)=BGS20i Subzone of Wilkinson (2000)). Significantly, *G. cristata* is not present, so that the sample is no lower than the interval between the **Arundel Sponge Bed** and the **Castle Hill Marls**. Combining both sets of faunal evidence suggests a position low down in the member, as indicated by the featuring.

A brash sample [ST 9930 1197] (Figure 2, Loc. 44) from low down in the member north-east of Gussage St Michael, yielded *Stensioeina pommerana, Gavelinella usakensis, G. stelligera, Bolivinoides culverensis* and *B.* cf. *decoratus*. The presence of common *G. usakensis* and *B. culverensis* indicates a *quadrata* age. *Gavelinella cristata* is absent (it becomes extinct a little above the **Arundel Sponge Bed**), so a position between the Arundel Sponge Bed and the **Castle Hill Marls** is probable.

Some 700 north-east of the above, another brash sample [ST 9975 1240] (Figure 2, Loc. 45) somewhat higher in the sequence yielded *Gavelinella usakensis, G. stelligera, G. trochus, Stensioeina granulata incondita, S. pommerana, Reussella szajnochae praecursor* and *Rugoglobigerina pilula*. *Bolivinoides* was not found, but the presence *of Gavelinella usakensis* and *G. trochus* infers the middle part of the *quadrata* zone (above **Pepper Box Marls**). The fauna is no older than B2i and is probably of B2ii zonal age of Swiecicki (middle part of BGS20).

A third brash sample [ST 9991 1163] (Figure 2, Loc. 46) in this general area yielded *Stensioeina granulata perfecta, S. pommerana. Gavelinella usakensis* and *Bolivinoides culverensis* indicating a position low in the *quadrata* Zone (possibly between the **Castle Hill Marls** and **Lancing Flint**).

The prominent feature at the north-western end of Gussage Hill is formed by the basal beds of the Tarrant Chalk. A brash sample [ST 9950 1344] (Figure 2, Loc. 47) from the top of Gussage Hill had the following foraminifera *Gavelinella usakensis, G. stelligera, Stensioeina pommerana, Bolivinoides culverensis* and *Neoflabellina rugosa*. *Bolivinoides culverensis* is rare in the *pilula* Zone, but *Gavelinella usakensis* is common, so that an age no older than the basal *quadrata* Zone (*usakensis* foraminiferal zone of Bailey et al., 1983 =BGS20i Subzone of Wilkinson (2000)) is more likely. Significantly, *Gavelinella cristata* is not present, so that the sample is no lower than the chalk between the **Arundel Sponge Bed** and the **Castle Hill Marls**.

North of Monkton Wimborne, microfauna from a sample of brash [SU 0157 1424] (Figure 2, Loc. 48) low down in the member included *Gavelinella stelligera, G. cristata, G. usakensis, Stensioeina pommerana, Bolivinoides pustulata* and *B.* aff. *strigillatus*. The concurrent range of *G. cristata* and *G. usakensis* places the fauna in the basal part of zone BGS20i and either a little below or a little above the **Arundel Sponge Bed**. From the position of the sample relative to the basal feature of the Tarrant Chalk, it presumably falls just above the Arundel Sponge Bed. Some 700 m north-east of this sample, one *Belemnitella* was found in brash [SU0220 1456] (Figure 2, Loc. 49).

A sample [SU 0193 1497] (Figure 2, Loc. 50) on the southern margin of Bottlebush Down yielded *Gavelinella usakensis, G. clementiana, G. trochus, G. lorneiana, Osangularia cordieriana, Pullenia quaternaria, Bolivinoides culverensis* and *Cibicides beaumontianus*

indicative of foraminiferal Zone BGS20iii (*Pullenia quaternaria* Zone of Bailey et al. (1984) and (B2iii of Swiecicki) and from the very top of the Tarrant Chalk.

On the east side of Bottlebrush Down, microfauna from a sample [SU 0259 1593] (Figure 2, Loc. 51) close to the base of the member include *Reussella szajnochae praecursor, Gavelinella cristata, G. stelligera, G. usakensis, G. lorneiana* and *Bolivinoides culverensis*. The fauna is poorly preserved, but the concurrent range of *G. cristata* and *G. usakensis* suggests a position very close to the **Arundel Sponge Bed**.

The prominent feature of Handley Hill [SU 013 164] (Figure 2, Loc. 52) is formed by the basal beds of the Tarrant Chalk.

Just north of Salisbury Plantation, a sample [SU 0279 1710] (Figure 2, Loc. 54) from low down in the member yielded *Gavelinella stelligera, G. cristata, Stensioeina pommerana, Cibicides beaumontianus* and *Bolivinoides culverensis*. The *Gavelinella cristata* Zone is recognised. The rare occurrence of *B. culverensis* suggests B1 foraminiferal zone of Swiecicki, whilst the absence of *usakensis* indicates the BGS19 Zone (which more or less equates with the *pilula* macrofaunal Zone, although the very basal part of the *quadrata* zone (below the **Arundel Sponge Bed**) cannot be ruled out entirely).

2.6.4.2 SPETISBURY CHALK MEMBER

An exposure [c. ST 9585 0617] (Figure 2, Loc. 55) south of Hogstock seen by Mr Holmes in 1936 yielded: *Porosphaera globularis, Bourgueticrinus elegans* and *Echinocorys marginata?* (crushed). *Echinocorys marginata?* might indicate the *quadrata* Zone, *cretaceus* Subzone, although Wood (1991) considered the fauna biozonally undiagnostic.

From a chalk pit [ST 9546 0863] (Figure 2, Loc. 56) close to the base of the member, about 1.2 km at 100° from Tarrant Monkton church, Mr Holmes collected the zonally undiagnostic fauna *Porosphaera* spp., *Conorca turbinella,* bryozoans, *Terebratulina* sp., small crinoid brachials and asteroid skeletal plates.

A brash sample [ST 9648 0914] (Figure 2, Loc. 57) from low down in the member east of Launceston Wood yielded *Gavelinella usakensis, Bolivinoides culverensis* and *B. pustulatus*.

Brash [ST 9727 0768] (Figure 2, Loc. 58) in a track south-west of Manswood yielded sparse foraminifera which included *Gavelinella usakensis, G. clementiana, Pullenia quaternaria, Bolivinoides culverensis, B. pustulata* and *Stensioeina pommerana* indicative of the BGS20iii Zone.

About 600 m north of Manswood, brash [ST 9763 0866] (Figure 2, Loc. 59) yielded the following foraminifera: abundant *Gavelinella usakensis,* together with *G. trochus, G. clementiana, Bolivinoides pustulata* and *B.* cf. *decoratus.* The sample is likely to fall in the BGS20iii Subzone. Some 600 m east, another brash sample [ST 9833 0861] (Figure 2, Loc. 60) from the top of a 10-m high escarpment yielded *Gavelinella usakensis, G. trochus, Bolivinoides culverensis, B. pustulatus* and *Pullenaria quaternaria* indicating the BGS20iii Subzone. A similar microfauna was recorded in a silage pit [Loc. 65a, SU 0203 1260] at Wimborne St. Giles (see below).

North-east of Moor Crichel, a sample from a silage pit [ST 9972 0952] (Figure 2, Loc. 61) yielded *Gavelinella usakensis, G. stelligera, Bolivinoides culverensis, Pullenia quaternaria* and *Stensioeina pommerana* indicative of Zone BGS20iii.

Brash [ST 0053 0981] (Figure 2, Loc. 62) at the foot of the escarpment west of Bowerswain Farm included *Gavelinella usakensis, Bolivinoides culverensis, B. pustulata* and *Pullenia quaternaria.* Also present are microcrinoid plates, presumably *Appliocrinus cretaceus*, which are common in the lower part of the BGS20iii Subzone. An *ex-situ* Portsdown Chalk macrofauna is detailed below.

Spoil of soft to firm, white, blocky chalk from old trial/burial pit [SU 0047 1058] (Figure 2, Loc. 63), c. 250 m north of Amen Corner, Gussage All Saints, close to the base of the member, yielded: *Porosphaera patelliformis,* a serpulid, bryozoans (c. 8), *?Terebratulina striatula*, *Limatula wintonensis, Lyropecten* (*Aequipecten*) *campaniensis, Neithea sexcostata* (2), indeterminate oysters, *Plicatula hantonensis, Pycnodonte vesiculare, ?Spondylus latus,* asteroid skeletal plates, *Applinocrinus?* (calyx fragments), *Bourgueticrinus* sp. (columnals), *Offaster?* (test fragments). The tentative identification of *Applinocrinus* may indicate the middle part of the *quadrata* Zone (*cretaceus* Subzone) (Gaster, 1924). Although the remainder of the fauna is biozonally undiagnostic, it is a fairly typical assemblage in the *cretaceus* Subzone, although bryozoa are far less numerous than might be expected (Gaster, 1924).

From a silage pit [SU 0126 1141] (Figure 2, Loc. 64) c. 900 m at 320° from Bockington Farm, near Gussage All Saints, were collected: *Lyropecten* (*Aequipecten*) *campaniensis?, Bourgueticrinus elegans* (columnal), *Echinocorys* cf. *marginata* and *?Offaster pilula nana* (destroyed in development). Wright and Smith (1987) recorded that *Bourgueticrinus elegans* is highly characteristic of the *pilula* and *quadrata* zones; Mortimore (1986b) specifically assigned this crinoid a range in the upper *pilula* Zone in Sussex. The association of *B. elegans* with *Echinocorys* cf. *marginata* and *?Offaster pilula nana* favours assignment to the *quadrata* Zone, and the last two specimens could indicate the *cretaceus* Subzone. This subzone is typically rich in bryozoa (Gaster, 1924), but this is not evident in the above fauna, although locally, the chalk has a gritty texture. The presence of the *cretaceus* Subzone would indicate the Tarrant Chalk, but the field evidence suggests the Spetisbury Chalk.

A small section on the edge of a silage pit [SU 0203 1260] (Figure 2, Loc. 65a) at the west end of All Hallows Farm, Wimborne St. Giles, yielded *Orbirhynchia?, Neithea* sp. (cap valve), *Pycnodonte vesiculare, Gonioteuthis* sp. (fragment) and *Bourgueticrinus elegans* (columnal? and theca). Wright and Smith (1987) recorded that *Bourgueticrinus elegans* is highly characteristic of the *pilula* and *quadrata* zones, and Mortimore (1986) specifically assigned this crinoid a range in the upper *pilula* Zone in Sussex, an interval in which Bailey et al. (1983) recorded a virtual absence of *Gonioteuthis*. Thus, the co-occurrence of *B. elegans* and *Gonioteuthis* suggests the *quadrata* Zone. In the absence of really common bryozoans (characteristic of the *cretaceus* Subzone (Gaster, 1924)), the top part (= Post Applinocrinus Beds of Christensen, 1991) of the Zone is suggested. A microsample from this pit yielded an anomalous microfauna: *Gavelinella usakensis, G. trochus, Reussella szajnochae praecursor,* common *Bolivinoides culverensis* and rare *B.* cf. *decoratus.* Although *Pullenia quaternaria* was not found, the fauna probably falls within BGS20ii or 20iii. A similar microfauna was recorded in the brash sample 600 m north of Manswood (see above, Loc. 60). The featuring in the Chalk is not strongly developed in this area, but a position low in the Spetisbury Chalk is inferred.

To the north-west, near Monkton Up Wimborne, a brash sample [SU 0143 1318] (Figure 2, Loc. 65b) from low down in the member yielded *Gavelinella lorneiana, G. usakensis, G. trochus, Pullenia quaternaria* and *Bolivinoides culverensis* and indicate the *Pullenia quaternaria* Zone of Bailey et al., above the **Whitecliff Marl** (BGS20iii Subzone).

2.6.5 Portsdown Chalk Formation

2.6.5.1 Moor Crichel and Mill Hill outliers

An old chalk pit [ST 9610 0754] (Figure 2, Loc. 66a), near Witchampton, yielded *Zoophycos* flints and *Echinocorys*, including *E. brydonei*. Close by, another small pit [ST 9606 0755] (Figure 2, Loc. 66b) which exposes 5 m of firm white chalk with a few knobbly flints, also yielded *E. brydonei? Echinocorys brydonei* characterises the highest part of the *G. quadrata* Zone, and in the Isle of Wight, its range appears to be wholly within the basal part of the Portsdown Chalk as defined by Bristow *et al.* (1987) (Woods, 1995; 1997). The latter suggests that the *Zoophycos* flints represent the **Précy-Warren Farm Zoophycos Event** of Mortimore

and Pomerol (1991b). Possibly, beneath the widespread Clay-with-flint cover in this area there is a thin remnant of the basal Portsdown Chalk, but it cannot be mapped out by feature.

Brash at edge of a field [ST 9985 0845] (Figure 2, Loc. 67) c. 400 m at 078° from Crichel House, Moor Crichel, included *Zoophycos* flints and *Belemnitella* sp. A microsample from close by [ST 9982 0843] (Figure 2, Loc. 68) yielded *Stensioeina pommerana*, rare *Gavelinella* cf. *trochus* and very rare *Eouvigerina galeata*, but lacked a faunal element characteristic of a position higher than BGS20iii Subzone.

A *Zoophycos* flint was found in brash [SU 0017 0880] (Figure 2, Loc. 69) in a field, c. 900 m at 056° from Crichel House.

In an old pit [SU 0035 0860] (Figure 2, Loc. 70) on the south side of Mill Hill Wood, Mr Dixon found *'B. mucronata'* and inoceramid fragments, suggestive of the *mucronata Zone* (Big Almer Wood Member).

Mr Holmes collected a small fauna from an old pit [SU 0045 0950] (Figure 2, Loc. 71) south-west of Bowerswain Farm: *Kingena* sp., *Plicatula hantonensis* and *Echinocorys subconicula*.

At the top of the escarpment [SU 0065 0975] (Figure 2, Loc. 72) c. 300 m at 242° from Bowerswain Farm, was found *Zoophycos* flints and *Belemnitella*. Brash at the foot of the escarpment [SU 0053 0981], consists of *Zoophycos* flints, *Echinocorys subconicula* (abraded flint internal mould) and *Belemnitella*. The assemblage is characteristic of the basal part of the *mucronata* Zone (Woods, 1995). However, field and microfaunal evidence (see above) suggests that the chalk at the foot of the scarp is the Spetisbury Chalk, and so the macrofauna is not thought to be *in situ*.

2.6.5.2 HINTON MARTELL TO CRANBORNE

Belemnitella was found in brash [ST 9963 0517] (Figure 2, Loc. 73) 1 km south of High Lea Farm. A microsample from close by [ST 9966 0515] at the top of a low, 5-m high, escarpment, yielded abundant inoceramid prisms and the foraminifera *Bolivinoides culverensis, Bolivinoides* cf. *decoratus*, *Gavelinella* cf. *monterelensis, G. usakensis, G. trochus, G. clementiana, G.* cf. *voltziana* and *Stensioeina pommerana.* The abundance of inoceramid debris indicates the Big Almer Wood Member. Although there are poorly preserved specimens tentatively assigned to *G. monterelensis* and *G. voltziana*, they are rare and probably out of place. The rest of the fauna suggest the highest part of the BGS20iv Subzone, rather than the basal BGS21 Subzone. A broken *Belemnitella* was found in brash [ST 9989 0546] (Figure 2, Loc. 74) some 400 m NE.

The chalk in the old pit [SU 0110 0590] (Figure 2, Loc. 75) south-west of Hinton Martell is described as 'soft white, with marcasite nodules and no flint' (Reid, 1902). The recorded fauna includes '*Belemnitella mucronata, Terebratulina striata* and *Rhynchonella plicatilis'*. A re-examination of the fauna by M A Woods identified *Cretirhynchia woodwardi.* This species generally indicates a position high in the *mucronata* Zone, but its range is not known with certainty and has been recorded with *Echinocorys conica* which occurs lower in the *mucronata* Zone.

From a well [SU 0155 0690] (Figure 2, Loc. 76) in the north corner of Sturt's Copse, Mr Dixon collected (in 1899), a fauna from a c. 20 m interval below the top of the chalk: *Cretirhynchia limbata* sensu Gaster, 1924, *Kingena* sp., *Belemnitella* sp. (3) and *Echinocorys* sp. (test fragments). Mapping indicates that this 20-m interval should all fall in the Portsdown Chalk, but *Cretirhynchia limbata* sensu Gaster, 1924 is more typical of the *G. quadrata* Zone (Gaster, 1924).

An old pit [SU 0172 0754] (Figure 2, Loc. 77) south-south-east of Chalbury Farm still exposes 2 m of firm, white chalk; there is one layer of knobbly flints at the top. Close by, *Belemnitella* was found in brash [SU 0173 0746] (Figure 2, Loc. 78).

Some 900 m west of Chalbury Farm [SU 0086 0774] (Figure 2, Loc. 79), five specimens of *Belemnitella* were found in the brash. Close by, a microsample [SU 0091 0787] (Figure 2, Loc. 80) yielded *Gavelinella clementiana, G. usakensis, G. trochus, G. monterelensis, G. lorneiana, G.* cf. *voltziana, Bolivinoides decoratus* and *Hedbergella* cf. *holmdelensis*. The incoming of *G monterelensis* and *G voltziana* is good evidence of the BGS21 Subzone.

Similarly, microfauna from a brash sample [SU 0158 0869] (Figure 2, Loc. 81) to the north-east, near the Horton Inn, yielded *Gavelinella monterelensis, G. usakensis, G. trochus, G. clementiana, G. voltziana, Bolivinoides decoratus* and *Stensioeina pommerana* indicative of the BGS21 Subzone.

At Horton to the east, *'Belemnitella mucronata'* was recorded in two pits [SU 0275 0750 and 0301 0752] (Figure 2, Loc. 82). Farther north, a large pit [SU 029 092] (Figure 2, Loc. 83), now filled, on the south-west side of Knowle Hill, yielded '*B. mucronata* and *Kingena lima*' to Mr Dixon. In a well [SU 0322 0975] (Figure 2, Loc. 84) on Knowle Hill, Mr Dixon noted a belemnite at a depth of 36 m.

An old pit [SU 0169 1022] (Figure 2, Loc. 85), c. 450 m at 208° from Bockington Farm, exposes a c. 2 m section of soft, inoceramid-rich chalk with horizons of spikey nodular flints and *Zoophycos*-like flints. From a shelly horizon in the middle of the section were collected: *Kingena* sp., loose *Belemnitella* sp. (3) and *Gonioteuthis* sp. The co-occurrence of *Gonioteuthis* and *Belemnitella* suggests the highest part of the *G. quadrata* Zone (Bailey et al., 1983), and the basal Portsdown Chalk (below the Farlington Marls) of Bristow et al. (1997). Foraminifera from a sample from this pit include: *Gavelinella clementiana, G. usakensis, G. trochus, Pullenia quaternaria, Stensioeina pommerana, Reussella szajnochae praecursor* and *Bolivinoides* cf. *decoratus*. The last species, if correctly identified, together with *G. trochus*, indicate the *decoratus* Zone; the absence of *G. montelerensis* suggests a position below the Farlington Marls (i.e. BGS20iv, highest *quadrata*, rather than the *mucronata* Zone), and supports the conclusion based on the macrofauna. The combination of abundant inoceramid debris with the micro- and macrofauna indicates the Big Almer Wood Member.

From a small exposure [SU 0180 1040] (Figure 2, Loc. 86) just to the north-east were collected a solitary coral, bryozoans, abundant comminuted inoceramid shell laths and fragments, asteroid skeletal plates, and an *Offaster* or *Galeola.* As above, the Big Almer Wood Member is indicated.

At Knowlton, some 700 m east-south-east of the above localities, a brash sample [SU 0242 1012] (Figure 2, Loc. 87) yielded the following foraminifera: *Gavelinella lorneiana, G. usakensis, G.* cf. *clementiana, G.* cf. *voltziana, Neoflabellina, Bolivinoides decoratus, Stensioeina pommerana* and *S. granulata incondita.* The *decoratus* Zone is indicated by the eponymous foraminifera of Bailey et al. However, *G. monterelensis* is not present, suggesting a position below the Farlington Marls, i.e. BGS20iv Subzone.

An old pit [SU 0388 1118] (Figure 2, Loc. 88) in St Giles Park formerly exposed soft white chalk with abundant flints and '*B. mucronata'*. Firm white chalk in tree roots [SU 0410 1138] (Figure 2, Loc. 89) at 900 m at 104° from St. Giles' House, yielded *Belemnitella* and *Echinocorys* sp. (crushed and incomplete, but quite large). To the north-north-east, *Belemnitella* is common in the brash [SU 0428 1185] (Figure 2, Loc. 90), and *Belemnitella* and a *Zoophycos* flint were found a little farther north-west [SU 0415 1200] (Figure 2, Loc. 91). In a well [SU 0453 1205] (Figure 2, Loc. 92) at Cranborne Lodge, Mr Dixon recorded 30 m of 'soft white chalk with occasional seams of nodular flints, a few tabulars and two marl seams'. One of them at 80 feet [24 m] yielded numerous coccospheres. *Belemnitella mucronata* was found at 90 feet [27 m]' (Reid, 1902, p.6).

'Belemnitella mucronata' was found by Mr Dixon to a depth of 8 m in soft chalk with rare thin-skinned flints in an old pit [SU 0458 1120] (Figure 2, Loc. 93), now filled, on the east side of the B3078 (Reid, 1902, p.6).

Belemnitella was found on the surface [SU 0334 1332] (Figure 2, Loc. 94) low down in the formation south-west of Nine Yews. Mr M Green (*pers. commn.* 1998) found *Belemnitella* in brash to the north [SU 0372 1396] (Figure 2, Loc. 95) and south-east [SU 0400 1333] (Figure 2, Loc, 96) of Nine Yews. Close by, another *Belemnitella* was found [SU 0391 1351] (Figure 2, Loc. 97).

A microsample [SU 0334 1422] (Figure 2, Loc. 98) on the north side of Bottlebush Clump yielded: *Gavelinella usakensis, G. lorneiana, G. trochus, G. clementiana, G. pommerana, Bolivinoides culverensis, B. decoratus* and *Reussella szajnochae praecursor* and also indicates the BGS20iv Subzone.

A microsample [SU 0483 1325] (Figure 2, Loc. 99) south of Manor Farm, Cranborne, yielded the following foraminifera: *Gavelinella clementiana, G. trochus, G. usakensis, Stensioeina pommerana, Pullenia quaternaria* and *Bolivinoides decoratus* indicative of the BGS20iv Subzone.

A small excavation [SU 0408 1462] (Figure 2, Loc. 100) on the north side of Cranborne Farm yielded *Belemnitella* (7 specimens), and common inoceramid shell fragments (including common shell laths in brushed chalk samples). A *Zoophycos* flint was also collected. A microsample from this locality yielded: *Stensioeina pommerana, Gavelinella usakensis, G. trochus, G. clementiana, Bolivinoides decoratus* and *B. culverensis*. The combination of lithology and fauna indicates the Big Almer Wood Member and the BGS20iv Subzone.

Loose *Belemnitella* were found on the fields east [SU 0438 1556] (Figure 2, Loc. 1001) and north-east [SU 0482 1624] (Figure 2, Loc. 102) of Black Bush. A microsample [SU 0467 1619] (Figure 2, Loc. 103) , about 7 m lower than the last site, yielded scarce foraminifera that included *Gavelinella usakensis, G. trochus, G. lorneiana, Stensioeina pommerana* and *Bolivinoides culverensis*. The fauna is no younger than late *quadrata* Zone (Scratchell's Marl) suggesting the very basal Portsdown Chalk (?top BGS20iii).

A microsample [SU 0360 1706] (Figure 2, Loc. 104) in poorly feature ground on the west side of Pentridge Down is thought to be from low down in the formation. It yielded *Gavelinella usakensis, G. trochus, Stensioeina pommerana, Pullenia quaternaria* and *Bolivinoides culverensis*. The absence of *Bolivinoides decoratus* suggests the fauna is from a horizon below Scratchell's Marl (top BGS20iii Subzone?); the sample may be from the highest Spetisbury Chalk.

3 Palaeogene

Readers should note that the descriptions of named units contained herein relate to the original 1:10 000 scale standards. The digital version of these sheets show the same units but designated on the basis of their lithology (eg. glauconitic sand in the Reading Formation and sand within the London Clay Formation). Wider examination of the units across the Ringwood (sheet 314) 1:50 000 map indicate that correlation of one sand unit to another is difficult and therefore designation by name, implying age equivalence, has proved inappropriate.

3.1 READING FORMATION

The Reading Formation has a persistent outcrop diagonally across the central part of the district. The outcrop width varies from 200 m to over 1 km. The formation is divided into two broad units: a lower, glauconitic, Chalbury Glauconitic Member, and an upper, commonly red-stained, unnamed clay member. Locally thin beds of fine- to coarse-grained sands are developed in the upper member.

3.1.1 Chalbury Glauconitic Member

At the base of the formation is a pebbly glauconitic sandy clay recognisable over much of the western part of the Wessex basin, but rarely more than 1 m thick. It becomes thick enough to map on the north-eastern margin of the Bournemouth district and is mapped right across the present area. It is named herein as the Chalbury Glauconitic Member.

The basal bed of the member is usually a pebble bed consisting of glauconite-coated flint pebbles and cobbles set in a glauconitic sand or sandy clay. The pebbles consist of well-rounded small flints (generally up to 4 cm across), but larger, scattered, well-rounded and angular flints and blocks of coarse-grained sandstone up to 10 cm across also occur. The pebble bed is succeeded by up to 4 m of sandy, very glauconitic clay with common oysters. In the Fordingbridge well north of the present area, the member consists of some 3 m of glauconitic quartz sand with oysters (Reid, 1902, p.8). At Verwood, the Rectory well proved 3.3 m of 'dead greensand' (Reid, 1902, p.9).

In addition to the oyster '*Ostrea bellovacina*', fully marine fossils have also been found locally (see details of the well section in Sturt's Copse, below).

3.1.2 Unnamed, red-stained member

Over most of its outcrop, this member consists almost entirely of 10 to 15 m of red-stained grey clay, but in the south of the area, as far north as Wiltshire Wood [SU 013 066], the clay is capped by 5 to 10 m of fine-to medium-grained sand. Typically, sands in the Reading Formation are part of fining-upward cycles. In the Woodlands Borehole, red-stained clay is overlain by such a fining-upwards sand unit. South of Hinton Martell [around SU 0115 0540], the Chalbury Glauconitic Member is either absent or, more probably, too thin to map and the red-stained unit apparently rests directly on the Chalk.

3.2 LONDON CLAY FORMATION

The London Clay extends in a broad tract some 1 to 3.5 km wide, north-eastwards from Hinton Martell in the south, to Woodlands in the north. King (1981) divided the formation into 5 major stratigraphical divisions (labelled A-E in ascending sequence), with each division bounded by major discontinuities. Less prominent discontinuities exist within these divisions and are used to subdivide them into, for example A1, A2, A3. The top of a division and subdivision is commonly the top of a coarsening-upward cycle (see King, 1981, fig. 8).

In the western part of the Hmpshire Basin, London Clay Divisions D and E are not identifiable as they are represented by the dominantly fluviatile Poole Formation (see Bristow et al., 1991, fig. 8).

Following Bristow et al. (1991), the London Clay, about 35 m thick, is divided into a lower, red-stained unit, the West Park Farm Member (only developed in the south-west), succeeded by two named sand members (Warmwell Farm Sand and Lytchett Matravers Sands) interbedded with clay members, named herein the Holt Member and Holt Forest Member.

3.2.1 West Park Farm Member

The West Park Farm Member superficially resembles the Reading Formation (Bristow et al., 1991, pp.23–24), but is differentiated by the following three criteria:

i) in places, red-stained clay, which does not show the high gamma-ray counts normally recorded in the Reading Formation, overlies blue-grey, silty clay typical of the London Clay;

ii) gamma-ray logs of the reddened strata show coarsening-upwards cycles characteristic of the London Clay, and,

iii) there is at least one bed of well-rounded flint pebbles within the reddened clays.

Within the present area, only mottled red and grey, and yellow and grey sandy clays were noted.

In the Bournemouth area, there is some sparse dinoflagellate evidence that the member falls in the *hyperacantha* Zone (Division A1 of King (1981)) (Bristow et al., 1991, p.25).

3.2.2 Warmwell Farm Sand

The Warmwell Farm Sand is well developed across the whole area. It usually forms a good feature on top of the Reading Formation, and a springline usually marks its base. Around Pentridge in the north-east, the member has overstepped the Reading Formation and rests directly on Chalk. Evidence outside the area of this report suggests that these outliers may be of Reading Formation Pebbles Sands however and this should be boarne in mind when reading the following text.

The Warmwell Farm Sand consists of 3 to 11 m of fine- to coarse-grained, locally pebbly, and locally glauconitic sand. The well at Rooks Hill provides a typical section. Locally, as in Wiltshire Wood [SU 013 065], the member consists almost entirely of well-rounded pebbles; elsewhere, as on Rye Hill [SU 043 103] and the outliers [SU 040 170, 0500 1674, 048 166 and 046 177] near Pentridge, very pebbly sands are developed. The very well rounded pebbles, consisting entirely of flint and commonly 'chatter-marked', are up to 15 cm across.

In the Bournemouth district, bivalves and gastropods from the Warmwell Farm Member are indicative of London Clay Division A, possibly Division A3 (Bristow et al., 1991, p.25, 29). Dinoflagellates in the Bournemouth area indicate the *meckelfeldensis* Zone (Division A2 or A3).

3.2.3 Holt Member

The Holt Member (herein named) consists of about 12 m of fine-grained, grey sandy, shelly, clay. Locally, thin pebble beds are developed. In the Holt area, in sections seen by King (1981, p.91) and Stinton (1966), the lithology and fauna suggests that the strata below a pebble bed fall in the London Clay Division B1, and that the pebble bed marks the base of B2. Foraminifera and dinoflagellate cysts from several localities in the Bournemouth area indicate that the member falls in the *simile* Zone (London Clay Division B) (Bristow et al., 1991, p.25). At a depth of 20.5 m in a borehole [SU 0362 0407] at Bowers Farm just south of the present area (Bristow, 1987), the following foraminifera were obtained (identified by M J Hughes): *Alabamina westraliensis* (Parr) (rare), *A. nobilis* Brotzen (common), *Brizalina anglica* (Cushman) (frequent), *Cibicides lobatulatus* (Walker & Jacob) (rare), *C. alleni* (Plummer) (common), *Pullenia quinqueloba* (Reuss) (rare), *Pulsiphonia prima* (Plummer) (rare) and *Spiroplectammina adamsi* Lalicker (frequent), and the dinoflagellate (identified by R Harland) *Apectodinium homomorphum*. Collectively, the *simile* Zone within Division B or the basal part of Division C is indicated and a lagoonal environment of deposition.

3.2.4 Lytchett Matravers Sand

The Lytchett Matravers Sand extends across the whole area and commonly forms hill caps. It consists of up to 5 m of silty and clayey, very fine- to fine-grained, locally glauconitic and locally pebbly, sand. Springs commonly mark the base of the member. The pebble bed noted at Holt Lodge Farm [SU 0526 0613] by Mr Dixon (see Details) appears to mark the top of the member.

The only fossils recorded from the Lytchett Matravers Member are from a depth of 15.5 m in the borehole [SU 0362 0407] at Bowers Farm just south of the present area (Bristow, 1987) (the member extended from 14 to 17.5 m). They included the foraminifera (identified by M J Hughes): *Alabamina nobilis* Brotzen (rare), *Cibicides lobatulatus* (Walker & Jacob) (rare), *C. alleni* (Plummer) (frequent), *Pulsiphonia prima* (Plummer) (rare) and *Spiroplectammina*

adamsi Lalicker (frequent), and the dinoflagellate cysts (identified by R. Harland) *Apectodinium homomorphum* and *Dracodinium* sp. Collectively, the *simile* Zone within Division B or the basal part of Division C is indicated and a lagoonal environment of deposition.

3.2.5 Holt Forest Member

There is a fairly extensive outcrop of this member, dipping at about 2° east-south-east, in the south-east of the area. About 5 m of the member are present at outcrop, but as much as 22 m appear to be present at depth in the Woodlands Borehole [SU 0659 0627]. There is no exposure. For the most part, mottled orange and grey sandy clay was augered, but clayey fine-grained sand was noted in one place [SU 0444 0533], and mottled red and pale grey clay in another place [SU 0475 0610].

The only fossils found in this member close to the area are in the borehole [SU 0362 0407] at Bowers Farm just south of the present area (Bristow, 1987). The following foraminifera (identified by M J Hughes) were obtained: *Alabamina westraliensis* (Parr) (common), *A. nobilis* Brotzen (very common), *Cibicides lobatulatus* (Walker & Jacob) (frequent), *C. alleni* (Plummer) (very common), *Globigerina* sp. *linaperta* Finlay (rare), *G. octocameratus* (Cushman & Hanna) (rare), *Karreria fallax* Rzehak (rare), *Pullenia quinqueloba* (Reuss) (rare), *Pulsiphonia prima* (Plummer) (frequent) and *Turrilina brevispira* Dam (rare), and the dinoflagellate cysts (identified by R Harland) *Apectodinium homomorphum* and *Homotryblium tenuispinosum* Davey & Williams. Collectively, the *simile* Zone within Division B or, more likely, the basal part of Division C is indicated and a lagoonal environment of deposition. In the Bournemouth district, the topmost part of the London Clay falls in the *varielongitudum* Zone (Bristow et al., 1991, p.26).

Details

3.2.5.1 CHALBURY GLAUCONITIC MEMBER

Although the Chalbury Glauconitic Member can be recognised in section (see next paragraph) from the southern margin of the area to Hinton Martell, it was not possible to map the member through the largely landslipped ground.

In the lane south of Hinton Martell, Mr Dixon saw the following descending sequence. No thickness was given for each unit, but the total sequence seen appears to be about 4 m:

[SU 0144 0584]
Clay, grey
Clay, red with green streaks
Clay, green, loamy, abundantly glauconitic a short distance down
[SU 0143 0586]
Oyster bed
[SU 0143 0589]
Loam, glauconitic
Chalk

Above the highest strata, red clay [SU 0146 0571], succeeded by pebbly sand [SU 0146 0568] of the Warmwell Farm Sand was proved.

Glauconitic sandy clay was augered [SU 0140 0581] in the field just west of the lane.

On the north side of Hinton Martell, the member crops out on the dipslope over an area about 150 m^2. At two points [SU 0126 0623 and 0132 0620], the junction with the Chalk was proved (respectively 0.6 and 1.1 m of glauconitic clay above chalk).

Northwards from this occurrence, the member cannot be traced in the steep ground around Wiltshire Wood, but reappears on the north-west side of Sturt's Copse, where at least 1.2 m of glauconitic grey clay was augered [SU 0143 0687].

In a well [SU 0155 0690] in Sturt's Copse, Chalbury, Mr Dixon saw the following section:

	Thickness (m)	*Depth* (m)
Soil and mottled clay (red, dark grey and buff)	4.27	4.27
Chalbury Glauconitic Member		
Oyster bed with race	0.22	4.49
Sand, loose, glauconitic	1.22	5.71
Oyster bed with race	0.61	6.32
Loam, sand and clay, glauconitic, with fossils	2.13	8.45
Chalk (top 0.6 m with irregular borings)	33.83	42.28

From unspecified horizons in the member were obtained '*Myliobatis* sp., *Odontaspis elegans*, shark's teeth, fish bones and scales, *Cardium, Corbula, Modiola, Mytilus* cf. *dutemplei, Nucula, Ostrea bellovacina, Pinna?*' and indeterminate bivalves. In addition, besides derived Chalk foraminifera, were found in situ '*Haplophragminum, Trochammina, Pulvinulina* and *Rotalia*' (Reid, 1902, p.11).

There is only a narrow outcrop in the steep ground north of Oxleaze Copse, but farther north-east, the outcrop broadens to a 400 m long dip slope (strata dipping at about 2° south-east). More than 1.3 m of glauconitic clay, locally with oysters, was proved in places [SU 0210 0752 and 0179 0754]. Mr Dixon saw an oyster bed at a depth of 1.35 m in a section [SU 0185 0772] at Chalbury Farm. Some 400 m east-north-east of the farm, a small outlier has been mapped. An auger hole [SU 0219 0791] in this tract proved 0.8 m of brown clay on 0.4 m of glauconitic sand.

In the steep ground west of Horton Hollow, the member could not be traced continuously, but its presence is proved by an auger hole [SU 0294 0714] at the top of an old chalk pit.

On a small outlier on the north-west side of Horton, an auger hole [SU 0281 0765] proved 1.2 m of weakly glauconitic grey clay on chalk. Nearby [SU 0286 0761], 1.1 m or red-brown pebbly clay was augered. Some 400 m north-north-east, pebbly clay is the dominant lithology of another outlier [SU 030 080].

There is an extensive outcrop of glauconitic sandy clay, almost 1 km wide, on the dipslope extending south-eastwards from Northill House. Oysters were encountered in augering at several points [SU 0308 0844 and 0337 0832]. Mr Dixon noted pale glauconitic laminated sand at one point [SU 0285 0830] on a small outlier south-east of the farm. Elsewhere on this outlier, glauconitic, orange and grey sandy clay was augered.

Just north-north-east of Ash Pit, glauconitic sand was augered [SU 0359 0858]. To the north-east of this occurrence [around SU 039 088], Mr Dixon noted that "*the surface shows many angular fragments of sandstone of fine to medium grain, pale but with occasional red blotches, with chalcedonic cement, and varying from hard sand-rock to cherty sandstone. These contain vertical roots, and appear to belong to a greyweather sandstone in place in the Reading Beds*". At the northern end of this tract, Mr Dixon noted a total 0.9 m of medium-grained sand passing down into pale grey loam [SU 0391 0892].

On the south side of Knowle Hill, four small outliers were mapped during the original geological survey. It is now thought that three of these are continuous with the larger outlier of Knowle Hill. '*Ostrea bellovacina*' was noted at two points [SU 0364 0908 and 0355 0919] in glauconitic loam by Mr Dixon.

In the lane [SU 0412 0942] on the south-west side of Woodlands Copse, Mr Dixon saw, beneath red clay (slip), 1.22 m of 'glauconitic loam and clay', resting on 0.3 m of 'brown glauconitic

loam full of flints'. The flints comprised large and unworn, small angular, or pebbles, some green-coated or pitted (Reid, 1902, p.11).

Glauconitic sandy clay was augered at one point [SU 0401 0992] in Six Acre Copse, and at two points [SU 0408 1069 and 0412 1065] on the west side of Bone Acre Copse. In a pit [SU 0153 1101] near the Keeper's Lodge, Wimborne St Giles, Mr Dixon saw glauconitic loamy sand with race and '*Ostrea bellovacina'*. The last place in the area where glauconitic sandy clay was augered was about 400 m north-east of the Keeper's Lodge [SU 0490 1114].

3.2.5.2 UNNAMED MEMBER

From the southern margin of the area to Hinton Martell, the member consists of about 10 m of mottled orange and grey, locally red-stained clay, capped by a bed of fine-grained sand. Much of the outcrop is obscured by landslip.

In an old sand pit [SU 0125 0525] about 800 m south of Hinton Martell, C Reid saw 9 m of cross-bedded buff sand. Ferruginous, fine- to medium-grained, sand was augered in the bottom of the pit.

An upper unit of sand also occurs on the hill in Wiltshire Wood. Coarse-grained pale sand was augered in the sides of an old pit [SU 0117 0655]. North-eastwards from this locality, only clay crops out, although in the Sturt's Copse brickpit [SU 015 068], Mr Dixon noted a bed of slightly glauconitic sand in red-mottled clay.

Clay was also worked for bricks [SU 0305 0705] at Horton Hollow, but no section remains. There, Mr Dixon noted red and buff mottled clay beneath the Warmwell Farm Sand.

Around Woodland Copse [SU 044 096] and northwards to Great Rough Copse [SU 047 103], the member is over 1 km wide, but there is no section. Augering proves mostly mottled orange and grey, sandy to very sandy, clay, only locally red stained.

Red and purple-stained clay is common on the outlier at Knowle Hill [SU 033 095].

3.2.6 London Clay

3.2.6.1 WEST PARK FARM MEMBER

The West Park Farm Member crops out over a 500-m tract north of Higher Manor Farm House [SU 0137 0530]. Mottled red and grey, and yellow and grey sandy clay were augered in this tract.

3.2.6.2 WARMWELL FARM SAND

In the south of the district, the member has an outcrop over 1 km wide, narrowing to less than 100 m east of Hinton Martell. For the most part, very fine- to fine-grained sand, patchily clayey, is the dominant lithology, but locally [SU 0184 0533] medium- to coarse-grained sand was augered; pebbles were recorded in several places [SU 0165 0502, 0208 0505, 0179 0514, 0183 0548, 0146 0553 (low down in the member), 0144 0560, 0162 0580, 0164 0599, 0183 0577 and 0193 0592]. Glauconitic fine-grained sand was augered [SU 0212 0527] close to the base of the deposit near Gaunt's Common. The sands were formerly worked in a small pit [SU 0150 0532] near Higher Manor Farm House.

A well [SU 0243 0579] at Rooks Hill proved the following sequence (Reid, 1902, p.19):

	Thickness (m)	*Depth* (m)
Holt Member		
Clay, weathered, mottled	2.13	2.13

Loam, buff, passing down into grey laminated clay with casts of lignite	3.05	5.18
Warmwell Farm Sand		
Sand, loose, buff with occasional clay seams	3.05	8.23
Sand, glauconitic with pebbles below	0.61	8.84
Clay, loamy, laminated with casts of lignite	0.20	10.04
Pebble-bed with flint pebbles up to 25 cm diameter	0.08	10.12
Loam with a little glauconite	0.20	10.32
Sand, glauconitic, passing down into a medium grained sand without glauconite	5.79	16.11

Mr Dixon who mapped this area in 1899 thought that the lower two units formed part of the Reading Formation, but the presence of glauconite suggests the Warmwell Farm Sand.

The thin layer of ferruginous sand with glauconite, a little wood and shells exposed in the lower part of the Holt Wood brick pit [SU 0308 0604] (Reid, 1902, p.18) may be part of the Warmwell Farm Member. The fossils included '*Cardium, Cytherea, Ostrea, Turritella Dixoni*, and a second species of *Turritella*'.

The outlier under Wiltshire Wood [around SU 013 066] north of Hinton Martell is dominantly a pebble bed of well-rounded flints, and was formerly dug for road and track making. A cemented pebble bed, 0.5 m thick, can be seen at the northern end [SU 0125 0658] of one pit, whilst at the southern end [SU 0122 0654], some 0.4 m of pebble bed is exposed. The pebbles are mostly in the range 2 to 5 cm, but some are up to 15 cm diameter.

From Hinton Martell northwards, and around Chalbury, the outcrop is narrow (mostly less than 50 m), but well marked by feature and spring. The outcrop widens considerably around Chalbury Common and extends down the valley on the west side of Holt Wood [to SU 030 056] and down the valley south-east of Linen Hall Farm [to 0345 0624], where Mr Dixon noted 0.6 m of 'glauconitic, micaceous, grey loamy sand and sandstone in the stream bed. Very fine- to fine-grained sand was commonly augered in this area; no pebble was noted.

At the old brick pit [SU 0265 0610] south of Chalbury Common, Mr Dixon noted a pebble bed with large and small pebbles, resting on buff clay loam, on red clay of the Reading Formation.

From Horton Hollow north-eastwards towards Woodlands, the Warmwell Farm Sand has an outcrop width of between 50 and 100 m. Mostly fine-grained sand was found in this tract, a few pebbles were noted. Just south of Woodlands Manor Farm, Mr Dixon noted buff, pebbly, glauconitic sand, passing down into 'loam' close to the base of the member [SU 0451 0800]. Just north of the farm [SU 0453 0834], fine-grained pebbly sand with ironstone fragments was seen. A little farther north [SU 0465 0858], at the base of the member, a medium-grained flinty sand with small pebbles up to 3.5 cm across was seen by Mr Dixon.

In the woods south-east of St Giles Park there are four outliers of pebbly sand. In the largest, westernmost outlier, the pebbles were dug for trackmaking. Mr Dixon recorded the following section [SU 0406 1031]: a pebble bed, 3 m thick, consisting of facetted and pitted flints up to 15 cm across in a matrix of coarse-grained sand and sub-angular flint fragments; an inclined seam of coarse-grained flinty sand, 5 cm thick, noted. A small section [SU 0408 1032] was still visible in 1998 and showed 1 m of poorly sorted (pebbles 5 to 10 cm diameter), well-rounded flint pebbles in a fine- to medium-grained matrix. At the southern end of the pit [SU 0415 1018], two greyweather sandstones were seen by Mr Dixon. Just to the east, 1 m of pebbly soil was seen [SU 0417 1017] during the present survey above a spring issuing from the base of the member. In a sand pit [SU 0405 1040] on the north side of this outlier, Mr Dixon recorded 2.4 m of medium-grained, pale, glauconitic loose sand.

A section [SU 0446 1050] on the northernmost outlier showed 1 m of poorly sorted, well-rounded flint gravel. In a pit [SU 0450 1003] on the south-eastern outlier, Mr Dixon saw

medium- to coarse-grained, flinty, glauconitic sand. The middle outlier [SU 0435 1020] appears to consist of pebbly sand; a line of springs mark its southern boundary.

Most of the rest of this section on the Warmwell Farm Sand are from the field notes of Mr Dixon.

At Woodlands, abundant pebbles were noted at the base of the member on the north side of the old brick pit [SU 0495 0924 to 0517 0920]. In the stream which flows eastwards towards Whitmore, was noted 0.9 m of medium- and fine-grained glauconitic sand and loam [SU 0537 0916].

On Rye Hill and its flanks, there are four outliers [SU 041 103, 0435 1020, 045 101 and 044 105] of pebbly sand. A small exposure [SU 0408 1032] still reveals 1 m of poorly sorted, well rounded pebbles in a fine- to medium-grained sand matrix; the pebbles vary from 5 to 10 cm diameter. On the south side of the hill, a pebble bed, 1 m thick, was formerly exposed [SU 0417 1017]. The outlier on the eastern side of the hill appears to be less pebbly; an old pit [SU 0450 1003] formerly worked fine-grained, brown sand. An exposure [SU 0447 1050] on the northern outlier showed 1 m of poorly sorted well rounded flint gravel.

On the west side of King's Wood, there are several old sandpits [around SU 051 099]. Fine-grained buff sand at one point [SU 0512 0992] was dug to a depth of 3 m. To the east, lies the old Sutton brick pit [SU 055 099]. There the following section was seen (Reid, 1902, p.18):

	Thickness (m)	*Depth* (m)
Holt Member		
Clay	0.61	0.61
Ironstone	0.05	0.66
Clay	0.61	1.27
Ironstone	0.08	1.35
Clay, glauconitic, loamy	0.05	1.40
Clay, pinkish	0.05	1.45
Loam, dark grey, glauconitic with fossils	0.46	1.91
Warmwell Farm Sand		
Pebble bed with coarse-grained flint sand	0.05	1.96
Sand, fine-grained, buff	0.15	2.11
Loam, pale grey	0.02	2.13
Sand, laminated, slightly glauconitic	1.35	3.48

Fossils from the two ironstones in the Holt Member include 'fish scale, *Bulla, Natica ambulacrum* Sow., *Phorus, Turritella Dixoni* Desh., *Turritella* sp., *Voluta elevata* Sow., *Cardita Brongniarti* Mant., *Glycimeris (Panopaea) intermedia* Sow., *Modiola?, Nucula, Ostrea, Hemiaster branderianus* Forbes'. King (1991) regarded the pebble bed at the top of the Warmwell Farm Sand as the basal bed of B1.

South and east of the brickpit, Mr Dixon recorded 'glauconitic sand' at the surface [SU 0592 0989], and 0.62 m of fine-grained glauconitic sand in the stream bed [SU 0596 0981]. In an old sand pit [SU 0610 0983] south of Sutton Holme, fine-grained buff sand was seen. Other old sandpits were recorded close to Sutton Holme [SU 0616 0989] and to the north-east [SU 0622 0998 and 0620 1001].

An old sand pit [SU 0588 1002] 180 m south-west of Sutton Farm formerly exposed 0.3 m of brown loam, on 0.22 m of sand, on 0.46 m of glauconitic sand and clay. Some 140 m north-west of the above pit, pebbly sand on red clay [SU 0578 1004] was noted. Several old sand pits were noted on the north-east side of Sutton Common [SU 0552 1010, 0544 1020 and 0554 1022]. In the middle pit, medium-grained, white, pebbly sand was seen, whilst in the third pit, and also just to the north [SU 0552 1030], medium-grained sand was recorded. Fine-grained sand and loam,

associated with a pebble bed, was seen low down in the member in the track [SU 0546 1028] at the northern end of the Common.

Another old sand pit [SU 0536 1043] was seen in the southern part of Maldry Wood. On the west side of the wood, medium-grained, pebbly sand was thrown out of a badger sett [SU 0530 1066]. Just to the east, old sand pits were recorded [around SU 0540 1068]. Close by, occurs medium-grained, pebbly sand near the base of the member [SU 0538 1070]. Loose pebbly sand was also seen farther east [SU 0551 1070].

In a badger hole [SU 0579 1090] on the east side of the wood 0.9 m of brown loam (partly wash was noted), resting on a 5 mm-thick ironstone with a white, fine-grained sandy core, on 1.22 m of fine-grained, laminated buff sand and loam.

On the north-west side of Sandy's Hill, 5 mm of loamy laminated sand, resting on 0.3 m of fine-grained pale sand was noted [SU 0603 1104]. In the lane on the north-east side of the hill, fine-grained glauconitic sand with a spring at the base was seen [SU 0620 1099], whilst about 15 m south-west in the lane, brown clay rested on 0.6 m of fine-grained pale sand. Pebbly sand was noted at the corner [SU 0618 1094] of the lane.

Creech Hill [SU 0445 1300] is capped by the Warmwell Farm Sand, which was worked in a small pit [SU 0446 1302] on the north side.

On the outliers [SU 040 170, 0500 1674, 048 166 and 046 177] near Pentridge, and near Cranborne Farm [SU 0475 1455, 0482 1473 and 049 149], very pebbly sand occurs and was worked for gravel in many places [SU 0385 1671, 0383 1699, 0389 1715, 0440 1729 and 0455 1767].

3.2.6.3 HOLT MEMBER

The interfluve extending from just south of Gaunt's Common [SU 027 500] to Chalbury [SU 020 067] is capped by the Holt Member, although there is no exposure. The beds were formerly worked in a pit [SU 024 508] at Rooks Hill, close to where a well proved at least 5.2 m of clay (see Warmwell Farm Sand details).

The member caps the interfluve at Holt Wood. In the brick pit [SU 031 060] in the wood, Mr Dixon saw 3 m of brown clay with, near the base, a thin layer of ferruginous sandstone with glauconite, a little wood and shells, both unaltered and as casts. The shells included '*Cardium, Cytherea, Ostrea, Turritella Dixoni* and a second species of *Turritella*'. A section seen by Stinton (1966), presumably from the more modern pit [SU 033 061], exposed a pebble bed with a diverse and well-preserved molluscan fauna including *Pitar sulcatarius,* tellinids, *'Corbula' pseudopisum, Nemocardium* spp. *Panopea intermedia, Euspira glaucinoides, Sigatica hantoniensis, Ficopsis smithii, Turritella terebellata, Aporrhais sowerbii clarendonensis, Streptolathyrus cymatodis* and turrids. An auger hole starting at this pebble bed proved 6 m of sandy clayey silts with *Venericor* sp. and '*Lucina' lamellata* and indicative of Division B1. The pebble bed is therefore thought to mark the base of B2 (King, 1980).

The Holt Member, dipping south-eastwards at about 2°, caps the interfluve from Horton Hollow [SU 030 069] to Ferndown Forest [SU 0430 0465].

North-east of Bagman's Farm, the surface of the Holt Member is very pebbly [SU 0493 0868 to 0499 0878]. Nearby [SU 0462 0845], at the base of the member, pebbly buff clay was noted.

In the old brickpit [SU 0500 0915] at Woodlands, Mr Dixon noted 2.1 m of brown clay. Farther east [SU 0530 0898 to 0546 0898], he noted 'brown pebbly clay', whilst close by [around SU 0550 0904] he recorded a 'pebble bed'.

The Verwood Brickyard [SU 076 092] formerly exposed the following section (Reid, 1902, p. 17):

	Thickness (m)
Clay with *Astarte?, Cytherea?* and fish scale; glauconitic in the lower unweathered part. Impersistent thin beds of fine-grained sandy ironstone, one near the base with *Turritella* and a leaf of *Hakea?*	5.48
Clay and pebbles resting on fnie-grained glauconitic sand and pebbles	0.25
Cockle bed. Sandstone, white, concretionary calcareous, glauconitic full of casts of shells (in places passing into ironstone	1.82

From the Cockle bed (the Verwood Sandstone Bed of King (1991)) were recorded '*Voluta, Fusus, Cerithium, Turritella Dixoni, Cardita Brongniarti, Modiola elegans* and *Ostrea flabellula*' (Reid, 1902). Additional material collected by Mr F C Stinton (in King, 1981, pp.90–91) included *Venericor* aff. *planicosta, Crassostrea multicostata, Atleta elevatus, Ficopsis smithii* and *Turriella* sp. Initially, King (1981) thought that the overlying pebble bed marked the top of Division B1, but later (1991) regarded it as the top of Division B2c.

In a small pit [SU 0783 0944] north-east of the station, but north of the railway line, Mr Dixon saw 1.2 m of soil and clay, on a 0.3 m thick pebble bed, on 0.15 m of ironstone, on fine loam. In the larger pit [SU 0785 0935] on the eastern side of the railway, he saw 3.6 m of clay on a pebble bed. He also noted 'small pebbles in clay' farther north [SU 0804 0961].

A well [SU 0781 0856] on the west side of Verwood proved 6 m of sand [Broadstone Sand] on 1.5 m of stiff blue clay.

3.2.6.4 LYTCHETT MATRAVERS SAND MEMBER

There is a small outlier [SU 022 060] of this member north-west of Rooks Hill. A more extensive outlier caps Chalbury Hill [around 019 068]. The base of this latter outlier is marked in several places by springs. The sand was formerly worked in a small pit [SU 0198 0674], but there is no exposure.

There are two small outliers [SU 0300 0675 and 033 067] south-east of Horton Hollow, and a more extensive one [SU 043 066] in Ferndown Forest, where the member dips at 1° eastwards. The main outcrop extends from just south of Holt Forest in the south [SU 035 050] to just south-east of Ferndown Forest [around SU 047 063]. In the former area, sand was worked in a small pit [SU 0335 0570]. Nearby [SU 0344 0570], Mr Dixon saw, beneath 1.5 m of sandy wash, 1.2 m of fine-grained, pale, slightly glauconitic sand with thin seams of loam. In Ferndown Forest, the base of the member is well marked by springs [SU 0462 0641 to 0478 0634].

Farther north, the member, dipping at 1° south-east, extends from Wigbeth [SU 0425 0725] to Horton Wood [around SU 049 066]. In this latter area, Mr Dixon noted fine-grained, buff, pebbly sand and sandrock in an old pit [SU 0495 0682]. Just to the south, Mr Dixon saw 2.4 m of fine-grained buff sand and loam in the excavations for an ornamental pond [SU 0497 0673]. Farther west [c. SU 0460 0672], pebbly sand was noted. Fine-grained sand can be augered in the banks of the lane nearby [SU 0497 0687].

Glauconitic pebbly sand augered in the bottom of a ditch [SU 0609 0620] on the south side of Horton Heath may be part of the Lytchett Matravers Sand. Similarly, on the west side of Pett's Hill, the 0.6 m of 'finely laminated glauconitic buff sand with a pebbly seam' [SU 0565 0719] noted by Mr Dixon may also be part of the member. Close by, the basal beds of the Holt Forest Member were seen (see below).

On the west side of the wood, Mr Dixon saw a section [SU 0511 0790] in medium-grained white pebbly sand. Mr Dixon saw evidence of the Lytchett Sand Matravers Member in several places in the central, northern and eastern part of Woodlands Park:

several small pits [around SU 056 080] south of the former Park House showed up to 0.9 m of fine- to medium-grained buff sand beneath pebbly wash;

to the east, a lane cutting [SU 0581 0805] showed (no thickness given) fine-grained brown sand , on fine-grained, pale, finely laminated, non-glauconitic sand with lignite fragments; just to the south, an old pit immediately to the south showed fine-grained buff sand;

to the north-east, an old pit [SU 0573 0845] fine-grained buff sand;

in the 2.4 m deep lane farther north, an overgrown section [SU 0577 0850] revealed fine-grained, buff sand, glauconitic in places;

Mr Dixon also noted fine-grained sand, locally pebbly, in several places [around SU 0595 0725].

3.2.6.5 HOLT FOREST MEMBER

There is a fairly extensive outcrop of this member, dipping at about 2° east-south-east, in the south-east of the area. There is no exposure. For the most part, mottled orange and grey sandy clay was augered in the south-east of the area, but clayey fine-grained sand was noted in one place [SU 0444 0533], and mottled red and pale grey clay in another place [SU 0475 0610]. At Holt Lodge Farm, Mr Dixon noted a section [SU 0526 0613] at the junction of the Lytchett Matravers Sand Member and Holt Forest Member, with 2.73 m of laminated loam resting on a seam of flint pebbles.

On the west side of Pett's Hill, Mr Dixon saw 0.9 m of 'brown and pale, roughly laminated clay with thin seams of sand'.

3.3 POOLE FORMATION

The Poole Formation, roughly equivalent to the Lower Bagshot Beds of earlier authors, only crops out in the south-east of the area, but has an extensive outcrop farther east. Some details, largely based on the notes of Mr Dixon made in 1899 and 1900, are included in this present account.

Where fully developed in the west-central part of the Wessex Basin, the formation, up to 140 m thick, is divided into an alternating sequence of sand/clay members (see Bristow et al., 1991, figs. 8 and 9). However, on the northern side of the basin, only about 50 m of the four highest members (Broadstone Sand, Broadstone Clay, Parkstone Sand, Parkstone Clay) are present, as the Broadstone Sand has overstepped the lower members to rest on London Clay.

The formation comprises an alternating sequence of fine- to coarse- or even very coarse-grained, fluviatile sands, which were commonly laid down in fining-upward cycles, interbedded with estuarine, commonly carbonaceous, commonly red-stained, clays and silts. Pollen, commonly abundant, together with sparse marine dinoflagellate cysts occurs in the clay members. The dinoflagellate cysts provide a poor correlation with the more fully marine sequences to the east. The Broadstone Clay and Sand members fall within the *coleothyypta* Zone, and the Parkstone Sand and Clay within the *intricatum* Zone (Bristow et al., 1991, fig. 8).

3.3.1 Broadstone Sand Member

The Broadstone Sand, consisting of fine-grained sand, is only about 5 m thick in the south of the area, around Crooked Withies [SU 048 051]. In the Woodlands Borehole, the member has thickened to 14 m.

3.3.2 Broadstone Clay Member

The Broadstone Clay is a persistent unit of medium to dark grey, commonly bituminous, clay and only locally red-stained. In the south, it is about 8 m thick; it is about 7 m thick in the Woodlands Borehole, but thickens north-eastwards into the Verwood area where it is about 15 m thick. It was extensively worked for bricks in this latter area.

One sample from a depth of 3.7 m in a borehole at Verwood [SU 0901 0751] (Clarke, 1981) yielded a sparse organic residue and palynoflora. It is dominated by plant tissue, mainly fragments of cuticle and pollen grains. Marine microplankton were encountered in small numbers, thus indicating that it formed in a marginal marine setting. The most prominent pollen type is *Spinizonocolpites echinatus*. Other miospores include *Caryapollenites, Cyathidites, Diporites, Inaperturopollenites hiatus, Milfordia, Tricolporopollenites* and *Verrucatisporites*. Dinoflagellate cysts include *Cordosphaeridium gracile, Homotryblium abbreviatum, H.* spp., indeterminate forms, *Nematosphaeropsis reticulensis, Spiniferites* spp. and *Wetzeliella articulata* (Riding, 1999). *Homotryblium abbreviatum, Nematosphaeropsis reticulensis* and *Wetzeliella articulata* are typical of the Eocene (Powell, 1992). The association is indicative of a tropical mangrove palaeoenvironment: *Spinizonocolpites echinatus* is the pollen of the mangrove palm plant *Nypa*. This species is especially prominent in the Early-Mid Eocene (Ypresian-Lutetian) (Collinson et al., 1981; Fredrickson, 1985). This palynological assemblage is typical of parts of the Poole Formation (Riding, 1998).

3.3.3 Parkstone Sand Member

There is a small outcrop in the south-east, around Crooked Withies [around SU 048 051], and which extends southwards and eastwards under Holt Heath [SU 057 043]. In this tract, copious springs mark the base of the member. East of the area, the Parkstone Sand occurs as an outlier on Horton [SU 063 073] and Woodlands Commons [SU 066 092], as small outliers [SU 086 080, 092 078, 097 082 and 095 087] around Verwood, and under river terrace deposits around Three Legged Cross [SU 083 056] and Lower Common [SU 098 060].

The member consists of 16 to 20 m of fine- to very coarse-grained sand. Two boreholes on Lower Common [SU 0973 0605 and 0972 0531] proved respectively 3 m of clayey. fine- to medium grained sand, and 4 m of very clayey, fine-grained sand.

3.3.4 Parkstone Clay Member

The Parkstone Clay crops out to the east of the district. There, it consists of carbonaceous and fine-grained, sandy clay.

Details

3.3.5 Broadstone Clay Member

In the south, the Broadstone Clay has a wide outcrop around Paradise House [SU 049 053]. The top of the member is marked in many places by powerful springs issuing from the base of the Parkstone Sand [around SU 0495 0512, 052 051, 059 050, 0603 0483, 0615 0475 and 0632 0485]. Across the col and south-east of this last area, the extensive head-covered boggy area is bounded by numerous springs and which are believed to issue from the base of the Parkstone Sand.

On the north side of the valley, there is an extensive area south-west of Brooklands Farm [around SU 0560 0575] in which mottled orange and grey silty and fine-grained sandy clay can be augered.

Around Mannington, springs [SU 0620 0517] again indicate the top of the member. Much of the outcrop is obscured by pebbly clayey sand. For example, at one point [SU 0641 0549] 1.2 m of wet, pebbly, clayey sand was proved. Nearby, an auger hole [SU 0640 0534] proved 0.4 m of pebbly sand on mottled orange and grey clay.

Several boreholes not accurately located at the site of the electricity transfer station [SU 075 053] proved thick sequences of clay. The most extensive sequence proved:

	Thickness (m)	*Depth* (m)
Made ground		
Gravel surfacing over brick fill	0.70	0.70
Broadstone Clay		
Clay, silty, soft, pale grey-brown	1.70	2.40
Clay, silty and silt, soft, pale to dark grey	0.70	3.10
Clay, silty, grey becoming brown	0.30	3.40
Lignite, black with thin bands of brown silty clay and grey silt	1.50	4.90
Clay, silty, pale grey with small lignite fragments	0.30	5.20
Clay, silty, stiff, dark grey-brown, with small pockets of pale grey silt	3.10	8.30
Clay, silty and clayey silt with fine-grained silty sand bands, dark grey; below 13.0 m becomes a dark grey, finely laminated silty clay with pale grey silt partings	6.50	14.80
Broadstone Sand		
Sand, fine- to medium-grained, silty (sand blowing up the borehole)	3.20	18.00

To the north, another borehole [SU 0751 0571] proved 0.3 m of peaty topsoil, on 2.28 m of soft yellow and grey sandy clay, on 12.03 m of very soft, grey, water-bearing silt with a few firm bands, on more than 2.89 m of firm grey silty clay.

Northwards from Mannington, a line of springs [SU 0612 0567 and 0615 0581 to 0620 0594] are found. Stiff grey clay was augered in a ditch [SU 0625 0603] close to the last locality.

On the east side of Horton Heath, springs [SU 0654 0665] issuing from the junction of the Broadstone Clay and Parkstone Sand are responsible for the names of Higher Bog Farm and Bog Farm. Farther north, Mr Dixon noted ‘clay dug out’ [SU 0622 0719], whilst a little farther north [SU 0622 0729] he noted ‘clay’ overlain by sand. He also recorded ‘clay’ to the north-west [SU 0614 0737] and north-north-west [SU 0617 0748].

A ‘soak’ [SU 0588 0703] noted by Mr Dixon on the south side of Pett’s Hill presumably marks the top of the Broadstone Clay. The junction of the Broadstone Clay and Parkstone Sand was noted by Mr Dixon on the north side of Pett’s Hill [SU 0592 0735] and in the wood to the north [SU 0602 0773 to 0608 0778], where it is associated with a line of springs. Brown clay and loam was seen about 200 m NE [SU 0619 0777]. South-west of Wedge Hill Farm, the junction of the two members was again noted [SU 0643 0774]. Buff stony clay close to the base of the member was noted to the north [SU 0641 0785]. Some 230 m ENE, 0.6 m of ‘green and brown, roughly laminated loam’ was noted. South-south-east of Wedge Hill Farm, Mr Dixon noted ‘mottled clay’ [SU 0667 0761].

On the north-east and east side of Redman’s Hill, a line of springs [SU 0737 0758 to 0749 0757; 0768 0716 to 0774 0732] marks the top of the Broadstone Clay.

An old clay pit [SU 0769 0816] formerly exposed 2.7 m of stony loam, on 0.46 m of dark loamy clay. To the north east, the old potteries [SU 0781 0830 and 0796 0829] presumably utilised similar material.

Much of Verwood is underlain by Broadstone Clay. Mr Dixon made many notes and recorded sections during 1899 and 1900 in what was then largely open countryside. To the east of the former Hayward's Farm, the junction of the Broadstone Clay and Parkstone Sand [SU 00827 0829 to 0837 0828] was noted, and traced the boundary north-eastwards (line of springs SU 0847 0856 to 0852 0857) to Bugden's Copse, where he saw 'clay' in several places [SU 0879 0862 to 0888 0867, around SU 0890 0864 and SU 0888 0872]. Just to the east of Hayward's Farm, 2.7 m of 'mottled clay' was seen [SU 0838 0824]. Some 0.3 m of 'stiff clay' was noted in Manor Road [SU 0866 0842]. Presumably, it was this clay, close to the top of the member, that was worked in the pottery [SU 0867 0827] just to the south. Farther east, 'mottled clay' was noted in one place [SU 0893 0842] and 'carbonaceous clay' and 'mottled clay with ironstone' nearby [SU 0911 0840 and 0912 0837].

Near Hainault Farm, an old well [SU 0909 0872] proved 2.1 m of gravel over 'clay'; nearby, another well [SU 0911 0871] penetrated 4.5 of gravelly loam over 'clay'. Black Hill [SU 095 087] is a small outlier of Parkstone Sand surrounded in Dixons time by several clay pits. These appear to have been subsequently enlarged into one pit, that is now the site of an industrial unit [SU 095 086]. A section in one of these pits [SU 0956 0869] showed:

	Thickness (m)
Clay, buff-grey, dicey, with masses of septarian clay-ironstone	2.73
Loam and sand, laminated	3.05
Clay, dark grey-buff, with masses of ironstone in layers	1.52
Clay, carbonaceous	0.30
Clay, dark, tough	0.46

East of the pit, stiff clay with particles of lignite were noted [SU 0993 0856]. About 110 m to the south, 8.8 m of carbonaceous clay was proved in a well [SU 0989 0950].

On Verwood Common, the junction of the Parkstone Sand and Broadstone Clay, locally marked by springs, was traced by Mr Dixon. At one point he saw an old pit which exposed 'stiff clay', on coarse loamy sand, on mottled laminated clay. On the south-western side of the now-built over part of Verwood Common he recorded 3 m of 'stiff white clay' in a clay trial hole [SU 0947 0800]; white clay was seen just to the south [around SU 0948 0796]. 'Pipe clay' was noted at one point [SU 0962 0790]. Some 50 m E [SU 0967 0788] was recorded 1.8 m of medium-grained sand; on 1.2 m of coarse-grained sand; on 0.3 m of laminated, pale blue, loamy clay; on 0.46 m of white pipe clay, passing into bluish grey, micaceous loamy clay.

Potterne Hill [SU 092 078] is an outlier of Parkstone Sand over Broadstone Clay. Mr Dixon mapped the boundary for a short distance [SU 0915 0769 to 0919 0768] on the south side of the hill; a spring [SU 0926 0768] marks the junction a short distance to the east. On the east side of the hill, a section not accurately located recorded cross-bedded coarse-grained sand with rotten flint chips on 0.9 m of stiff clay. North-west of the hill, Dixon saw 1.5 m of gravelly loam [Head], resting on 'stiff clay' in an old pit [SU 0900 0802].

On the opposite side of the river to Potterne Hill, a borehole [SU 0901 0751] proved 1.7 m of river terrace deposits, over 4.0 m of dark bluish grey silty clay (Clarke, 1981). The palynoflora recovered from the clay is described in the General section.

On Lower Common, 'laminated loamy clay' was seen at one point [SU 0945 0673], whilst nearby [SU 0952 0680], 0.9 m of stony loam, overlay 0.9 m of laminated loamy clay. To the north-west, a clay trial hole [SU 0924 0698] proved 1.2 m of 'white impalpable loam, on 2.4 m of black, carbonaceous and pyritous loam', on a hard bed.

In the stream bed [c. SU 0968 0902] on the north side of Verwood, Mr Dixon noted 1.2 m of mottled clay, on pale stony sand [no thickness given], on laminated loam with abundant leaves. Just to the south [SU 0968 0891] stiff pale clay was seen beneath 1.5 m of gravel and sand. On the west side of Noon Hill, mottled clay was noted [SU 0999 0898].

Broadstone Clay must have been exposed in the southern part [SU 091 094] of the pit just south of Stephen's Castle. Mr Dixon traced the upper boundary northwards on the west side of the Castle. South-east of the pit, 'mottled clay' was noted in two places [SU 0933 0907 and 0935 0900]. Some 250 m W of this last occurrence, 1.2 m of mottled clay with broken ironstone masses was seen. On the west side of the pit, mottled loamy clay was noted [SU 0877 0927].

There is no detail of the old Verwood Pottery pit [SU 0860 0913] which was already disused at the beginning of the 20th Century. Some 300 m SE is the old Rectory well [SU 0875 0885]. The published account (Reid, 1902, p.56) differs slightly from Mr Dixon's notes. The latter are included here: made ground, 1.5 m; on 'sand and loam', 6.0 m [?partly Broadstone Clay]; on 4.5 m of 'clay and claystone'; on 18 m of 'grey sand [Broadstone Sand].

3.3.6 Parkstone Sand Member

In the railway cutting [SU 0758 0745] on the east side of Redman's Hill, Mr Dixon saw 6 m of fine- to very coarse-grained sand and sandrock with thin seams of pale loam.

The base of the member was traced by Mr Dixon for a short distance [SU 0887 0878 to 0920 0897] on the north side of Budgen's Copse, Verwood. Fine- to medium-grained sand of the Parkstone Sand was worked beneath Parkstone Clay in a fairly large pit [SU 091 095] until fairly recently on the north side of the village, just below Stephen's Castle. North of the Castle, the base of the member could be easily followed north-north-eastwards by the loose sand thrown out by rabbits.

3.3.7 Parkstone Clay Member

At the top of the pit [SU 091 095] on the south side of Stephen's Castle, brown, carbonaceous, sandy clays and clayey fine-grained sands are exposed. The proportion of sand to clay varies rapidly along the face, such that beds of sand up to 1.5 m thick are developed locally. The best exposures are on the south [SU 0910 0965] and west [SU 0905 0967] sides of the north part of the pit. To the north-north-east of the Castle, Mr Dixon traced the upper boundary, partly by springlines towards Pistle Down.

4 DRIFT

4.1 CLAY-WITH-FLINTS

Extensive areas of Clay-with-flints cap the interfluves in the area between Witchampton and Long Crichel in the south, and between Tollard Royal and Sixpenny Handley in the north. In the south, the clay caps commonly form long 'dip slopes' inclined south-eastwards or eastwards, in many cases coming down to the valley bottoms. The northern spreads are less extensive, but show a similar feature.

For the most part, the deposits consist of clayey gravel, with brown, angular to sub-angular flint clasts up to 15 cm across, set in a reddish brown clay matrix. Locally, as at Cashmoor [ST 9725 1335], the deposits are very gravelly and have been worked as a source of gravel. On the north side of Chetterwood [ST 9630 0866 to 9707 0857] and west of Manswood [around ST 9738 0760], large knobbly flints are common in the Clay-with-flints. There are few sections through the deposits, but they appear not to exceed 3 m in thickness. One section [SU 0253 1218] showed up to 2 m of flinty clay resting on the cryoturbated top of the Chalk. At Witchampton, a

roadside exposure [ST 9858 0630] showed 2 m of reddish brown flinty clay. On the south side of Mill Hill, an old pit [SU 0005 0793] exposes up to 1.5 m of reddish brown clay in pipes, on 2.7 m of chalk rubble, on soft white chalk. Near Gussage St Andrew, an old pit ST 9710 1426] exposes 2 m of flinty clay with a cryoturbated base, on Chalk. As in the above pits, in many places, chalk has been worked from under the drift cover, such that there are many 'inliers' of chalk in the pit bottoms within the main drift spread.

4.2 OLDER HEAD

Head comprises heterogeneous deposits derived from the downhill movement by solifluction of weathered surface material from the solid formations and older drift deposits. Much of the Head accumulated under periglacial conditions when freeze-thaw disrupted strata which, during the spring and summer thaws, became sufficiently water-saturated and mobile to move downslope. Soil creep and minor mass movement have added their contribution and probably continue to do so.

In places, such as around Witchampton and Wimborne St Giles, there are patches of clayey gravel that extend down slope from Clay-with-flints [SU 028 121] and River Terrace Deposits [ST 978 058 to 999 072] or extend upslope from the normal valley fill [ST 968 054] which are regarded as older solifluction deposits. Almost certainly, these older deposits have been modified by later solifluction processes and will have contributed material to the younger Head deposits which, in places, rest on top of the older deposits.

4.3 HEAD

Most of the dry valleys on the Chalk are floored by Head deposits. Some of these deposits may include some waterlain material. There is no exposure, but the deposits appears to consist for the most part of gravelly clay, with a variable gravel content of sub-angular brown flints, such that the surface deposits along many valleys appear to be a clayey gravel. In places [ST 969 0605, 9695 0607], the deposits have been worked for gravel. Head in some valleys close to the Palaeogene outcrop commonly have a high content of well-rounded pebbles. Ditch sections [SU 0166 0922, 0164 0914 and 0179 0920] north of Stanbridge Mill Farm, however, revealed 1.2 m of pellety chalk with scattered flints. Near Manor Farm, Gussage St Michael, 2 m of crumbly pellety chalk is exposed [ST 9798 1242] low down on the valley side. Near South Monkton Farm, there is a spread of peaty gravel [around SU 021 133].

4.4 RIVER TERRACE DEPOSITS

Spreads of River Terrace gravels, mainly associated with the River Allen, have been recognised at five different levels within the area, and are numbered one to five in ascending height.

The deposits consists of clayey sandy gravel, with the clasts mostly brown sub-angular flints

Details

4.4.1 Fifth River Terrace Deposits

Fifth River Terrace Deposits have an upper surface about 35 m above the floodplain. There is an extensive spread on the hill top near Witchampton [ST 984 063 to 991 078]. Locally, they have been worked for gravel [ST 9863 0650].

4.4.2 Fourth River Terrace Deposits

The Fourth Terrace Deposits have an upper surface about 10 to 12 m above the floodplain. They have been recognised south [ST 975 051 and 986 058] and north-east [ST 995 074] of Witchampton, and south-east of Moor Crichel [ST 998 080].

4.4.3 Third River Terrace Deposits

South of Witchampton, there is a spread of clayey gravel [ST 984 052] with an upper surface about 8 m above the floodplain.

4.4.4 Second River Terrace Deposits

Small deposits of this terrace interval occur near Wimborne St Giles. Their upper surface is about 2 m higher than the floodplain. There is a more extensive spread [SU 004 147] with a hummocky surface just east of Down Farm.

4.4.5 First River Terrace Deposits

There is a wide, extensive spread of terrace deposits of this interval on the east side of the River Allen at Witchampton [ST 992 050 to SU 000 067]. The upper surface of the deposits is about 0.5 to 1 m above the floodplain.

4.5 PEAT

Most of the floodplain of the River Allen is underlain by peat or highly organic Alluvium. It extends from the southern margin of the area upstream to Monkton Up Wimborne [SU 0135 1350]. In the south, there is one west-bank tributary which is floored by peat [upstream to ST 9746 0540].

There is no detail of thickness, lithology or fauna.

4.6 ALLUVIUM

Unnamed (?Crichel and Gussage) north bank tributaries of the River Allen, and the River Allen north of Monkton Up Wimborne, have a very gravelly floodplain. At Gussage St Michael, some 1.2 m of gravel is exposed in the sides of the stream [ST 9787 1290 to 9806 1253]. The upper reaches of the Cranborne along Water Lake Bottom has a very peaty floodplain.

4.7 LANDSLIP

Landslips associated with the clays of the Reading Formation occur in three places in the south of the district. The two southernmost ones [SU 011 051 and 014 058] are about 100 m wide and extend down on to the Chalk. The third one [SU 0220 0685] near Chalbury occurs on a north-facing slope over a 400 m tract wholly within the Reading Formation.

4.8 SWALLOW HOLES

Scattered swallow holes have been noted on the Chalk outcrop across the district. Unlike in the Bournemouth and Dorchester areas, there is no concentration of swallow holes close to the boundary between the Palaeogene deposits and Chalk. In the present area, most swallow holes occur in the valley bottoms, but a few occur on the interfluves.

North of Farnham, swallow holes occur in the bottom of three valleys [ST 9534 1691, 9521 1604 and 9643 1683]. To the north-north-east of Oakley Farm, a large circular depression [SU 0113

1860] is believed to be a swallow hole on the interfluve. South of Sixpenny Handley, a 30-m diameter depression [SU 0005 1552] occurs in the valley bottom. Similarly, in the upper reaches of Water Lake Bottom, there is a small depression [SU 0304 1664] in the valley bottom. The 40 m diameter 'gravel pit' [SU 0393 1724] on the north side Pentridge Hill appears to be a solution hollow. At Chettle, an oval depression [ST 9541 1337] in the valley bottom is thought to be a swallow hole. In the south, chalk is exposed in the bottom of a swallow hole [ST 9712 0825] of a plateau covered with Clay-with-flints, and towards the head of a shallow valley to the south [ST 9717 0797]. To the north-east, there is a swallow hole [ST 9822 0893] in the valley west of Cockroad Farm.

4.9 MADE GROUND

Because of a lack of large-scale exploitation of the various geological deposits, there is no legacy of extensive areas of worked or backfilled ground, although some small pits [e.g. SU 029 092] have been infilled, mostly with farm material. A small valley [ST 9535 0594] on the old Tarrant Rushton Airfield has been partially infilled; the nature of the fill is unknown.

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