Geology of the Salisbury Sheet Area

Report on the Geology of Sheet 298 Salisbury
and its adjacent area.
A compilation of the results of the survey in Spring and Autumn 2003 and from the River Bourne survey of 1999

Internal Report IR/06/011

Natural Environment Research Council

British Geological Survey

Onshore Geology Series

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Front Cover: Stonehenge 2004, a view looking northeast from [SU 122 421]. Photo P 535208.

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Frontispiece. Stonehenge, Amesbury 1926 photographed by J Rhodes. Looking east-northeast. General view from ditch. [SU 121 421]. Photo P203203.

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1 INTRODUCTION

1.1 Topographic Setting

The Salisbury Sheet area extends over about 600 km^2 of east Wiltshire and northwest Hampshire (Figure 1). The area described in this report covers the western margin of the Chalk outcrop from the margins of the Salisbury Plain Training Area in the north to the ridge south of the River Ebble. In the east Palaeogene deposits are preserved in the Alderbury – Mottisfont Syncline and to the west wedge-shaped outcrops of Jurassic and Lower Cretaceous strata are exposed in the valley of the River Nadder. The area is dissected by the north to south flowing River Avon which is joined on the left bank by the Bourne River and on the right bank by the Rivers Wylye, Nadder and Ebble. These rivers cut the area into seven major interfluve areas founded principally on the Chalk Group (Figure 2). The valleys of the eastward flowing right bank tributaries exhume the lower beds of the Chalk Group and in the case of the River Nadder beds down to the level of the Jurassic Kimmeridge Clay Formation are seen at outcrop associated with the major east – west trending periclinal Mere Fault Structure.

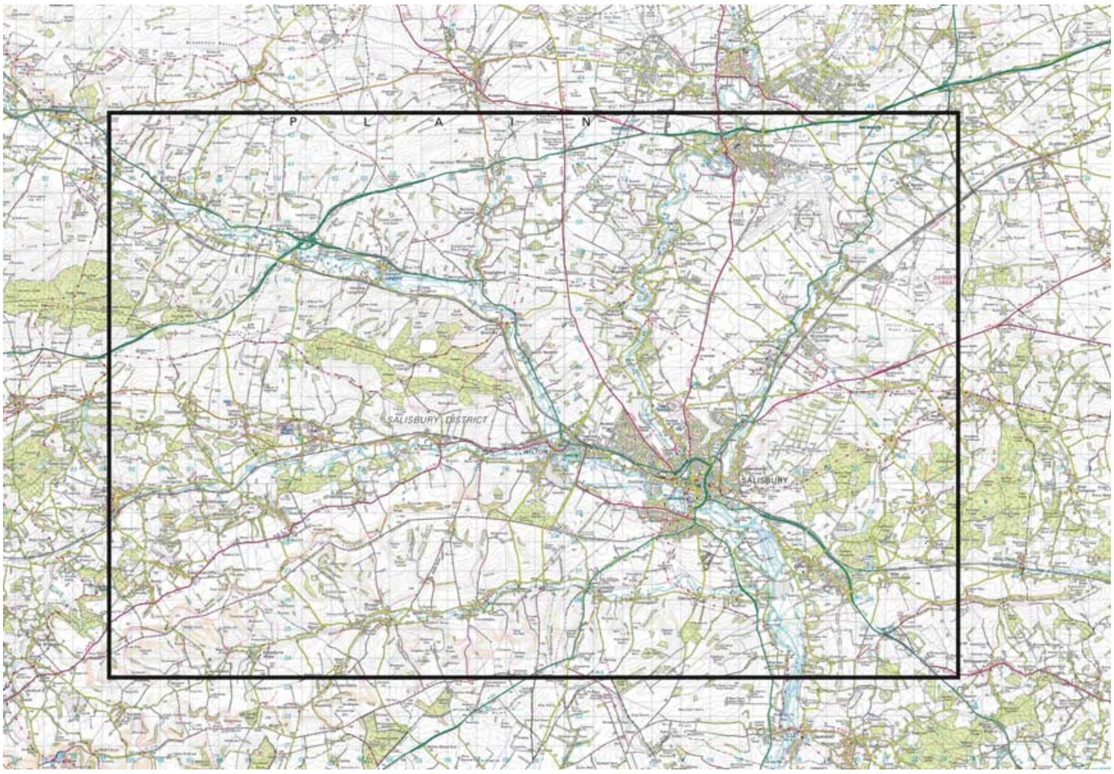


Figure 1: Location of the Salisbury Sheet area

The Chalk forms an extensive gentle southerly dipping dipslope that is punctuated by several small anticlines and synclines, and dissected by numerous dry valleys. A secondary Chalk escarpment, much degraded and dissected, is represented by the ranges of hills from Porton Down passing through Salisbury and forming the ridges south of the River Nadder and Ebble.

1.2 History Of Research

The district and surrounding sheet areas were first systematically surveyed at the one-inch scale in the mid 1800s and resurveyed on the six-inch scale at the turn of the $19^{th}/20^{th}$ centuries. The Shaftsbury (Sheet 313) district to the southwest was resurveyed at the 1:10 000 scale between 1986 and 1990, with surveying at the same scale being completed over the Wincanton (Sheet 297), Ringwood (Sheet 314) and Winchester (Sheet 299) districts in, respectively, 1994, 2000 and 2001(Figure 3). The Devizes (Sheet 282) to the north is based on mapping at the six-inch scale dated 1899 and was reprinted with minor amendments in 1959 at the ‘one-inch’ scale and is currently out of print (this sheet area is the

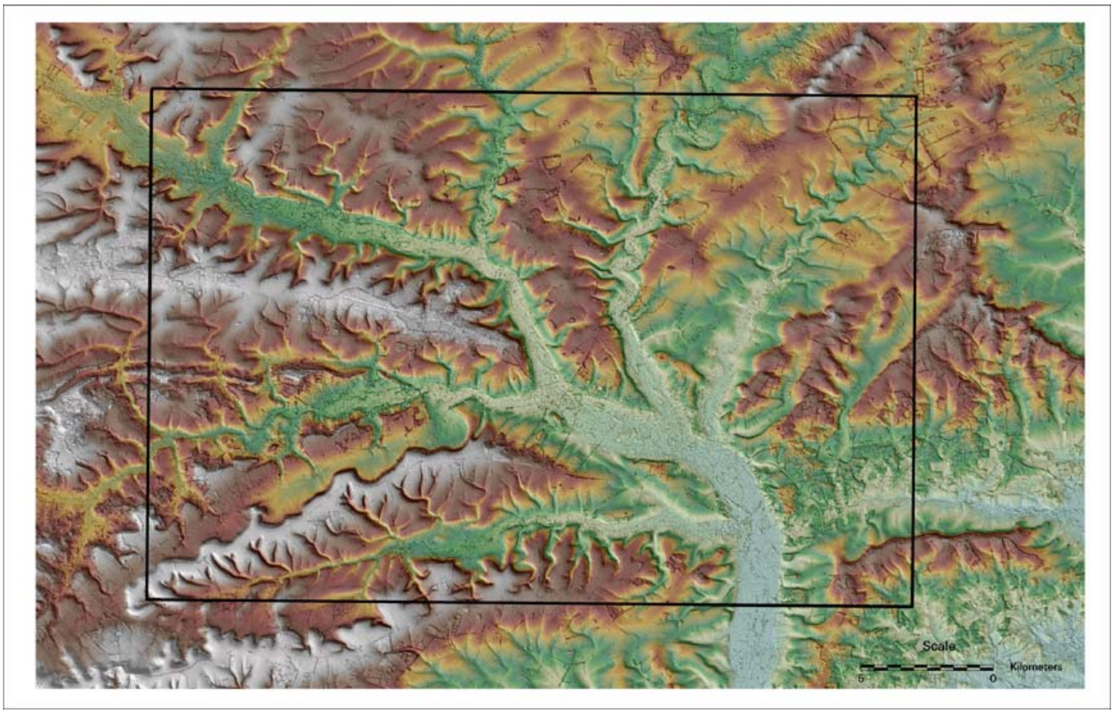


Figure 2: Shaded relief topographic map of the Salisbury Sheet area.

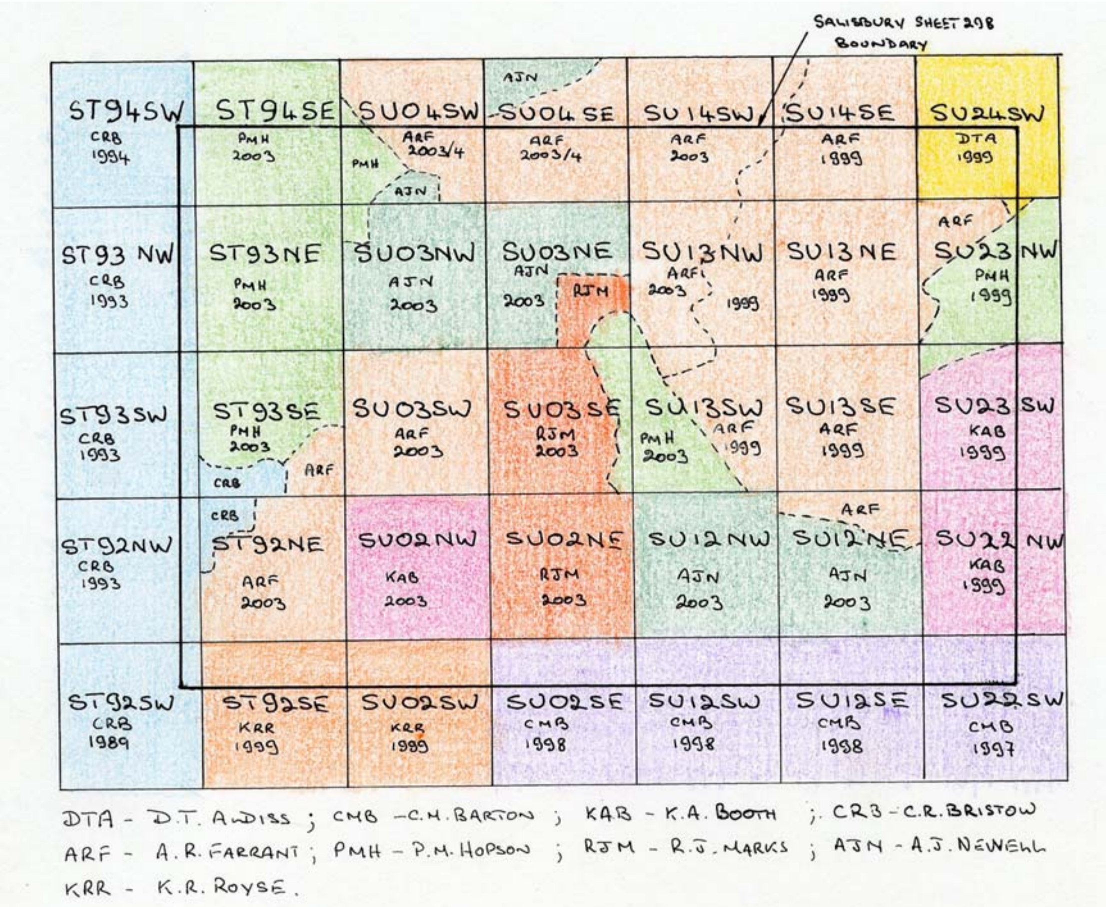


Figure 3: Mapping ‘ownership’

subject of the current survey programme 2004 to 2006). Additional 1:10 000 scale mapping covering the district to the east of the River Avon northwards from Salisbury to the Vale of Pewsey, was completed in 1999 as part of a contract partly sponsored by the Environment Agency. This survey was incorporated into the recently completed Winchester sheet area and will be utilised in the compilation of this Salisbury sheet and the Devizes and Andover sheets as they come-up for resurvey.

Sheet 298 (Salisbury) was mapped by W T Aveline and published on 'Old Series' One-inch Geological Sheet 15 in 1856 and on Sheet 14 in 1957. The sheet area was resurveyed on the new series six-inch scale by C Reid, F J Bennett and A J Jukes-Browne and published at the one-inch scale as Sheet 298 (New Series), with drift, in 1903. The sheet was reconstituted in 1950 from the one-inch scale without geological revision and reprinted on the 1st series 1:50 000 base in 1976. The new 1:10 000 scale survey commenced in 2001 and was completed in 2003 by D T Aldiss, L B Bateson, K A Booth, A R Farrant, P M Hopson, R J Marks and A J Newell (Figure 3) with support from D J Evans (deep geology), I P Wilkinson (microbiostratigraphy) and M A Woods (macrobiostratigraphy).

The memoirs accompanying each of the New Series Geological Sheets (Reid, 1903; Jukes-Browne, 1905; Jukes-Browne, 1908; Osborne White, 1912) are all now out of print. A part of the Sheet 299 (Winchester) area was described by H W Bristow and W Whitaker in their memoir covering parts of Berkshire and Hampshire (sheet 12) in 1862, and by W Topley in 1875 in the memoir covering the Geology of the Weald.

A J Jukes-Browne and W Hill recorded some observations on the Lower and Upper Cretaceous rocks of the area in the memoirs on the Cretaceous Rocks of Britain published between 1900 and 1904. These are now out of print. Brydone’s (1912; 1942) descriptions of the Chalk of Hampshire include biostratigraphical details for many individual localities in Hampshire, including some within the present area. Correlation of the Lower Chalk (now the Grey Chalk Subgroup) of southeast England was expounded by Kennedy (1969), whilst the petrology, conditions of deposition, and diagenesis of the Chalk Group were considered by Hancock (1975). Bromley and Gale (1982) considered the lithostratigraphy of the Chalk Rock at many sites across southern England; a number of their sites fall within the Salisbury area. Robinson (1986) described in detail the stratigraphy of the Chalk of the North Downs and Mortimore (1986; 1987) did the same for the Middle Chalk and Upper Chalk (now the White Chalk Subgroup) of Sussex. Bristow et al. (1995) proposed a new scheme of lithostratigraphic nomenclature for the Chalk Group in the Shaftesbury district of Dorset. The units recognised in Dorset and in Sussex can be traced into Hampshire and Wiltshire (Bristow et al., 1997), and form the basis of the description of the Chalk in this report. The lithostratigraphy of the Chalk Group was the subject of a Geological Society Stratigraphic Commission review in 1999 that broadly endorsed the units put forward by Bristow et al. (1997), and recommended adoption of the scheme shown in Table 1 (Rawson et al. 2001). The Palaeogene strata of the Hampshire Basin are discussed in a paper by Edwards and Freshney (1987).

There are a number of papers that describe the local geology of the Salisbury district and its immediate hinterland. Andrews and Jukes-Browne (1894) discussed the ‘Purbeck Beds’ of the Vale of Wardour. Blake (1881) in a general treatise on the Portland Rocks of England discussed numerous localities in the Vale of Wardour. Hudleston (1881) gave a general account of the Vale of Wardour. Mottram (1957) gave early views on the Mere fault and the Vale of Wardour anticline. Wimbledon (1976) discussed the ‘Portland Beds’ of Wiltshire and various Jurassic exposures in the district formed part of Woodward’s treatise (1895) on the Jurassic Rocks of Britain.

There are a number of papers on the Quaternary of the district. Clay (1927) described flint implements found in the River Nadder valley, Delair and Shackley (1979) reviewed the work on the famous Fisherton Brickpits, Read (1885) on flint implements at Bemerton and Milford Hill, Sealy (1955) on the terraces of the Salisbury Avon.

1.3 Geological Succession

The solid formations and drift deposits mapped during the survey are listed in Table 1.

Table 1. The geological succession in the Salisbury District

DRIFT	**Thickness (m)**
Quaternary	
Peat	1-2
Alluvium	1+
River terrace deposits	up to 5
River Terrace Deposits (Fisherton Brickearth)	up to 5
Head	up to 5
Gravelly head	up to 5
Gravelly older head	up to 5
Older head	up to 5
Clay-with-flints	1-10
SOLID	
Palaeogene	
Bracklesham Group, Wittering Formation	5-15
Thames Group, London Clay Formation	35-50
Lambeth Group, Reading Formation	15-20
Upper Cretaceous	
Chalk Group (White Chalk Subgroup)	
Portsdown Chalk Formation	5-10
Culver Chalk Formation	35-45
Newhaven Chalk Formation	55-70
Seaford Chalk Formation	60-70
Lewes Nodular Chalk Formation	40-45
New Pit Chalk Formation	25-35
Holywell Nodular Chalk Formation	15-25
Chalk Group (Grey Chalk Subgroup)	
Zig Zag Chalk Formation	46-65
West Melbury Marly Chalk Formation	25-40
Lower Cretaceous	
Upper Greensand Formation	35-75
Gault Formation	25-58
Lower Greensand Group	up to 20
Wealden Group	up to 10
Upper Jurassic	
Purbeck Group	23-28
Portland Group	33-50
Kimmeridge Clay Formation	up to 10
Concealed Strata	
Jurassic	
Kimmeridge Clay Formation	184-273
Corallian Group	43-51
Oxford Clay and Kellaways Formations	135-190
Great Oolite Group	118-180
Inferior Oolite Group	15-42
Lias Group	256-430
Permo Triassic	120-286
Carboniferous	206-287
Ordovician, Silurian and Devonian strata undivided	Unknown
Cambrian	1211+

National Grid References quoted in this report, given in the form [SU 1234 5678], are all within Grid Zone SU and ST, unless otherwise stated. All the boreholes mentioned in the text are identified by a BGS Borehole Registration Number in the form SU13SE 23.

Digital coloured computer printed copies of the 1:10 000 maps can be purchased from BGS, Keyworth, where records of the boreholes may also be consulted. This report includes interpretations of data available at the time of writing. Additional information is available in BGS files. Neither the report nor its complementary 1:10 000 scale geological maps should be taken as a substitute for detailed site investigations. Users should note that the stratigraphic nomenclature used in this report is liable to revision.

2 STRUCTURE

2.1 General History

Structurally, the district falls within the Wessex Basin (Figure 4), which comprises a system of post-Variscan extensional sedimentary basins and 'highs' that covered much of southern England, south of the London Platform and Mendip Hills, during Permian to Mesozoic times. At greater depths are Palaeozoic strata (Figure 5) that were strongly deformed during the Variscan Orogeny, a period of tectonic upheaval and mountain building that culminated at the end of the Carboniferous. The rocks of the 'Variscan Basement' are weakly metamorphosed shales, sandstones and limestones of Cambrian to Carboniferous age. Several major southward-dipping thrust zones and northwest-orientated wrench faults, thought to have originated during the Variscan Orogeny, have been tentatively identified in the basement. This deformation was followed by a long period of erosion and a major unconformity marks the base of the Permo-Triassic sequence.

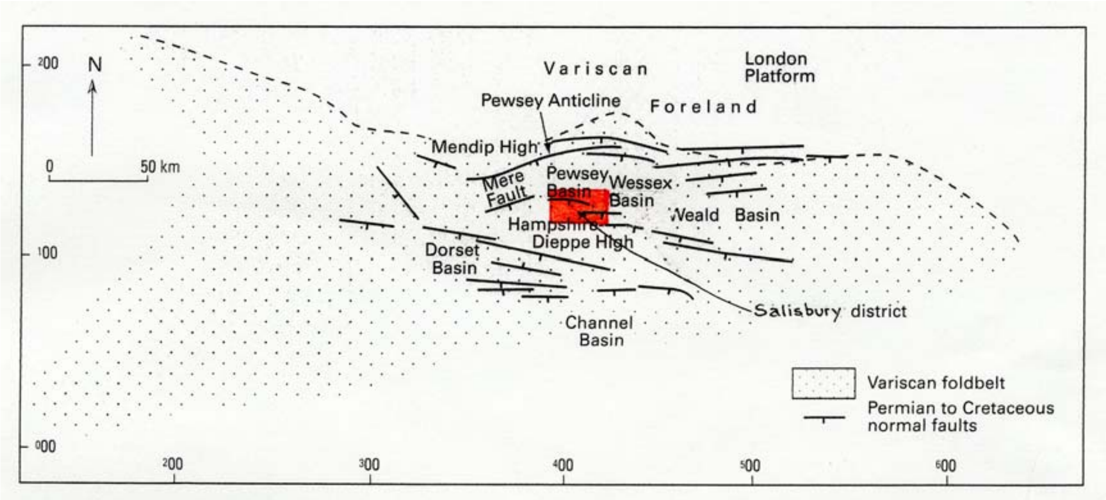


Figure 4: Structures of the Wessex Basin, showing major faulting and other named structures

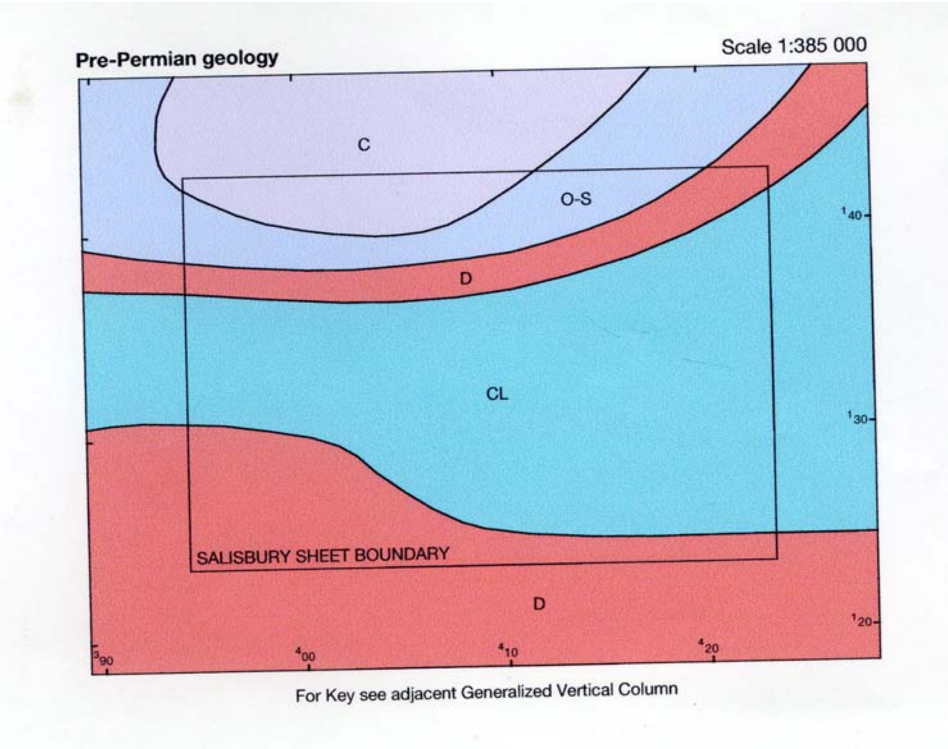


Figure 5: The lithological units beneath the basal Permo-Triassic surface (after Smith, 1985)

In Permian times, subsidence associated with periods of tectonic extension began to affect southern England, initiating the development of a number of smaller fault-bounded basins within the wider Wessex Basin. Sedimentation in the expanding Wessex Basin began to the south and west of this district. Deposition gradually spread eastwards, so that the earliest Mesozoic rocks present at depth within the district are a sequence of red beds thought to be of Triassic age. Crustal extension was accommodated by reactivation of existing faults in the Variscan basement, which show evidence of syndepositional downthrown to the south during Permian and Mesozoic times. The largest of these faults divides the region into a series of structural provinces (Chadwick, 1986) such as the Weald/Wessex Basin (including the Mere and Pewsey 'sub'-basins) and Channel Basin, separated by the Hampshire–Dieppe High (also known as the Cranborne–Fordingbridge High); the main Variscan front lies to the north of the district (Figure 4; Busby and Smith, 2001, Figure 2).

This district straddles the northern margin of the Hampshire–Dieppe High and part of the Wessex Basin; the boundary between these two structural provinces lies along the Mere Fault complex (Portsdown–Middleton Faults farther east) which underlie associated anticlines (Hopson, 2000a). The Hogs Back–Kingsclere–Pewsey structure to the north of this district marks the boundary between the Weald/Wessex Basin and the London Platform.

Syndepositional movement on major faults resulted in thicker Jurassic sequences being laid down on the downthrown (hanging wall) sides. Major periods of active extensional faulting occurred during the Jurassic and during deposition of the 'Wealden Group' of the Lower Cretaceous. During periods of relative tectonic quiescence, rates of sedimentation increased evenly towards the depocentre of the Weald Basin towards the east of this district.

The sea began to flood the Wessex Basin in Rhaetian (Late Triassic) times, depositing the Penarth Group. The area of marine deposition increased gradually throughout the Jurassic, although minor periods of erosion occurred, mainly at the basin margins. By Upper Oxfordian to Kimmeridgian times, the London Platform was probably entirely submerged. Towards the end of Kimmeridgian times, the London Platform began to re-emerge, probably due to a combination of global sea-level fall and a reduction in the rate of tectonic subsidence. This resulted in erosion on the margins of the Wessex Basin and the beginning of the development of the Late Cimmerian unconformity. This marine regression continued into Cretaceous times, the environment of deposition changing from offshore marine (Kimmeridge Clay Formation) through shallow marine (Portland Group), to brackish water and evaporites (Purbeck Group), and fluviatile ('Wealden Group'). The final period of extensional fault movement, marked by normal faulting, resulted in the accumulation of thick sequences of 'Wealden Group' sediments in the main fault-bounded troughs in the Wessex Basin, whereas to the west, beneath this district, and on the intervening exposed highs erosion occurred.

A period of regional subsidence followed (associated with sporadic tectonic movements along pre-existing fault lines) and combined with eustatic rise in sea level, led to a renewed marine transgression of the Wessex Basin. The ensuing deposition of the Lower Greensand Group, Gault Formation, Upper Greensand Formation, and eventually the Chalk Group covered all the surrounding high areas, including the London Platform. A global fall in sea level at the end of the Cretaceous resulted in erosion of parts of the higher Chalk units and the development of a pre-Cainozoic unconformity. Later, deposition in Eocene to Oligocene times was followed by the onset of the compressive tectonic regime during mid-Neogene 'Alpine' earth movements. These movements effectively reversed the sense of movement on the major bounding faults of the Wessex and Channel basins causing inversion of the basins and highs. Uplift is estimated at about 1500 m (Simpson et al., 1989) for both the former Weald and Channel depocentres. Subsequently, erosion during the Neogene and Quaternary has unroofed these inverted basins. This extended and complex erosional period in sub-tropical to periglacial environments and associated with considerable sea-level variation gave rise to the present-day landscape.

The Salisbury Sheet lies within the Wessex Basin, a major structural element of southern England, whose formation influenced the deposition of strata from Permo-Triassic times through to the Palaeogene. Deposition within this basin reflects expansion and contraction in response to major earth movements associated with the opening of the Atlantic and English Channel and later contraction during the Alpine compression. The sheet forms the southern part of the area between two principal complex folded and faulted structural elements of that basin. Within the sheet and to the south of

Salisbury the Wardour asymmetric anticlinal structure which manifests itself partly as the complex Mere Fault, runs east – west through the Vale of Wardour passing to the east into the offset Dean Hill Anticline. Further north, beyond the confines if this sheet area, the similar asymmetric east – west structure of the Pewsey anticline runs through the Vale of Pewsey (Chadwick, 1986). The main structural elements of the basin are related to low-angle thrusts of Variscan age, which during later expansion initiated normal fault formation. These faults have been reactivated a number of times throughout the Jurassic and Cretaceous with the final 'Alpine' reactivation being in a reverse sense.

Figures 6 to 9 are generated from the interpretation of seismic profiles and show the depth (as a conversion from the two-way-travel time of the seismic data) to various horizons beneath the Salisbury district.

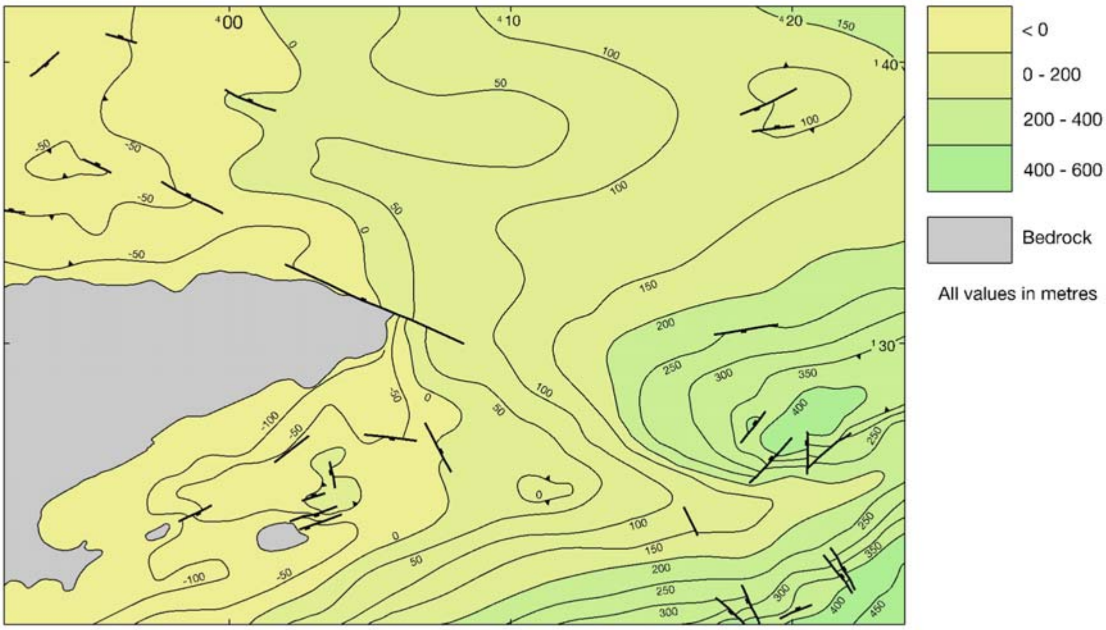


Figure 6. The depth of the base of the Chalk Group relative to OD. D J Evans (pers. Comm., 2005)

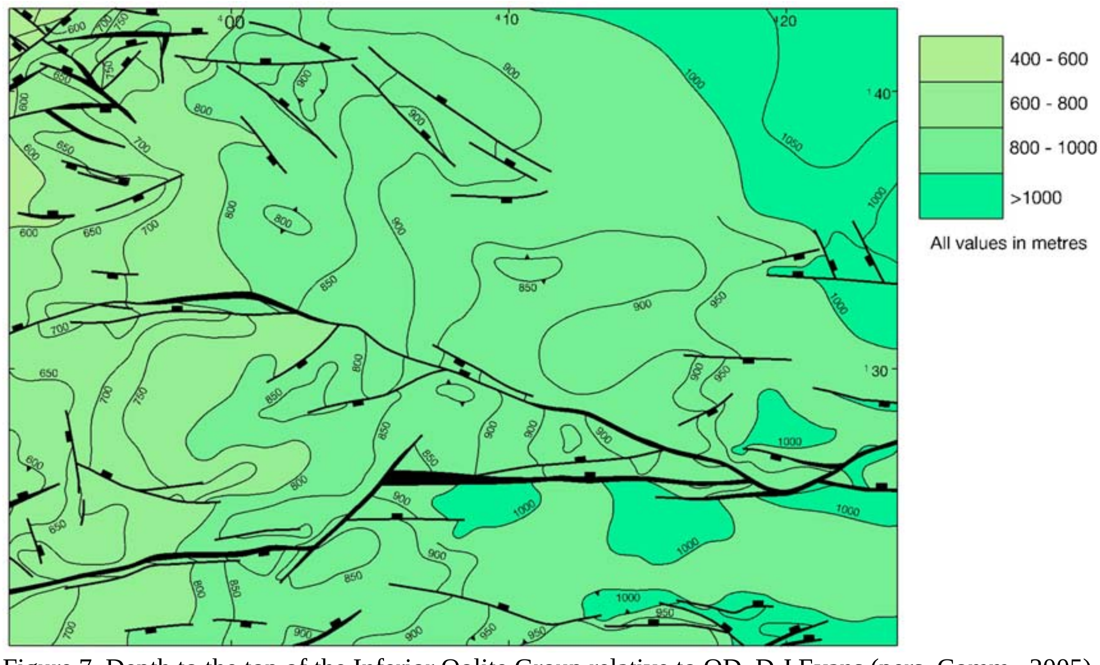


Figure 7. Depth to the top of the Inferior Oolite Group relative to OD. D J Evans (pers. Comm., 2005)

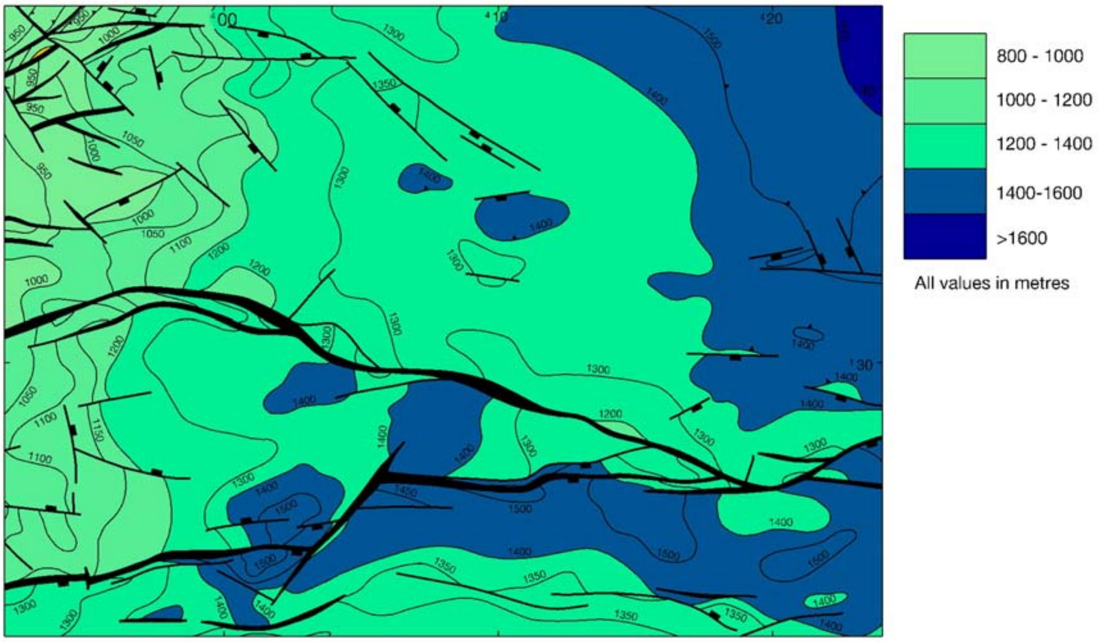


Figure 8. Depth to the top of the Penarth Group relative to OD. D J Evans (pers. comm., 2005).

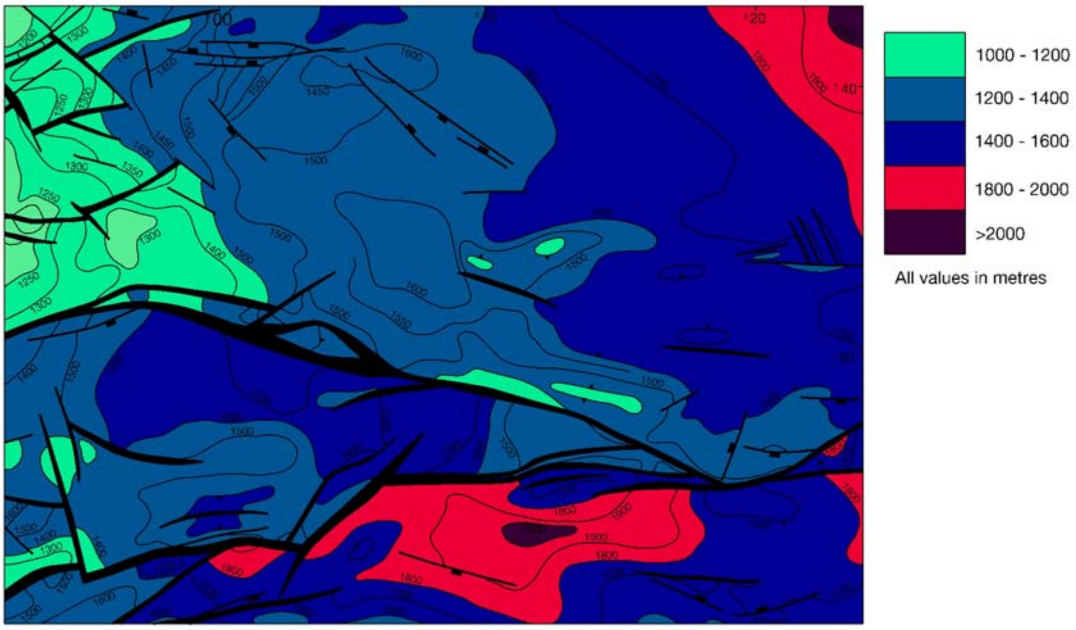


Figure 9. Depth to the top of the Undivided Variscan Basement relative to OD. D J Evans (pers. comm., 2005)

The geological resurvey of this district has demonstrated the presence of a number of relatively small synclines and anticlines that affect the Chalk outcrop and the distribution of the Lower Cretaceous and youngest Jurassic strata in the Vale of Wardour (Figure 10).

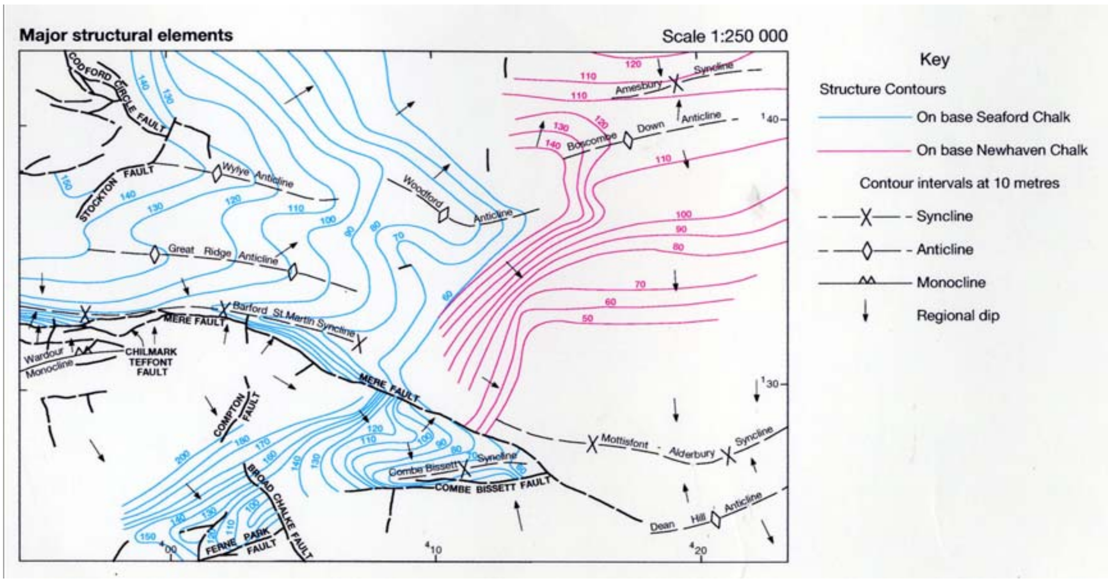


Figure 10: Fold and fault trends at surface as demonstrated by structural contours on selected horizons.

Regionally, south of the Vale of Pewsey, the chalk dips gently southwards at generally less than 2°, at least as far south as Netheravon and Tidworth in the east and Chitterne in the west where the dip shallows. South of here the structure becomes more complicated.

In the extreme north and east of the district a broad low amplitude east-west oriented syncline extends across the district, through Cholderton and plunging east towards Thruxton. To the west, this broad syncline splits into two, one branch extending through Bulford Camp (and principally on the southern part of the Devizes sheet), the other just north of Boscombe Down Airfield is the Amesbury Syncline. A small east-west anticline (unnamed) separates the two, running parallel the A303, but dies out eastwards near Beacon Hill just north of the district. It is asymmetric and appears to have a much steeper northern limb (dips up to 5º) and amplitude of c. 10 to 15m. On the southern limb of the main, undivided, syncline around Grateley, the regional dip is between about 0.2º and 0.5º towards the northeast or possibly the east-north-east.

Further to the south is a broad gentle northward facing pericline or dome structure centred on High Post [SU 151 365]. This broad low amplitude (c. 15-20m) structure is best seen in the Avon valley around Middle Woodford in the Avon valley where the Lewes Chalk is brought up in the core of the anticline (Woodford Anticline). To the east, and slightly offset to the north, a similar anticline (Boscombe Down anticline) trends through High Post, Boscombe Down and extends on to the northern part of Porton Down, just south of Grateley. To the west, the Woodford Anticline swings round to a north-westerly orientation and merges with the Wylye Anticline, again with a slight offset, but this time towards the south. It appears that these structures are related and have an en-echelon relationship, which may be determined by faulting at depth. This structure is probably the continuation of the Stockbridge anticline to the east (Booth, 1999, Farrant, 1999). This style of folding probably reflects tectonic inversion of normal faults within Jurassic strata at depth (Chadwick, 1993) similar to that invoked for the Purbeck disturbance in Dorset and the Isle of Wight by Underhill and Paterson (1998). Similar periclinal structures caused by east-west faulting at depth are known to occur elsewhere on the Salisbury and Winchester sheets (Farrant, 1999).

In the west of the district the Wylye Anticline is cross-cut by numerous faults. This is possibly the result of the reduced thickness of the Upper Cretaceous and the more brittle fracture of the Upper Greensand Formation exposed in the valley bottom.

North of the Wylye/Woodford anticline, north and east of the Yarnbury Castle - Chitterne Ridge (sheet SU04SW), structural contours on the Severn Sisters Flint - *Volviceramus* acme (a key marker within the Seaford Chalk Formation) suggest a dip of approximately 1º to the northeast, swinging to a more east-north-easterly direction just south of Yarnbury Castle.

Immediately south of this periclinal structure to the east of the River Avon, the dip increases up to 3º to the south; further east the dip is much gentler at between 0.5º and 2º to the south or southeast. Westward a shallow syncline (unnamed) separates the Wylye Anticline from the Great Ridge Anticline.

South of Great Ridge the dip again becomes southerly into the very tight Barford St Martin Syncline created as a 'drag-structure' immediately to the north of the Mere Fault. This syncline broadens and fades eastward into the Wylye valley but matches with the much broader structure of the Mottisfont – Alderbury Syncline east of the River Avon. This may well reflect a deep-seated north-westerly orientated structure in the basement as the reversed Mere Fault Structure also fades eastward into the periclinal Dean Hill Anticline.

In the west of the district the Wardour Monocline, with its steep northerly dipping limb, affects the Jurassic and Lower Cretaceous strata exposed in the River Nadder valley. This structure fades towards the east where it also broadens into a symmetrical anticline.

The Coombe Bissett Syncline appears to be similar in its formation to the Barford St Martin syncline as it has the Coombe Bissett Fault on its southern flank.

2.2 Faulting

There are a number of recognisable, mappable faults at surface in the area, and most of those occur on the primary Chalk scarp and associated with the Mere Fault complex within the River Nadder valley.

A small fault was noted in a valley south of Boscombe Down airfield where a major flint band is down thrown by about two metres. This fault could not be traced laterally for any distance because of the lack of significant lithological contrast.

The principal fault on the Salisbury sheet is the Mere Fault. This runs from the sheet margin in the west along the Nadder valley north of the Upper Greensand ridge before diving under the flood plain of the river near Barford St Martin. It continues southeast to Odstock in the east where it dies beneath the Avon valley.

At surface the Mere Fault is a single, southerly dipping, steeply inclined or vertical reverse fault, down throwing to the north. The maximum throw is estimated to be around 100 m (?), but the throw is variable along its length. At the surface, the western portion of the Mere Fault becomes complex with a strongly developed set of normal faults associated with it. At Baverstock, a small north-south oriented fault appears to cut the Mere Fault, and corresponds to a marked increase in the dip either side of the fault. To the east of Baverstock, the fault is less well marked and much of the displacement is taken up by folding associated with the tight Barford St Martin Syncline. Further east south of Wilton the Mere Fault becomes less distinct and in part difficult to trace within the similar lithologies of the White Chalk Subgroup. Here, in addition to field observation of gross formational lithologies, it has been detected with the aid of macro- and micro- fossils that clearly show a variable maximum throw on the fault in the range 50 to 70 metres. Further east through Odstock a throw of as little as 20 metres is indicated and the fault dies beneath the Quaternary deposits of the River Avon and cannot be detected east of the valley. Here however the asymmetric Dean Hill Anticline is thought to demonstrate the line of this structure at depth.

Much of this reverse movement is associated with post Cretaceous reverse movement following basin contraction. At depth the null-point at which the reversed sense of movement on the fault cannot be detected is within the lowermost Jurassic and Permo-Triassic over much of the length of the fault but may well be considerably higher stratigraphically in some parts.

Medium-scale faulting is noted in the headwater regions of the Wylye, Nadder and Ebble rivers where the Cretaceous strata are thin due to erosion. These faults probably reflect early Cretaceous reactivation of deep-seated normal faulting and perhaps attest to the continued expansion of the Wessex Basin at this time. The more significant faults are named where they can be detected but their continuation into the higher formations of the Chalk is frequently not possible due either to the similarity of the lithologies adjacent to the fault, a simple reduction in throw or a change in the ‘style’ (the different way in which faults propagate through differing lithologies) of the faulting (see below).

Many smaller faults with throws of less than 1m were seen in several of the disused pits, but could not be traced outside the pits. A notable example is a small pit near Baverstock [SU 0313 3288] where several small conjugate faults with throws of up to 0.2m could be seen. This minor faulting may well be a ubiquitous feature of the chalk. Instead of discrete faults, the strata may be displaced by several metres by numerous minor shear zones over a distance of several tens of metres, thus smearing the ‘fault’ zone over quite a wide area with little or no surface expression. On seismic profiles, faults that exist within the harder sequences beneath the Chalk apparently tend to become attenuated as they propagate upwards. Instead of a discrete fault, displacement can be dispersed into zones of numerous relatively minor faults. Such zones could be several tens of metres wide, and can themselves die out upwards, passing up into anticlines or synclines.

Plate 1. Fault zone in Newhaven Chalk, West Harnham Chalk Pit. [SU12812 28758]. P584715

Tectonic activity during deposition can affect Chalk lithology on a basin-wide scale. There is growing evidence that tectonic and eustatic movement occurred in phases throughout the Upper Cretaceous (Mortimore and Pomerol, 1987; Mortimore and Pomerol, 1991; Mortimore et al., 1998, Evans and Hopson, 2000). Four major tectonic phases (demonstrated in Germany and the eastern Anglo-Paris basin) caused local channelling and slumping, and the local formation of hard-grounds and phosphatic chalks, as well as variations in marl development throughout southern England. Some characteristics of the Chalk in the present area may be a result of these continued movements, for example the presence of a bed of very hard chalks near the top of the Seaford Chalk and the thin marl seams in the New Pit and Newhaven Chalk. In this district, phosphatic chalks have been seen associated with a channel cut into the Seaford Chalk, but the attenuation of the Tarrant and Spetisbury Chalk members within the Culver Chalk Formation may also be due to channelling or thinning northwards towards the London-Platform.

It is assumed that drainage lines tend to follow major fractures within the Chalk. Although fracture sets control valley orientation, topography and regional dip exert a strong influence.

A study east of the River Avon (as part of the Bourne Catchment study for the Environment Agency) demonstrated two strong preferred orientations are apparent in linear elements of the local drainage,

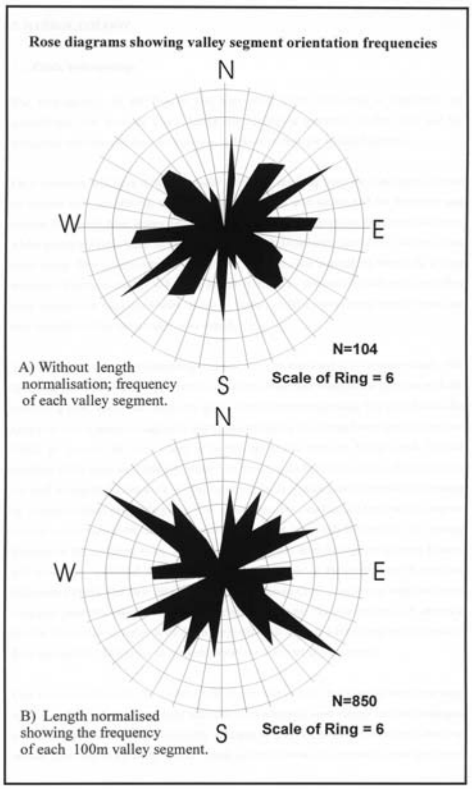


Figure 11: Rose diagrams showing the analysis of the valley orientations within the River Bourne Catchment area.

one trending ENE-WSW is most clearly developed to the east of the River Bourne. The second trends NW-SE and is clearly displayed in many of the dry valleys. Analysis of the valley orientations clearly displays these two major fracture sets, together with two minor sets; one north-south and another almost east-west. Figure 11a displays the frequency of linear valley segments across this area, and shows the trending ENE-WSW fracture set is the most frequent. Yet another fracture set running NNW-SSE appears to be present north of Amesbury. Figure 11b displays similar data for the southern portion of the district with a length-scaling factor to take into account and normalise the differing lengths of each linear valley segment. The NW-SE fracture set is clearly the preferred valley orientation in this area. This fracture pattern is consistent with a regional compressive stress directed north-north-east to south-south-west.

The Avon valley itself follows two major joint sets; at 160-340º in the northern half of the study area, outside this district on the Devizes sheet, and 015-195º south of Amesbury. The 160-340º determines the majority of its course joint set, but the section between Amesbury and Little Durnford follows the 015-195º set. The Bourne and Nine Mile River both follow a north-south orientation in their upper reaches, but are still influenced by frequent ENE-WSW and NW-SE fracture sets. Further south, the ENE-WSW and NW-SE fracture sets become more dominant. This major change of valley orientation along these two dominant sets occurs along a line from Bulford to Newton Tony and appears to be independent of the major structures.

Outside this study area similar lineations can be detected in valley segments and these are shown in Figure 12. To the west of the Avon there is a strong orientation of ENE – WSW that is followed by the Rivers Ebble and Nadder. A weaker NW – SE trend is evident in many of the minor dry valleys to these rivers. There is a strong North – South/NNW – SSE trend within the Lower Wylye and River Till valleys. The upper Wylye valley follows a WNW – ESE trend with it dry valley ‘tributaries’ being generally perpendicular.

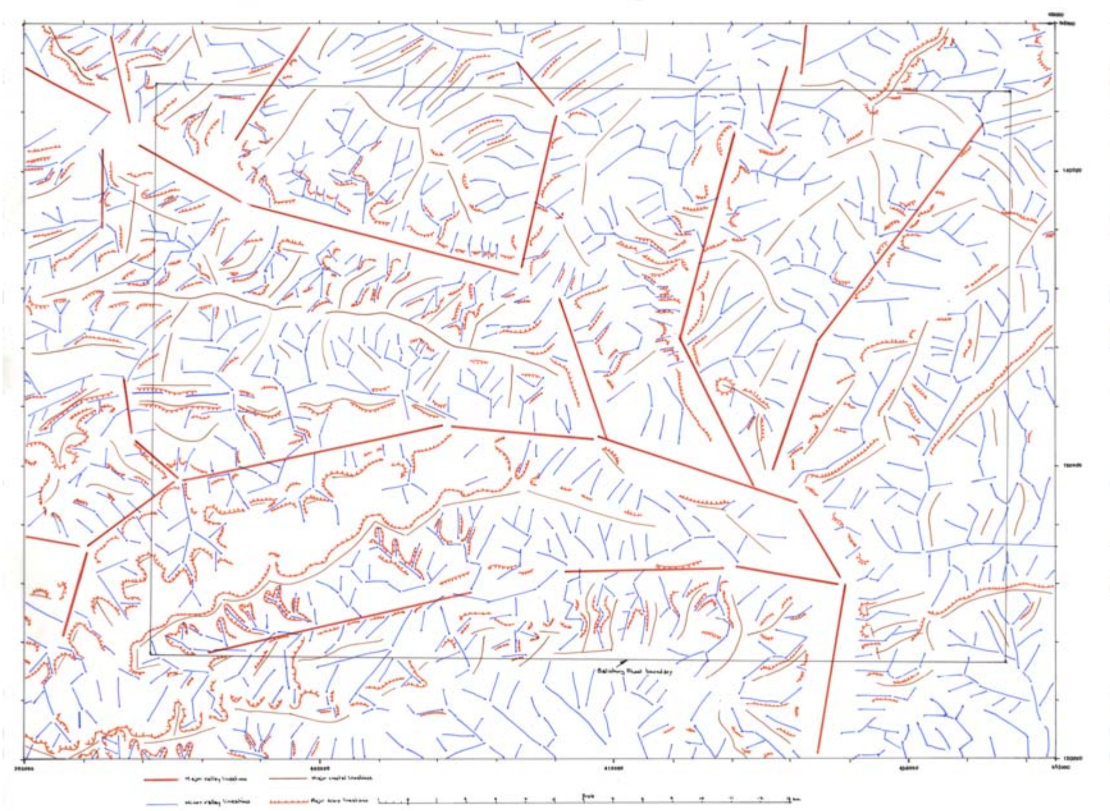


Figure 12: Lineations of valley segments and major scarp features throughout the Salisbury district.

3 CONCEALED STRATA

3.1 Introduction

There are 4 deep boreholes, within or close-by the district, that penetrate below the base of the exposed strata, and a further number that prove extended successions of and beneath the Chalk.

The four deepest wells at **Shrewton** (SU04SW1 [SU 03137 41989]), **Yarnbury** (SU04SW5 [SU 03357 41053]), **Netherhampton 1** (SU12NW6 [SU 11315 28766]), and **Farley South** (SU22NW2 [SU 23589 28529]) investigate the deep strata to basement beneath the district.

Additional boreholes at **Long Hall, Stockton** (ST93NE3 [ST 9800 3793]), **Codford St. Peter** (ST94SE26 [ST 9535 4008], and ST94SE21 [ST 9552 4008]), **Tisbury** (ST92NW2 [ST 9359 2907]), **New House Farm, Chitterne** (SU04SW2 [SU 0080 4310]), **Fisherton De La Mere** (SU03NW21 [SU 0010 3998]), **Grouley Wood (Wylye)** (SU03NW20 [SU 0107 3731]), **Boscombe Down** (SU13NE1 [SU 1791 3924]) and **Alderbury** (SU12NE7 [SU 1965 2672]) are deep water wells. These will be described within the relevant sections of this report.

Table 2: Stratal thicknesses within the four deep hydrocarbon wells

Strata	**Shrewton**	**Yarnbury**	**Netherhampton**	**Farley South**
Borehole Number	**SU04SW 1**	**SU04SW 5**	**SU12NW 6**	**SU22NW 2**
Grid Reference	**03137 41989**	**03357 41053**	**11315 28766**	**23589 28529**
Palaeogene	Absent	Absent	Absent	35.0
White Chalk Subgroup	112.4	116.0	142.0	325.0
Grey Chalk Subgroup	49.1	63.4	79.0	78.0
Upper Greensand Formation	67.9	73.4	37.0	44.4
Gault Formation	45.7	33.8	58.0	51.0
Lower Greensand Group	10.0	6.1	20.0	17.7
Wealden 'Group'	Absent	Absent	Absent	? Absent
Purbeck Group	Absent	36.9	23.0	28.3
Portland Group	47.5	32.9	37.0	50.0
Kimmeridge Clay Formation	273.7	204.8	247.0	184.0
Corallian Group	50.6	42.7	48.0	48.0
Oxford Clay Formation	179.8	173.7	125.0	151.0
Kellaways Formation	10.4	9.4	10.0	11.0
Great Oolite Group	180.4	168.0	141.0	118.0
Inferior Oolite Group	21.9	15.5	32.0	41.5
Lias Group *	430.4	373.4	297.8	256.0
Penarth Group	16.4	15.5	14.6	16.1
Permo-Triassic	286.4	264.3	119.8	238.4
Basement	1211.3+[1]	49.1+[2]	206.0+[3]	287.0+[4]

Notes:
*The Lias Group undivided encompasses the old divisions of Lower, Middle and Upper Lias. Modern terminology that can be applied to the strata encountered in these boreholes is discussed below in section 3.8.
1 Cambrian, Tremadoc. This borehole describes 39.6 m of (?) Tremadoc above the extended section in rocks of Tremadoc age. Herein it is considered to be basal Permian. See text below.
2 Cambrian, Tremadoc
3 Carboniferous Limestone
4 Carboniferous Limestone

Ordovician, Silurian and Devonian strata are suspected (and in some areas imaged on seismic profiles) at depth beneath parts of the district but they are not penetrated by boreholes within or close to this district. A digest of the available data on the concealed strata is given below based on the lithologies described in the four principal boreholes, the Pre-Permian Geology Map of the United Kingdom (South) and numerous other papers and publications. The degree of detail generally reflects the volume of data available.

3.2 Cambrian

Proved in the Shrewton and Yarnbury boreholes the Cambrian strata, preserved in the core of an anticlinal structure at depth in the north of the district, is considered to be of Tremadoc age. The rocks encountered in these boreholes are grey to very dark grey, siltstone with interbedded mudstone and fine-grained sandstone. All are micaceous and with calcite veining in part and there are subordinate beds that are calcareous or slightly calcareous throughout. At depth in the Shrewton borehole the rocks are generally pyriteous. Dipmeter logs run in the Shrewton borehole suggest a strong dip in a generally southerly or south-westerly direction of between 20˚ to 48˚ throughout this succession.

Within the Shrewton borehole (1743.5 m to 1783.1 m [5720 to 5850 feet]) the highest part of the Tremadoc strata have high ‘dips’ to the north indicated on the Dipmeter log. These are also described as calcareous, micaceous siltstone and mudstone but they are of a generally grey colour with distinct reddish brown and greenish grey interbeds some of which are mottled. The lithology, colour contrasts, high contrary dips, the higher stratal velocities measured and the more ‘ratty’ appearance to the gamma log suggest that these are questionably basal Permian dune cross-bedded units and the ‘dip’ is therefore considered to indicate dune foresets showing a south to north wind direction (see Permian description below).

3.3 Ordovician to Silurian

The Pre-Permian geology map of the southern UK (Smith, 1985) shows undivided Ordovician and Silurian (and Devonian, see below) strata having an arcuate subcrop around the Cambrian strata previously described. There is very little evidence as to the lithological character of these rocks in nearby boreholes although it is believed that a full succession is present.

The nearest analogues for this succession are the Silurian strata brought to surface in the Beacon Hill Pericline, one of the en-echelon structures of the Mendip Hills about 35 km due west of the Shrewton Borehole. Here the approximately 350 m of exposed Silurian comprises tuffs with fossiliferous mudstone of Wenlockian age overlain by 200m of andesitic lavas (Bristow, et al. 1999). Other nearby Silurian strata is described in the Bristol special Sheet Memoir (Kellaway and Welch, 1993). The nearest exposed and similar Ordovician strata are probably in south Wales.

3.4 Devonian

Devonian strata is postulated in the north, south of Shrewton and Yarnbury boreholes, and proven again to the south of the complex Mere Fault (see Figure 5) beneath the Vale of Wardour, and the postulated extension of the Mere Fault towards the east. There are no boreholes that penetrate this succession within the Salisbury district.

To the east, Devonian strata were penetrated beneath a major unconformity in the Stockbridge 1 (SU43NE5 [SU4451 1355]) and Goodworth 1 (SU34SE14 [SU 4369 1419]) boreholes. These boreholes are north of the eastward extension of the Mere Fault and describe Lower Devonian strata. Here, the descriptions, of the limited thicknesses penetrated, show sandstone with subordinate siltstone and mudstone in fining-upward cycles of fluviatile origin. These continental successions were deposited on the Brabant Massif to the north of the Cornwall Basin (Ziegler, 1982) that was itself a part of the Variscan Foredeep Basin. The subcrop patterns on the Pre-Permian map (Smith, 1985) would suggest that these rocks dip towards the south and southeast and probably at similar angles to the older strata.

To the south, 15 km beyond the district boundary, the Cranborne Borehole (SU00NW1 [SU 03408 09073]) proved 378 m of strata considered to be representative of the Devonian rocks preserved within the Cranborne – Fordingbridge High structural unit of the Wessex Basin. The northern boundary of this structural high is the Mere Fault complex and these same strata are therefore believed to underlie the southern part of the Salisbury district.

The Upper Devonian strata in this borehole (from 1663 m to 2041 m depth) comprises grey-green, infrequently red to brown, mudstone with subordinate siltstone and thin widely interspersed fine-to coarse-grained sandstone units. Much of the succession is also described as shale, and chlorite is noted at the top and base of the strata, both aspects of the lithology indicating a very low grade of metamorphism. The rocks are micaceous and progressively pyritic with depth, they are dolomitised in part and have common calcite veining. Palaeogeographically they are postulated to have been deposited in a shelf sea (the Cornwall basin of Ziegler, 1982).

3.5 Carboniferous

Carboniferous strata underlie the central part of the Salisbury district at depth. Evidence from the Wincanton district to the west (Brunton Borehole ST63SE19 [ST 6896 3284]) suggests a general dip for these deposits of 20˚ to the south-southwest. They form the basement beneath the southern part of the structural Pewsey Basin an element of the larger Wessex Basin. The Pewsey Basin is bounded in the south, by the complex Mere structure, and to the north by the Pewsey structure. Evidence from the Stockbridge and Goodworth boreholes suggest that the Carboniferous is separated from the Lower Devonian by the post-Devonian unconformity in the Pewsey Basin. It is not known whether younger Devonian strata are present away from these boreholes

The rocks encountered in the Netherhampton and Farley South boreholes are Lower Carboniferous (Dinantian) platform carbonates. They are generally described in the Netherhampton borehole as white, light grey, pink, red and brown limestone and mudstone, cemented to strongly cemented, slickensided and stylolitic. A more comprehensive description in Farley South indicates a succession of interbedded limestone and chert with numerous dolomitic limestone and dolomite units with rare beds of calcareous siltstone. The succession is generally light to dark grey with light brown, pink and red tones being associated with the dolomite rich units.

These platform carbonates formed in a shelf sea on the southern margin of the emergent London Brabant Massif.

3.6 Permian – Triassic

The thickness variation of the Permian - Triassic strata (including the Penarth Group, see below) is shown in Table 3:

The **Permian** strata encountered within the Shrewton and Yarnbury boreholes comprise interbedded, red, micaceous mudstone and siltstone with rare thin sandstone interbeds. Towards the base within the Yarnbury Borehole a white to reddish brown, microcrystalline, 'chalky' limestone is described from chippings but a sidewall core failed to make any recovery.

As mentioned above, the lithological and geophysical log characteristics of the uppermost (?) Tremadoc strata, beneath the identified Permian, suggest that this unit may also be of Permian age.

The **Triassic** strata of the Wessex Basin are broadly divided into four lithostratigraphical units. A basal Aylesbeare Mudstone Group, intermediate Sherwood Sandstone and Mercia Mudstone groups and a thin uppermost Penarth Group. The division between the Sherwood Sandstone and Mercia Mudstone groups is known to be diachronous within the individual depositional basins that make up the British Isles Triassic, with this boundary being younger in the south (in the Wessex, Avon/South Wales and Worcester basins) than in the north (e.g. the East Midlands Basin).

To the west on the Wincanton sheet (Bristow et al., 1999) the thickest Triassic strata are postulated south of the Mere Fault (the Mere Basin) with a thinner sequence to the north (the Pewsey Basin) and to the south (on the Cranborne – Fordingbridge High). The lowest 350 m (beneath the Mercia Mudstone Group) of this thicker succession is thought to comprise a lower mudstone unit, the Aylesbeare Mudstone Group, overlain by an interval having the typical seismic signature of the Sherwood Sandstone Group. Seismic reflection data suggest that the Mercia Mudstone Group is up to

400 m thick in the Mere Basin thinning, by onlap, both to the Mendips northward and onto the Cranborne – Fordingbridge High to the south. In the Avon Basin (Kellaway and Welch, 1993) to the northwest of this district there is a longer period of non-deposition or erosion post the Carboniferous and the strata of the Triassic basin 'laps' against older strata, such that calcareous, ferruginous sandstones equivalent to the Redcliffe Sandstone Formation (most recently proposed as a member of the Eldersfield Mudstone Formation [Howard, 2003 pers. comm.]) of Mercia Mudstone age rest on older strata.

Table 3. Thickness variation of the Permian and Triassic succession proven within the four deep wells related to the district.

Borehole	Permian	Sherwood Sandstone Group	Mercia Mudstone Group	Penarth Group[5]
Shrewton	72.8 m[1]	102.7 m[2]	110.9 m[4]	White Lias 9.4 m Cotham & Westbury 7.0 m
Yarnbury	31.1 m	131.7 m[2]	101.5 m	White Lias 8.5 m Cotham & Westbury 7.0 m
Netherhampton	Absent	7.0 m	112.8 m	White Lias 7.9 m Cotham and Westbury 6.7 m
Farley South	Absent	21.3 m[3]	217.0 m	White Lias 8.5 m Cotham & Westbury 7.6 m

Notes:-

1. Includes 39.6 m tentatively assigned to the Tremadoc (see Cambrian discussion above)
2. Divided into the traditional terms of Bunter Sandstone, below, and Keuper Sandstone, above, with thicknesses of 64.6 m and 38.1 m respectively in Shrewton and 81.7 m and 50.0 m respectively in Yarnbury. No attempt has been made to equate these two units with defined formations at outcrop although the lithologies are most likely to accord with divisions seen in nearby basins.
3. This unit is described as microbreccia on the log for this borehole. It is considered to be Triassic in age but may well be Permian.
4. Include 9.1 m of Blue Anchor Formation (the Tea Green Marls of traditional nomenclature).
5. The Penarth Group divisions are discussed in the relevant section below.

Within this district the thickness of Triassic strata is proven in all four deep boreholes each of which is placed north of the Mere Fault and its continuation, offset southward, to the east. These four boreholes demonstrate a thinner succession immediately to the north of the Mere Fault thickening northwards into the Pewsey Basin. Further to the south, outside the district, the Cranborne Borehole proves a thin succession associated with the Cranborne – Fordingbridge High. Northward from this high towards the Mere Fault a thicker Triassic succession, postulated from seismic data within the Mere Basin, must extend east beneath the southern part of the district but is not corroborated by direct borehole evidence.

There is no indication of the Aylesbeare Mudstone Group north of the Mere Fault, presumably lost through onlap against the faulted Mere Basin and only the upper three groups of the Triassic are positively identified from boreholes in this district.

As defined within the Shrewton and Yarnbury boreholes the Sherwood Sandstone Group is divided into older Bunter Sandstone 'Equivalent' and younger Keuper Sandstone 'Equivalent' (essentially following the traditional scheme of Hull, 1869). Thus defined the Sherwood Sandstone Group comprises interbedded, red and grey-green mudstone and siltstone (the 'Keuper Sandstone') overlying very fine- to medium-grained, calcareous sandstone with interbeds of siltstone (the 'Bunter Sandstone'). In terms of the British Triassic succession these terms are no longer meaningful. However, if this boundary between older and younger beds is correctly defined within these boreholes then there is an erosional event between the two 'equivalents' that can be related to the extensive and well known Hardegson Disconformity. Modern terminology based on distant outcrops in the southwest of England Basin (SWB) and in the Worcester Basin (WB) would suggest that the lower beds beneath the disconformity are equivalent to the Budleigh Salterton Pebble Beds (SWB) or the Wildmoor Sandstone Formation (WB). The upper beds are equivalent to the Otter Sandstone Formation (SWB) or the Bromsgrove Sandstone Formation (WB).

However it could be postulated that the calcareous nature of the lower sandstone (the 'Bunter Sandstone Equivalent') and its generally siltstone/mudstone lithology of the overlying 'Keuper Sandstone', may indicate that this unit is a marginal facies of the Triassic perhaps even equivalent to the Redcliffe Formation of the Bristol district and thus the whole Sherwood Sandstone Group succession as defined herein could be considered as entirely within the Mercia Mudstone Group.

The highest beds (1496.6 m to 1505.7 m) of the Mercia Mudstone Group are attributed to the Blue Anchor Formation in the Shrewton borehole. They are described as dark grey and greenish grey calcareous mudstone. This unit has not been identified within the other deep boreholes in the district but may still be present in these borehole successions as there is only a slight non-sequential contact with the overlying Penarth Group.

The **Penarth Group**, of Rhaetian age, is believed to underlie the whole district since the massive limestone (Langport Member or 'White Lias') at the top of the succession forms a prominent seismic reflector identified widely. The group was deposited in marginal marine and lagoonal conditions as a precursor to the fully marine conditions prevalent in the Jurassic. As such the group brings an end to the long period of continental red-bed sedimentation characteristic of the Permian and much of the Triassic periods.

The group is now divided into the Westbury Formation overlain by the Lilstock Formation. The Westbury Formation is equivalent to the Westbury Beds, Black Shales and the Rhaetic Bone Beds of the older literature. The Lilstock Formation includes the Cotham Member (formerly Cotham Beds), and the Langport Member (formerly the White Lias). Whilst the upper part of the succession is identified as the White Lias in all four boreholes and can therefore be attributed to the Langport Member, the succession below is described as the Cotham and Westbury Beds. The lithological descriptions are insufficient to place the Westbury Formation/Lilstock Formation boundary with any certainty.

In areas adjacent to the Salisbury district the Westbury Formation comprises dark grey to black laminated to finely bedded micaceous, carbonaceous and pyriteous mudstone (or shale). The Cotham Member is described as white to pale greenish grey calcareous siltstone with traces of pyrite and shell fragments. The Langport Member is hard microcrystalline white to grey sparsely bioclastic limestone, argillaceous in part, with carbonaceous material and pyrite.

The greater part of the **Jurassic** succession is encountered at depth beneath the Salisbury district. In general the successions described are insufficiently detailed to allow direct comparisons with strata exposed to the west and southwest and readers are recommended to consult the Wincanton (Bristow et al. 1999) and Shaftsbury (Bristow et al., 1995) memoirs for detailed lithostratigraphical descriptions. Where possible correlatives are discussed in the sections below.

3.7 Lias Group (Lower Jurassic)

Traditionally the Lias was divided into Lower, Middle and Upper units and it is these that appear on the logs for the four deep boreholes. The Lias Group has recently been formally divided (Cox, Sumbler and Ivimey-Cook, 1999) into a number of formations and members based on the regional basins across the British Isles. This document brings together a multitude of quasi-formal and informal names (some used to classify the strata in this district) into a UK wide hierarchy. Many of the names are heavily entrenched in the literature but often poorly defined. The scheme for the Wessex and Worcester Basins are shown in Table 4. In general the formations can be identified within the described successions in the four deep boreholes although the identification of individual members is more difficult due to the inevitable gaps in the described strata in these uncored sections. A correlation of the Lias Group between the boreholes is given in Figure 13.

To the west the Wincanton memoir (Bristow et al., 1999) describes the traditional terms Lower, Middle and Upper Lias with locally named units separated by non-sequences. Here the top of the Lower Lias is placed at the top of the Ditcheat Clay (a lateral equivalent of the Green Ammonite 'Beds') and the top of the Middle Lias at the disconformity at the top of a lower Marlstone Rock Bed. It is not known whether the identified gaps in the succession pass eastward beneath the Salisbury district.

In the Yarnbury Borehole (SU04 SW5 [SU03357 41053]) the Lower Lias is described as claystone, medium to dark grey, hard blocky, silty pyritic very calcareous and interbedded with hard brittle,

Table 4: Correlation of the Lias Group

	Wessex Basin Formations	**Wessex Basin Members (Dorset Coast)**	**Worcester Basin Formations S N**	**Worcester Basin Members**
Lias Group	Bridport Sand		Bridport Sand__ / ___/ ___ / Whitby / Mudstone	Undivided formally as yet
		Down Cliff Clay		
	Beacon Limestone	Eype Mouth Limestone		
		Marlstone Rock	Marlstone Rock	
	Dyrham	Thorncombe Sand	Dyrham	
		Down Cliff Sand		
		Eype Clay		
	Charmouth Mudstone	Green Ammonite	Charmouth Mudstone	
		Belemnite Marl		
		Black Ven Marl		
		Shales-with-Beef		
	Blue Lias	Undivided	Blue Lias	Rugby
				Saltford Shale
				Wilmcote

blocky, microcrystalline argillaceous light to medium grey limestone grading to calcareous claystone. This lower part of the succession is regarded as Hettangian in age. Similar lithologies are described for the Sinemurian and Lower Pliensbachian parts of the succession above but these are generally micaceous and shelly. They grade in colour from dark greyish brown to very dark grey black. Taken together the Lower Lias amounts to some 402 ft (122.5 m) of strata. It is not possible from the descriptions to determine the horizon at which the change from Blue Lias Formation to Charmouth Mudstone Formation occurs. The Middle Lias of Upper Pliensbachian age comprises 436 ft (132.9 m) of clean, white to pale grey, very fine- to fine-grained sandstone, calcareous, micaceous and with a trace of glauconite which grades downwards into calcareous and pyritic siltstone and claystone with thin interbeds of soft ‘chalky’ limestone. The Marlstone Rock Bed (equivalent) is described as 5 ft (1.5 m) of white to buff (pale brown) firm to hard microcrystalline and sparry limestone and considered to be of Upper Pliensbachian age. Above is 29 ft (8.8 m) of a ‘Junction Bed’ comprising light grey, calcareous very fine-grained sandstone with thin interbeds of claystone and limestone overlain by a cream microcrystalline slightly dolomitic hard limestone both of which are of Toarcian age. These beds can be considered as equivalent to the Dyrham Formation. The Upper Lias of Toarcian to Bajocian age is 353 ft (107.6 m) thick and comprises a basal unit of grey and greyish brown siltstone and claystone with thin limestone interbeds which grades up into greenish grey, glauconitic, calcareous, pyritic, very fine-grained sandstone possibly equivalent to the Bridport Sand Formation of the Dorset coast.

Very similar successions are described within the three other deep wells in the district and are not expanded upon herein.

3.8 Inferior Oolite Group (Middle Jurassic)

The Inferior Oolite Group to the west in the Wincanton district (there termed the Inferior Oolite Formation) is known to contain appreciable breaks in the succession. The group spans the latest Aalenian, Bajocian and earliest Bathonian stages. In general the descriptions available from the four deep boreholes of the Salisbury district are insufficient to determine whether these breaks in deposition extend beneath this area. The Group is shown undivided in Figure 14 that shows a correlation of the whole of the Middle Jurassic.

In the Yarnbury Borehole (SU04 SW5 [SU03357 41053]) the Inferior Oolite is described as 51 ft (15.5 m) of interbedded limestone and claystone. The limestone is pale to medium grey, friable to firm, sucrosic, with some fine- to medium-grained ooids, and is argillaceous and sandy in places. The claystone is medium grey to dark greenish grey slightly calcareous with mica and a trace of pyrite.

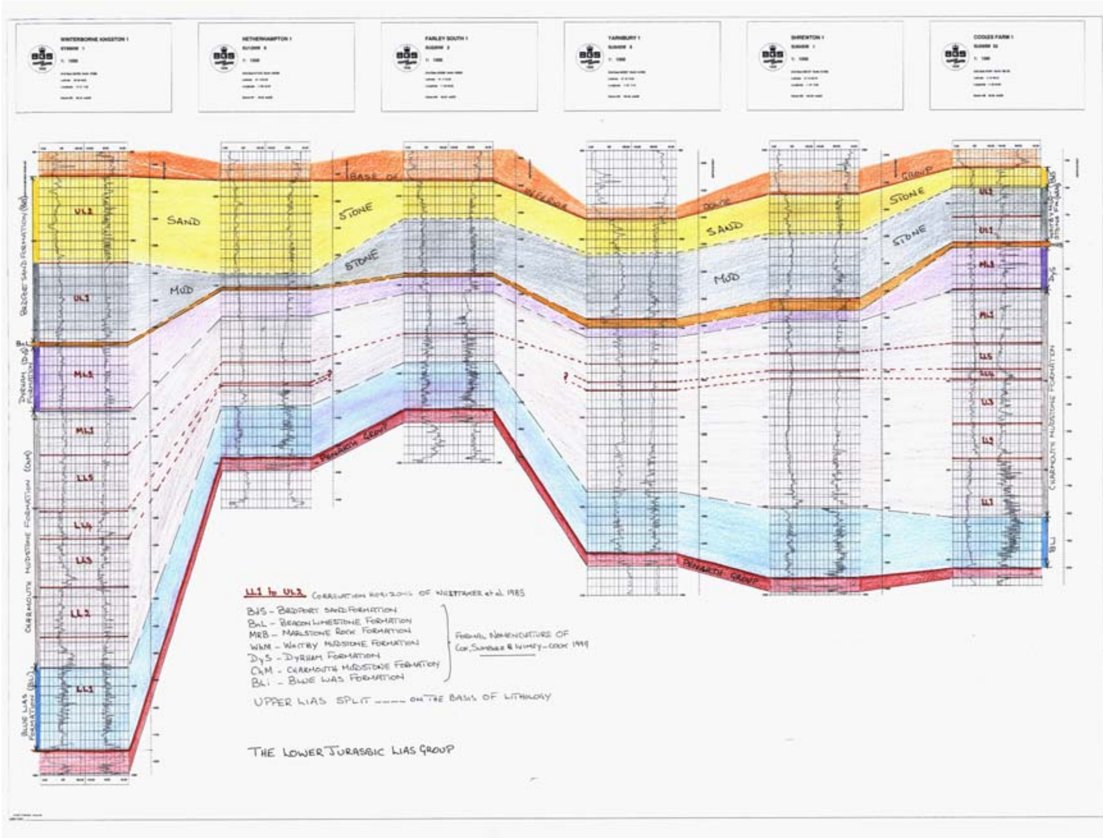


Figure 13: A correlation of the Lias Group between the four deep wells within the district and key boreholes to the north and south.

3.9 Great Oolite Group (Middle Jurassic)

This group comprises four formations each divided into a number of members. In ascending order they are the Fullers Earth Formation, Frome Clay Formation, Forest Marble Formation and the Cornbrash Formation. Each of these is identified at outcrop to the west on the Wincanton sheet where they are known to span the Bathonian and earliest Callovian stages. With the exception of the Frome Clay Formation (a newer term adopted since the publication of the four completion logs where this unit is called the Great Oolite undifferentiated) all are tentatively identified within the four deep boreholes within this district (without the formal formation suffix). Table 5 shows the relative thicknesses determined within the four boreholes for each of the units. Figure 14 gives a correlation of the Middle Jurassic succession based on the downhole log signatures from the four principal wells with others outside the district.

The most complete descriptions of the group are given in the Yarnbury Borehole (SU04 SW5 [SU03357 41053]). The Fullers Earth Formation is described as 129 ft (39.3 m) of limestone overlying sandstone and claystone. The limestone is light grey to dark brownish grey fine to coarsely crystalline with silty laminations. Beneath is very fine- to fine-grained light brownish grey calcareous sandstone over grey to greenish grey calcareous claystone. In the west on Wincanton the formation is divided in part by the Fullers Earth Rock 'Member' but it is also noted that the upper part of the formation is probably incorporated within the Frome Clay Formation. The same may be true beneath this district.

The Frome Clay Formation was formerly included within the upper Fullers Earth and its is not entirely clear within the four boreholes as to whether this formation is included within the descriptions for the thicker Fullers Earth successions in Yarnbury and Shrewton or within the undifferentiated Great Oolite in the Netherhampton and Farley South boreholes. It may well be that this part of the succession is absent in the south as the Mere Fault complex is approached.

Table 5: Comparative thicknesses for the named units within the Great Oolite Group

	Netherhampton	Farley South	Yarnbury	Shrewton
Cornbrash	22 ft (6.7 m)	17 ft (5.2 m)	34 ft (10.4 m)	34 ft (10.4 m)
Forest Marble	215 ft (65.5 m)	205 ft (62.5 m)	314 ft (95.7 m)	321 ft (97.8 m)
Great Oolite undifferentiated (Frome Clay)	158 ft (48.2 m)	136 ft (41.5 m)	74 ft (22.6 m)	79 ft (24.1 m)
Fullers Earth	65 ft (19.8 m)	29 ft (8.8 m)	129 ft (39.3 m)	158 ft (48.2 m)
Total	460 ft (140.2 m)	387 ft (118.0 m)	551 ft (167.9 m)	592 ft (180.4 m)

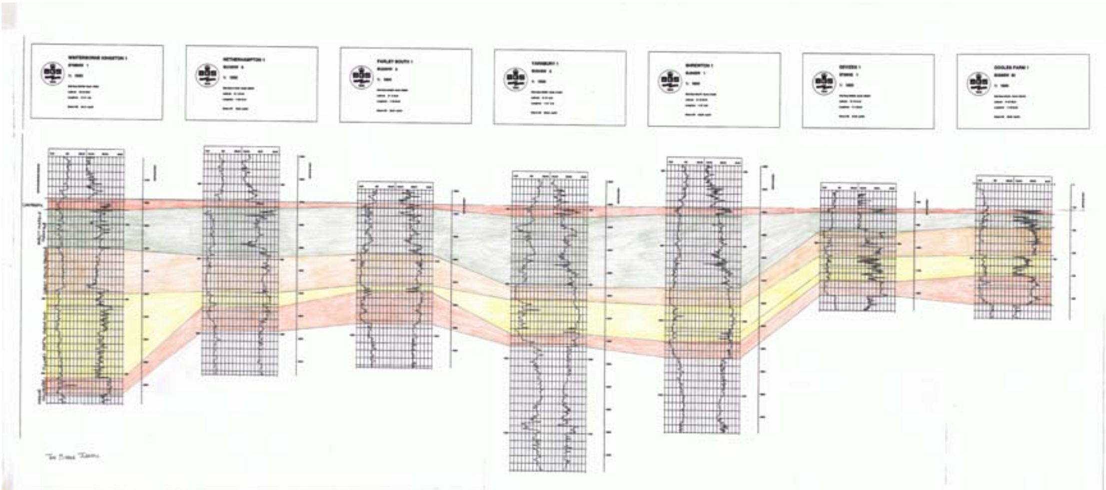


Figure 14: A correlation of the Middle Jurassic succession within the four deep wells in the district and with key boreholes to north and south.

Throughout the four boreholes the Great Oolite (undifferentiated) strata is described as limestone. In the Yarnbury borehole this unit is described as cream to buff, hard, oolitic limestone. Ooids vary from fine- to coarse-grained and are present within a sparry to microcrystalline argillaceous matrix. In the north and east of the Wincanton district the memoir states that the Frome Clay passes from a principally argillaceous succession into one dominated by shelf limestones and it is tempting to make this association for these limestones.

The Forest Marble Formation succession is highly variable. The unit is principally of sandy calcareous mudstone with subordinate argillaceous, calcareous sandstone and argillaceous limestone to the west in the Wincanton district. Similar descriptions are known from the four boreholes in this district. In Wincanton the formation is between 35 and 40 metres thick at outcrop. The unit ascribed to the Forest Marble within the four boreholes is considerably thicker being around 60 to 65 metre in the southeast and between 95 and 100 m in the north.

The Cornbrash Formation at outcrop to the west is traditionally divided on lithological and faunal grounds into lower and upper units. The lower, of Bathonian age, and the upper of Callovian age. The lower comprises pale cream ooidal and biomicritic limestone with thin shelly mudstone partings whilst the upper unit is sparsely sandy, peloidal, biomicritic limestone overlying fine-grained calcareous sandstone and sandy biosparite limestone. Descriptions in the four boreholes in the Salisbury district are dominated by limestone but there is insufficient detail to say whether the upper and lower units are present.

3.10 Kellaways Formation (Middle Jurassic)

The formation, of lower Callovian age is traditionally divided into an upper Kellaways Sand Member (Kellaways Rock in some literature) and a lower Kellaways Clay Member. These two members have only locally been identified at outcrop to the west in the Wincanton district where the succession is dominated by medium grey sandy mudstone.

In the Salisbury district the Kellaways Beds are recognised within the Yarnbury Borehole (SU04 SW5 [SU03357 41053]) with Kellaways Rock overlying Kellaways Clay being recognised in the other three wells. In Yarnbury the formation is described as unconsolidated very fine-grained sandstone overlying pale grey well-cemented, calcareous pyriteous and carbonaceous very fine-grained sandstone and moderately calcareous medium grey claystone. In the other boreholes the lower unit is described as mudstone, grey with calcareous siltstone.

3.11 Oxford Clay Formation (Middle/Upper Jurassic)

Traditionally this formation was divided into three and these lower, middle and upper divisions have now been formalised as the Peterborough, Stewartby and Weymouth members respectively. The Peterborough and Stewartby members are of Callovian age whilst the Weymouth Member is of Oxfordian age.

In the four deep wells the formation is described as a monotonous succession light to dark grey, in part calcareous, pyriteous, micaceous and bituminous mudstone and claystone with some thin limestone and sandstone beds and is not divided. To the west within the Wincanton district the Peterborough Member is described as brown fissile mudstone and is the most fossiliferous part of the formation. The Stewartby and Weymouth members are undivided and comprise calcareous medium grey, variably silty, shelly mudstone with some thin, very fine-grained, poorly cemented sandstones.

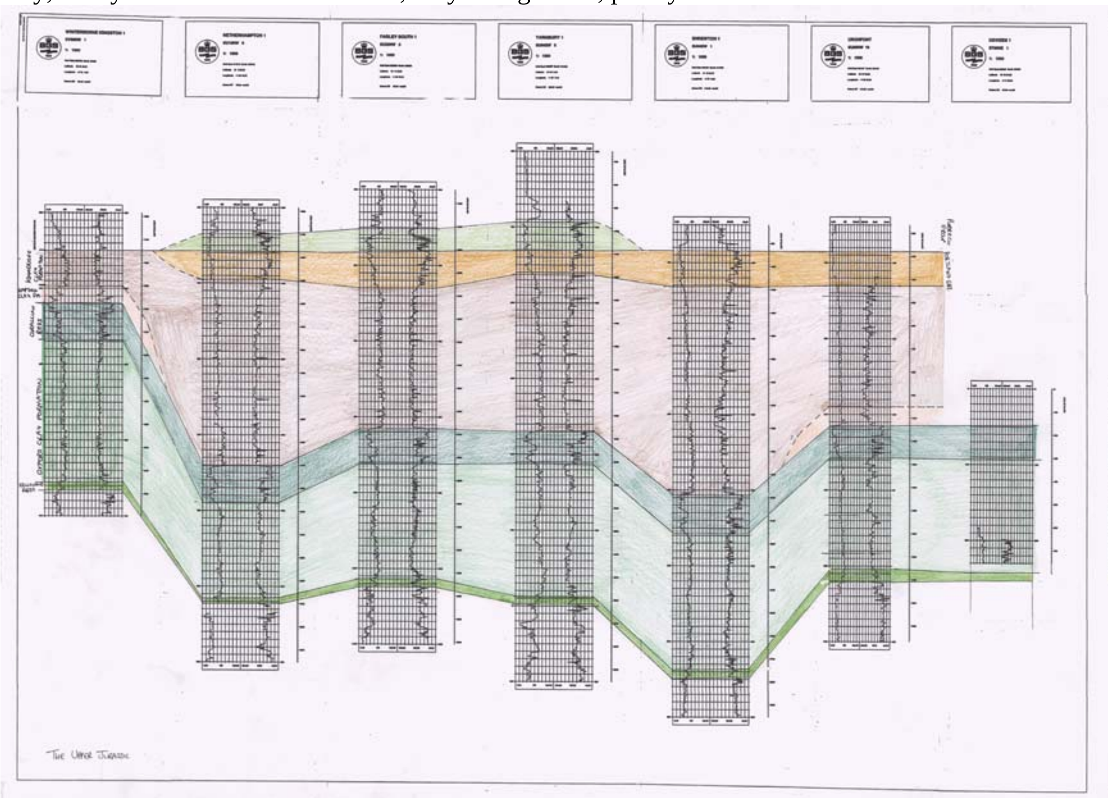


Figure 15: A correlation of the Upper Jurassic succession within the four deep wells in the district and with key boreholes to the north and south.

3.12 Corallian Group (Upper Jurassic)

The Corallian Group represents an episode of relatively shallow marine mixed carbonate and siliciclastic sedimentation between two long periods of deep-water argillaceous shelf sedimentation represented by the Oxford Clay Formation and Kimmeridge Clay Formation. In the Yarnbury Borehole (SU04 SW5 [SU 03357 41053]) the Corallian is described as a grey silty mudstone passing up into calcareous and glauconitic sandstone and into ooidal and pisolitic limestone. In other wells there is a lower sandstone unit described. Bed by bed correlation with the outcrop within the

Wincanton district to the west is not possible on the scant evidence provided by the deep wells. Figure 15 gives a group and formational level correlation for the Upper Jurassic of the four deep wells with well-known wells outside the area.

3.13 The Kimmeridge Clay Formation and Lower Greensand Subcrop

Although the Kimmeridge Clay Formation is mostly concealed within the Salisbury district it is the oldest outcropping unit and therefore dealt with in the following Jurassic section that commences the description of the rocks at outcrop within the Salisbury district.

Chadwick and Kirby (1982) produced a subcrop map of the strata encountered below the Lower Greensand/Gault unconformity based on an interpretation of the seismic data available at that time. The area described includes the Salisbury Sheet. The subcrop map and contours on the sub-Lower Greensand surface are reproduced herein. Their principal conclusion was that they located major faults in the subsurface that affected Jurassic strata that in turn gave valuable information about the history of these significant growth faults. Fault activity controlled sedimentation throughout the Jurassic most notably during the deposition of the Lias and Kimmeridge Clay. During deposition of the Upper Jurassic the depocentre transferred northeastwards towards the Weald with concurrent erosion in the west prior to deposition of the Lower Greensand.

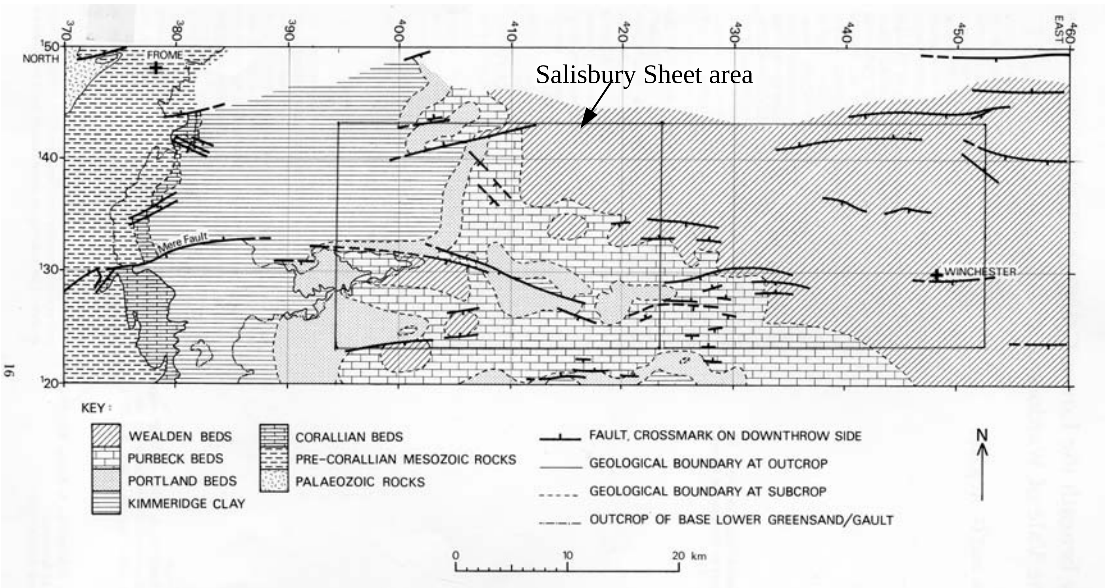


Figure 16: The subcrop beneath the Lower Greensand Group and Gault Formation (Chadwick and Kirby, 1982).

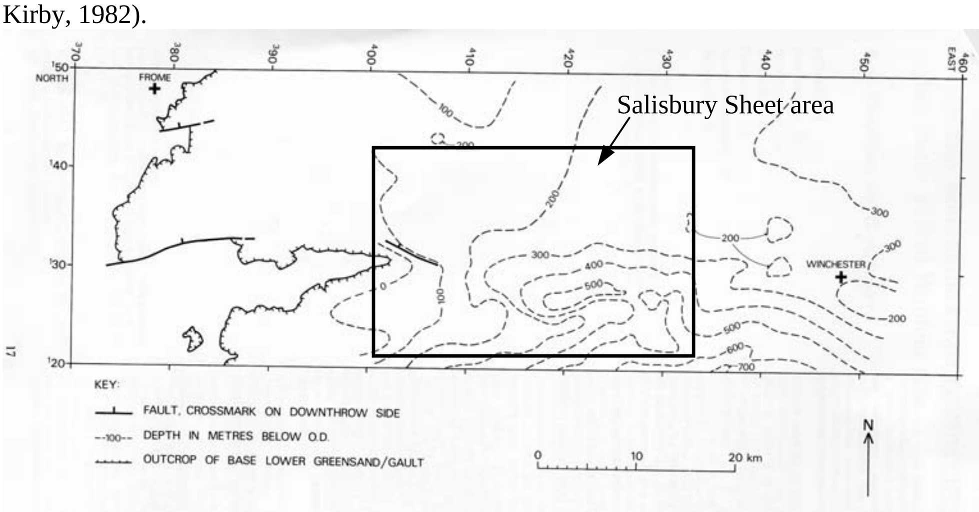


Figure 17: Depth to base Lower Greensand Group/Gault Formation boundary (Chadwick and Kirby, 1982).

4 UPPER JURASSIC

4.1 Kimmeridge Clay Formation

The Kimmeridge Clay Formation forms low lying ground in the west within the valleys of the River Nadder and River Sem (Figure 18). There is virtually no exposure with the larger part of the outcrop obscured by fluviatile and head deposits. The succession of the Kimmeridge Clay Formation is known from the Tisbury Borehole and the nearby Westbury Quarry section (Figures19, 20 and 21). A generalised section of the Tisbury Borehole and other data from that district was published in the Wincanton Memoir (Bristow et al., 1999, Figure 25) and repeated as Figure 19 herein. The Tisbury Borehole ST92NW2 [ST9359 2907] drilled in the bottom of the Tucking Mill Quarry west of Tisbury, and just to the west of the district, proved an incomplete succession of 233.55 m within the upper part of the Kimmeridge Clay Formation (Figure 20). The lower part of the Kimmeridge Clay Formation not penetrated in the Tisbury borehole is described from the Westbury quarry (Figure 21) on the Frome Sheet 281 to the northwest of the district (Birkelund et al., 1983). Comparisons with the adjacent Wincanton and Shaftsbury districts suggest that up to 280 m of Kimmeridge Clay exists at outcrop where the full succession is found beneath the Portland Group but is elsewhere truncated beneath the Lower Cretaceous unconformity. Correlation of the Tisbury Borehole and the Westbury quarry based on the identification of the Crussoliceras Band (Tisbury) and Crussoliceras Limestone E6 at Westbury suggest that the full formation thickness could be as much as 304 m. In the subcrop the full thickness of the formation varies between 184 m and 273.7 m in the four deep boreholes suggesting a thickness reduction in a southeasterly direction beneath the Salisbury district.

In general this succession comprises a variable, small-scale rhythmically bedded, calcareous, kerogen-rich, bituminous, dark grey to black mudstone and oilshale with silty and sandy mudstone. The rhythms are identified by the presence of thin siltstone and cementstone beds.

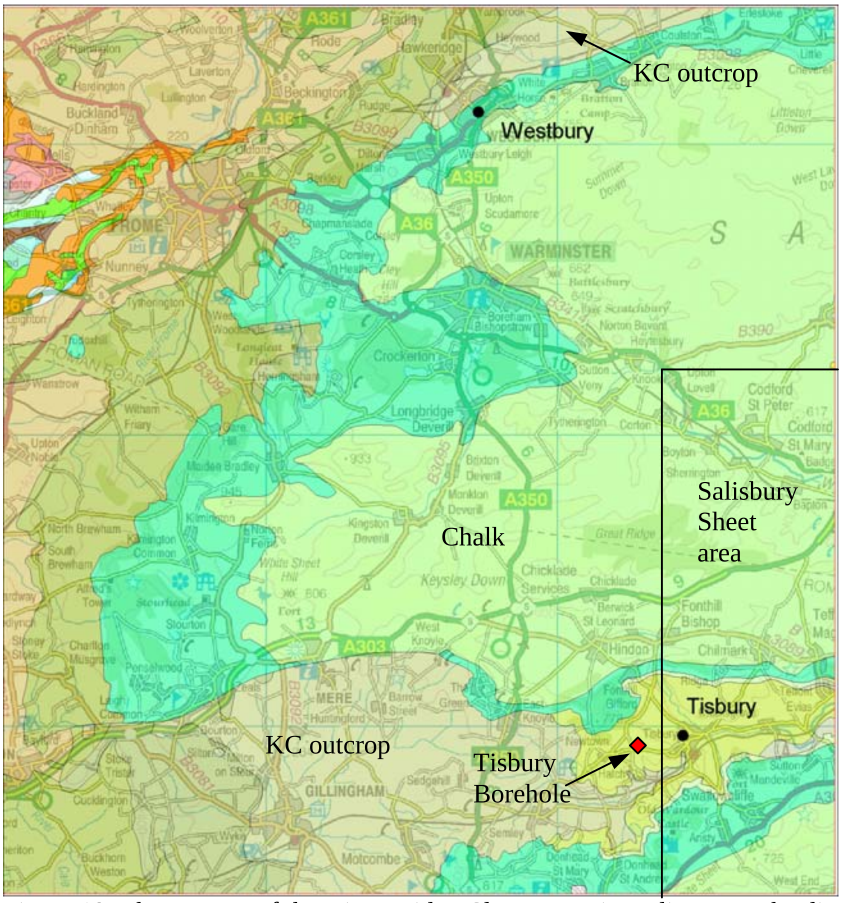


Figure 18: The outcrop of the Kimmeridge Clay Formation adjacent to the district and the location of key stratigraphical sites.

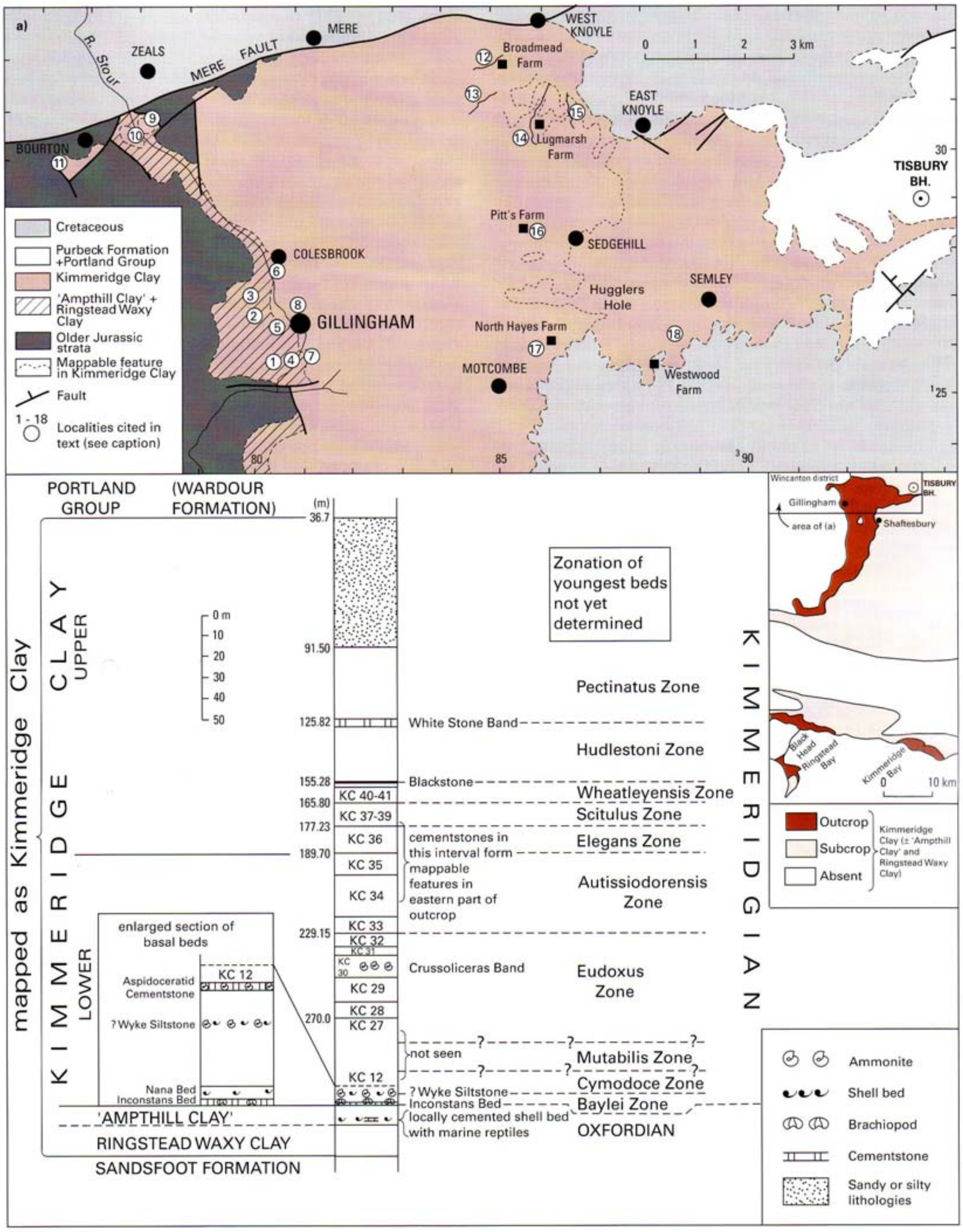


Figure 19. The Kimmeridge Clay Formation succession and key localities within the Wincanton sheet area and a log of the Tisbury Borehole (Bristow et al., 1999).

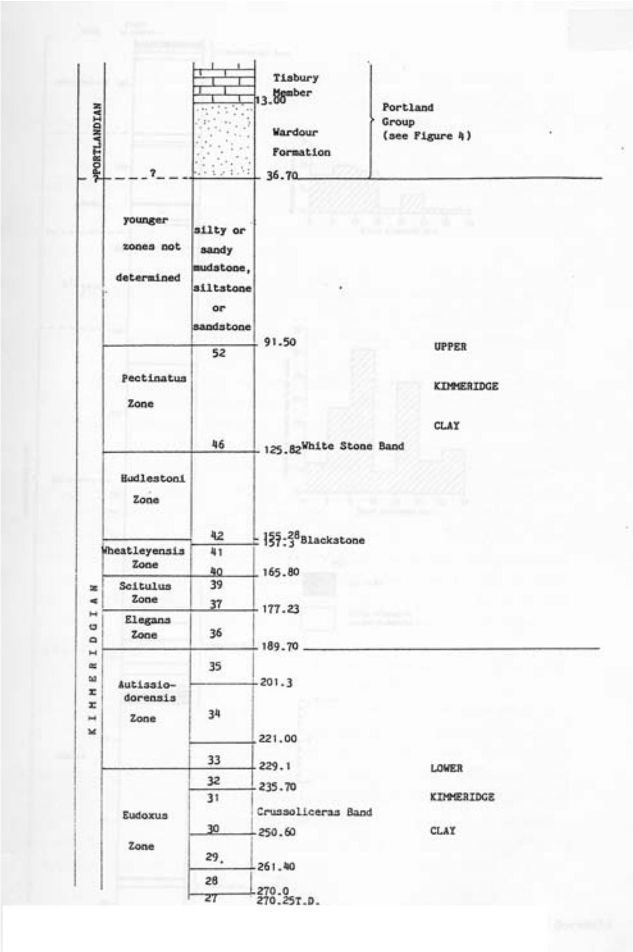


Figure 20: The outline succession in the Tisbury Borehole ST92NW2 [ST 9359 2907]

The Kimmeridge Clay Formation is traditionally divided into lower and upper parts. Whilst these divisions have no formal lithostratigraphical status they are readily distinguished. In the Tisbury Borehole the Upper Kimmeridge Clay is 153 m thick with unbottomed Lower Kimmeridge Clay of 80.55 m beneath. The succession can be further divided into many numbered small-scale stratigraphical units that can be traced in the formation from cored borehole sequences in eastern England (Cox and Gallois, 1979; Gallois and Cox, 1976; Gallois, 2000; Gallois and Etches, 2001) into this area. In addition, named marker beds described from the Dorset coast exposures have been identified in the successions immediately west of this district. The scheme relies on a combination of faunal markers and rhythmic lithological variation within the fine-scale ammonite zonation. The palynology, and ostracod and foraminiferal assemblages from the Tisbury Borehole are described in technical reports of the BGS (Riding, 1993; Wilkinson, 1997a; Wilkinson, 1997b; Yakovleva, 1997).

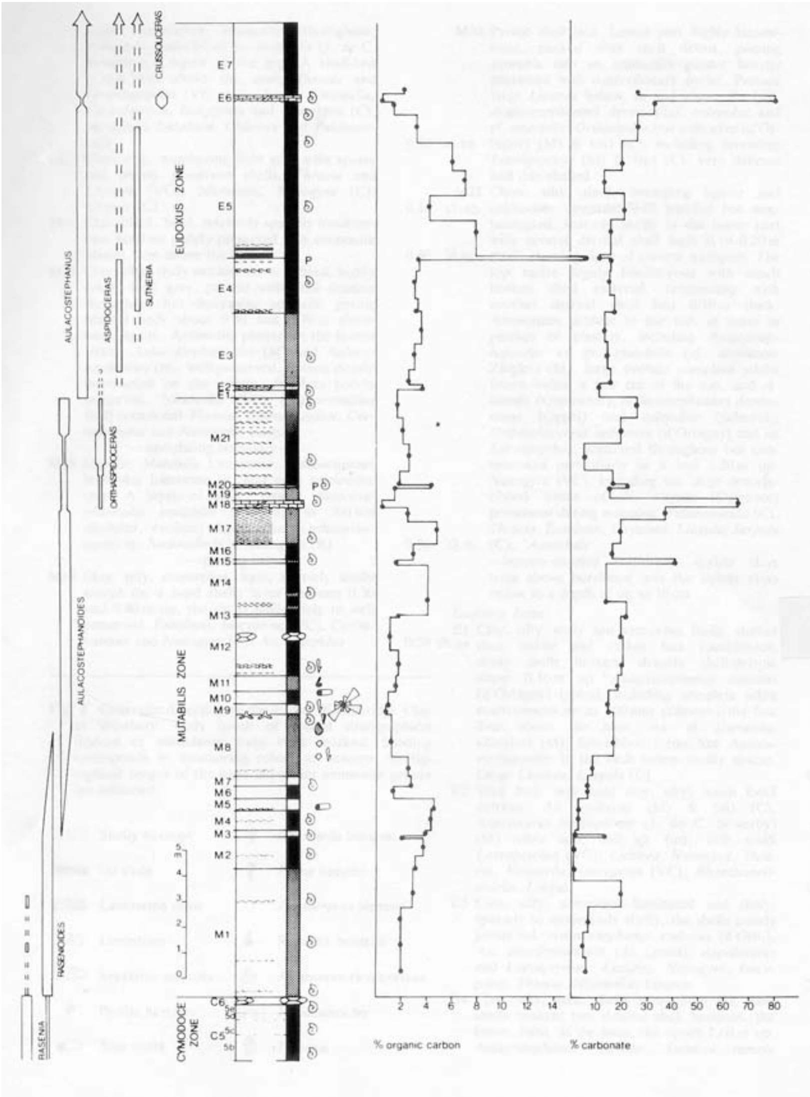


Figure 21. Lithological log for the lower Kimmeridge Clay Formation at Westbury Quarry based on Birkeland et al. (1983, Fig. 2).

Details

The Kimmeridge Clay Formation crops out in the valley [ST 937 310 to 947 300] downstream of the lake at Fonthill Gifford.

The Salisbury Memoir states that the formation only crops out in the bottom of the valley near Tisbury but that there is no clear section. A well in the alluvium immediately north of Wallmead Farm [ST 9447 2844] is described as terminating in black unctuous clay. This site is not registered within the records held by BGS.

The four deep hydrocarbon wells all identify the Kimmeridge Clay Formation (see table 2 above). Descriptions are variable with those from the Shrewton and Yarnbury boreholes being the most comprehensive. The Kimmeridge Clay of Shrewton is described as mudstone, dark grey to black, calcareous, finely micaceous and carbonaceous with interbedded thin limestones towards base and near the top, pyrite common towards base and top; whilst in Yarnbury the description is claystone, brown to grey becoming grey, locally silty and micaceous with thin limestones. Becomes shale, dark brown to dark grey, fissile, locally sandy, with limestones and shell debris.

4.2 Portland Group

The Portland Group crops out in the west of the district where the River Nadder cuts down through the Wardour Anticline principally around Tisbury [ST 952 296] and also within the tributary valley around Chilmark Common [ST 973 313], the so-called 'Chilmark Ravine'.

Traditionally the group is divided into a lower arenaceous unit, the informal Lower Portland Beds, and the Upper Portland Beds that are principally limestones (Woodward, 1895). The Upper Portland Beds have been further divided into five based largely on their building stone potential and these subdivided into a number of beds based on quarrymen's terminology (see Table 6 below).

The old memoir for Salisbury (Reid, 1903) introduces the Portland Group thus:- " Portland Beds comprise a very variable set of strata. In the upper part they include shelly limestones, oolite, chalky and compact limestones, with local layers and nodules of chert, and some beds of sand and calcareous sandstone. The lower beds comprise alternations of greenish-grey glauconitic sand with thin loams and clays. The thickness of the entire formation in the Vale of Wardour is about 100 feet (30.5 m), and it extends from near Donhead and East Knoyle in the west to Tisbury and Chicksgrove, where it sinks beneath the stream level. In the Chilmark valley, however, it again appears, and has been extensively worked. How far it extends eastward beneath the newer strata is still unknown".

Table 6: The general section of the Upper Portland oolitic strata in the Vale of Wardour given in the memoir (Reid, 1903).

			ft	in	(**m**)
Lower Purbeck Beds.		Flaggy limestones, dirt-beds, and peculiar oolitic beds.			
Upper Portland Beds	Upper Building Stones	Buff sandy and oolitic limestones, compact limestone, and occasional chert-seams in lower part -	10' to 16'	0"	(3 to 4.9)
	Chalky Series	Soft white chalky limestone, with nodules and veins of black chert -	4' to 24'	0"	(1.2 to 7.3)
	Ragstone	Brown, gritty, and shelly limestone, divided in places by seam of rubbly marl -	4' 6" to 5'	6"	(1.4 to 1.7)
		Pale shelly and oolitic limestones, with rubbly shelly marl at base	3'	3"	(1.0)
	Upper Portland Beds	Trough bed: Hard buff sandy and oolitic limestone, the surface covered with bivalves (*Trigonia gibbosa**), the bed merging into that below -	2'	8"	(0.8)
	Building Stones	Glauconitic and sandy limestones; divided locally into:-	15'	4"	(4.7)
		Green Bed - 5' 0"			(1.52)
		Slant Bed - 1' 0"			(0.30)
		Pinney Bed - 2' 0"			(0.61)
		Cleaving or			

Hard Bed	-	3’	0”	(0.91)
Fretting Bed	-	3’	4”	(1.02)
Under Beds	-	3’	0”	(0.91)

Lower Portland Beds.

Kimmeridge Clay

* now called *Laevitrigonia gibbosa*

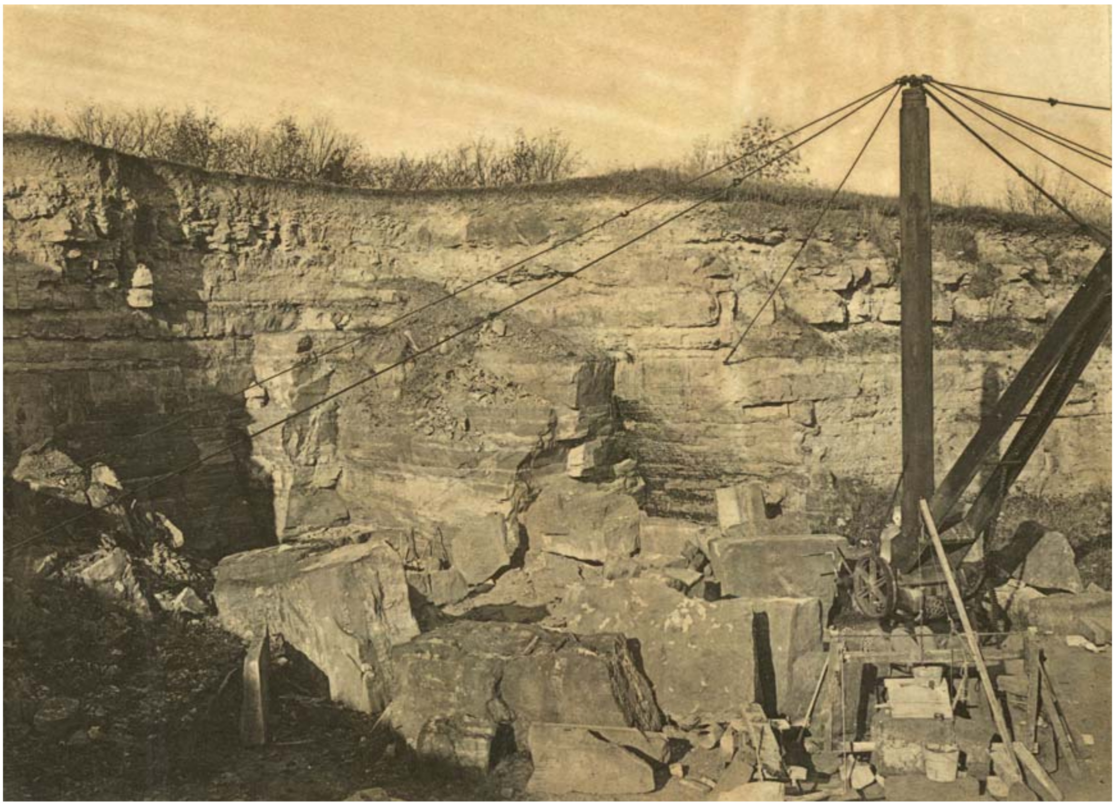


Plate 2. Chilmark Ravine, West side. Upper Portland, 'lower building stones'. [ST 976 313] Photo P 238834.

Wimbledon (1976) formalised this nomenclature, dividing the Portland Group into two formations, he gave a correlation of two major sections within the district (Figure 22). A lower Portland Sand Formation and an upper Portland Stone Formation, each divided further into members. This designation is essentially biostratigraphical and was modified in Bristow (1995) on the basis of a ‘mappable’ lithostratigraphy.

The Wardour Formation corresponds to the Lower Portland Beds of Woodward (1895) and to the Wardour Member of Wimbledon (1976). The Wardour Member term was introduced for the basal, dominantly sandy, part of Wimbledon’s Portland Sand Formation (which also includes the dominantly limestone successions of his Chicksgrove and Tisbury members). Bristow (1995) considered these younger two members to be more appropriately part of the overlying Portland Stone Formation and re-designated the Wardour Member the Wardour Formation.

The Portland Stone Formation of this account, following Bristow and Lott (1994, 1995) and Bristow et al. (1999), corresponds to the Upper Portland Beds of Woodward (1895) and is divided into three members, namely the Tisbury, Wockley and Chilmark members. These member names were introduced by Wimbledon (1975) but their interpretation has been modified to closely follow the units that can be traced during mapping. Wimbledon’s Chicksgrove and Tisbury members, seen in exposures, are not divisible at outcrop and they are both included within the Tisbury Member of this account which also includes the Ragstone introduced by Woodward (1895) and an unnamed ‘sand’ proven during mapping to the west of this district.

Plate 3. Chilmark Ravine, east side. Upper Portland, 'Chalky Series'. [ST 973 312]. Photo P 238835

Table 7: Comparison of the schemes developed for the Portland Group

<table>
<tr><td colspan="2">Woodward (1895)</td><td colspan="2">Wimbledon (1976)</td><td colspan="2">Bristow (1995) & this account</td></tr>
<tr><td rowspan="5">Upper Portland Beds</td><td>Upper Building Stones</td><td rowspan="3">Portland Stone Formation</td><td>Chilmark Member</td><td rowspan="5">Portland Stone Formation</td><td>Chilmark Member</td></tr>
<tr><td>Chalky Series</td><td rowspan="2">Wockley Member</td><td>Wockley Member</td></tr>
<tr><td>Ragstone</td><td rowspan="3">Tisbury Member

(‘Sand’ unit)</td></tr>
<tr><td rowspan="2">Lower Building Stones*</td><td rowspan="3">Portland Sand Formation</td><td>Tisbury Member</td></tr>
<tr><td>Chicksgrove Member</td></tr>
<tr><td colspan="2">Lower Portland Beds</td><td>Wardour Member</td><td colspan="2">Wardour Formation</td></tr>
</table>

- Includes an upper Trough Bed and a lower series of glauconitic and sandy limestones given, in descending order, the quarryman’s terms Green Bed, Slant Bed, Pinney Bed, Cleaving or Hard Bed, Fretting Bed and Under Beds (see generalised section from Salisbury memoir reproduced above).

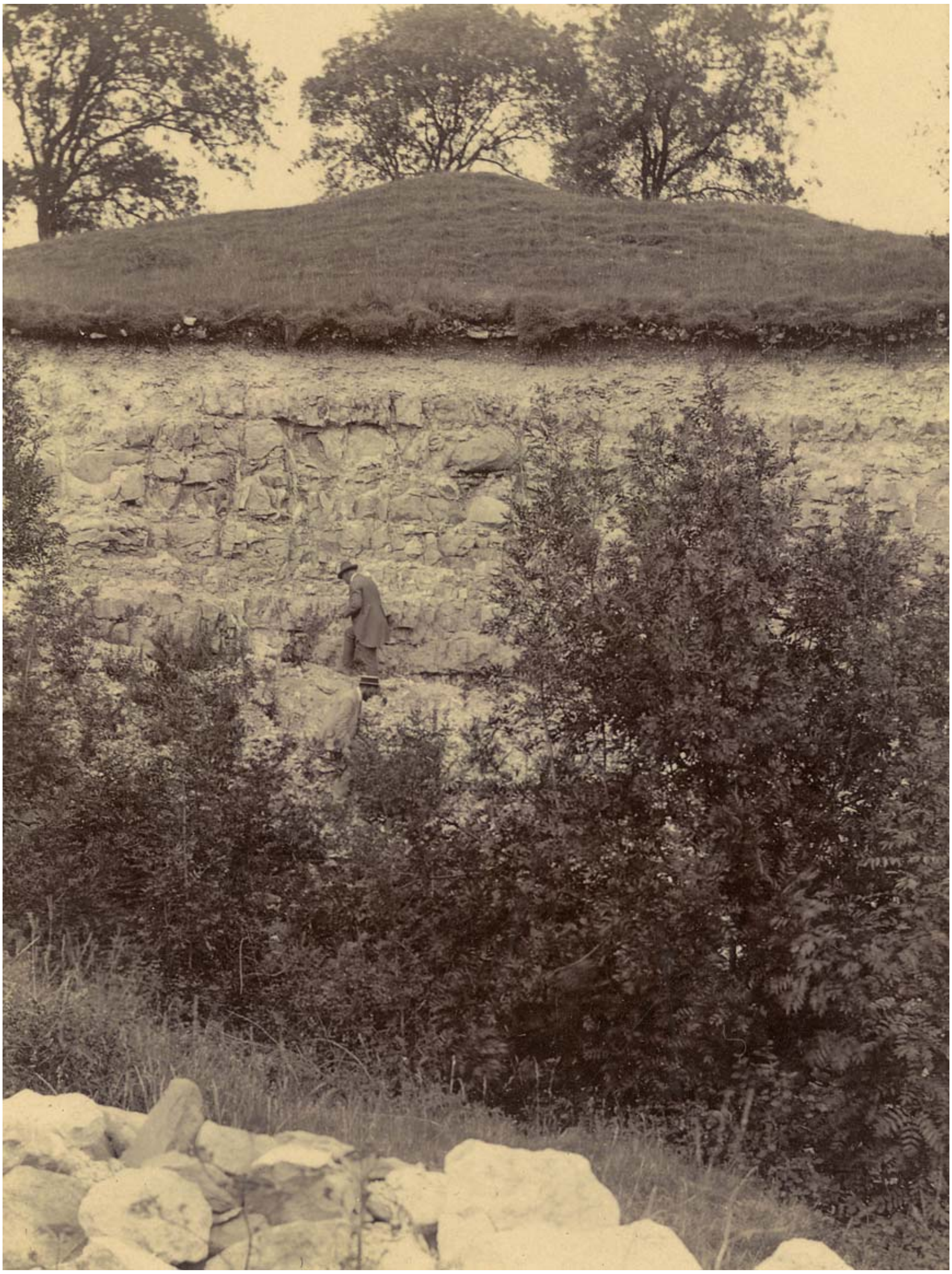


Plate 4. Chilmark Ravine. Upper and Chalk Beds of Portland Stone. [ST 973 312]. Photo P 250096

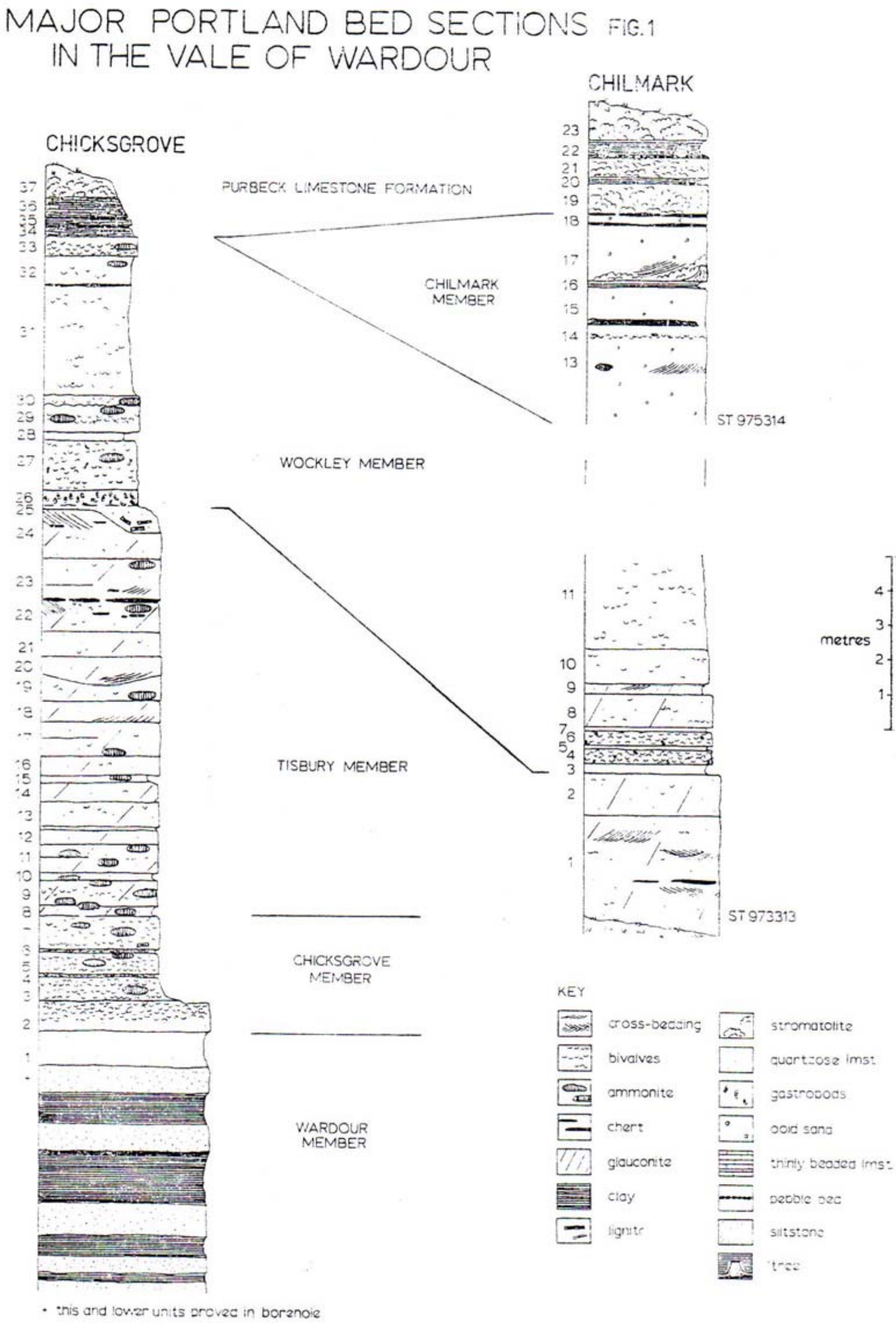


Figure 22. The stratigraphy and correlation of two major sections within the Portland Group from Wimbledon (1976, fig. 1). Portland Sand Formation equates to the Tisbury, Chicksgrove and Wardour members; Portland Stone Formation equates to the Chilmark and Wockley members

These beds have been extensively worked in the area and provided much of the stone used in the building of Salisbury Cathedral (indicating of course the antiquity of some of the workings) and other buildings locally both grand and humble. Not surprisingly the age and change in ownership of most of the workings, the majority long since abandoned and overgrown, has resulted in a confusion of locality names in the literature. The Dean and Chapter (Commissioners) of Salisbury Cathedral requested BGS to describe the stratigraphy and lithology of the Portland Group between Tisbury and Chilmark Ravine at the commencement of the major long-term restoration project for the building. Particular reference was taken of units described for their use as building stone for the extensive repairs required at the cathedral. The area was geologically surveyed in the autumn of 1994 and many field brash and quarry samples taken for petrographical description in comparison to samples removed from the cathedral. Historical searches through the literature revealed a wealth of information and the final reports by Bristow and Lott (1994, 1995) also included a valuable clarification of the various names attributed to the known exposures described by previous authors. Much of their descriptive work is incorporated in this volume and their terminology followed. The area was not resurveyed during the mapping of the Salisbury Sheet in 2003 but the surrounding ground was completed and both incorporated into new 1:10 000 scale standard maps.

4.2.1. Wardour Formation

The base of the Wardour Formation is taken at the base of a bed of fine-grained, glauconitic sandstone, which forms the base of a fining-upwards succession. Springs are a common feature of this sand permitting the boundary to be traced with ease across unexposed ground. The bulk of the formation comprises beds of bioturbated siltstone and friable sparsely shelly sandstone of variable thickness. In the Tisbury Borehole (Figure 23 and 24) small (3 to 4 mm) lydite pebbles were noted and a similar bed was noted by Wimbledon (1976) 3.5 m from the top of the formation at Chicksgrove.

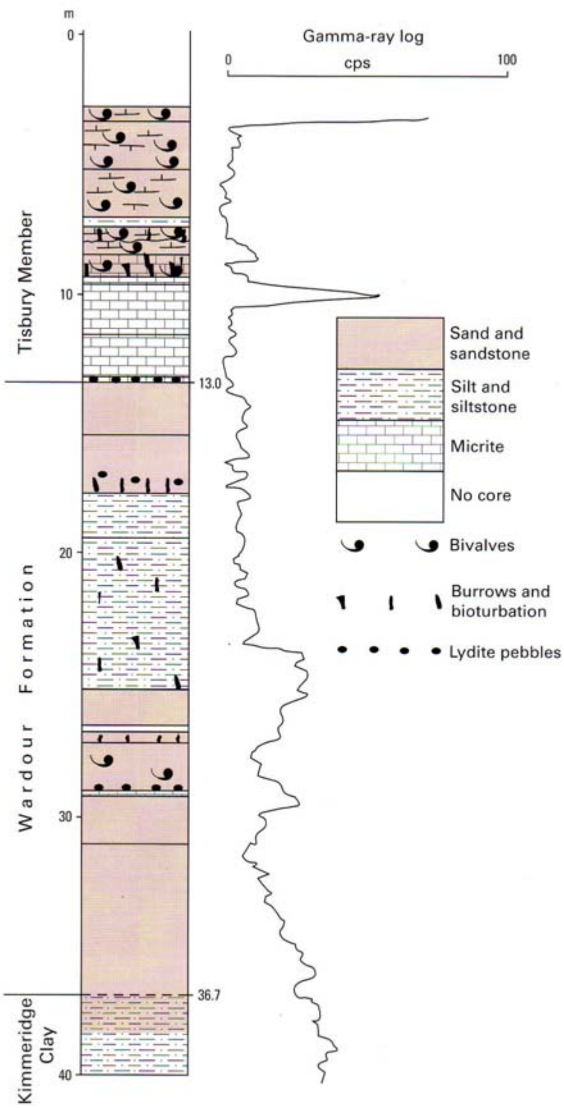


Figure 23. The Portland Group succession proven in the Tisbury Borehole (Bristow et al., 1999)

The formation is 23.7 m thick in the Tisbury Borehole and apparently thins over much of the outcrop. This thinning may well be an artefact of cambering of the overlying limestones.

Dinoflagellates indicate that the basal 5m of the Wardour Formation in the Tisbury Borehole, corresponding to the fining-upwards glauconitic sandstone, fall within the youngest zones of the Kimmeridgian Stage. The succeeding beds span the a*lbani* and basal g*laucolithus* zones.

This formation outcrops around Tisbury on the lower valley flanks of the River Nadder and River Sem where very fine-grained orange sand can be augered. Further descriptions of the Wardour Formation are given in the following Portland Stone Formation sections where they appear in the exposures created for building stone extraction.

4.2.2. Portland Stone Formation

The Portland Stone Formation consists, in terms of its mappability, of three distinct parts each given member status by Bristow and Lott (1994, 1995, 1996) and in the Wincanton Memoir by Bristow et al. (1999). The succession commences with the Tisbury Member that includes the Chicksgrove Member of Wimbledon (1976) at the base and the Ragstone as defined by Woodward (1895) at the top. This member is succeeded by the Wockley Member (which locally includes significant chert beds) and the overlying Chilmark Member. Because of the variable nature of this formation descriptions of the known exposures by numerous authors since the early 1800s have been difficult to follow as quarrying progressed and this situation is further complicated by inconsistencies in the naming of sites. The details included in this report follow those compiled by Bristow and Lott (1994, 1995, 1996)

4.2.2.1 Tisbury Member

The member is equivalent to the Lower Building Stones and Ragstone of the Woodward (1895). Its outcrop in this district is limited to the flanks of the River Nadder from Tisbury eastward towards Upper Chicksgrove [ST 960 300] and as an inlier within the Chilmark Ravine [ST 975 312]. The member has been extensively quarried in both areas.

The base of the Tisbury Member is taken at the abrupt change from the fine-grained clayey sand of the Wardour Formation into calcareous siltstones and sandstones, sandy limestones and micritic limestones characteristic of the lower part of the Tisbury Member. Lydite pebbles have been noted in places at this junction. The member can be divided in exposures into three units each of variable thickness.

The lower unit described by Wimbledon (1976) from the Chicksgrove Quarry [ST 9620 2960] comprises 2 to 4 metres of well-bedded, pinkish grey, bioturbated, shelly micrites.

Within the medial part of the member the rocks comprise porous fine-grained glauconitic sandstones with silty and sandy, bioclastic and peloidal limestones with glauconite grains. The glauconite content varies from 1 to 6%, with up to 20% of bioclastic grains and up to 38% silica silt and sand grains. There is a general and gradual decrease in siliceous material and an increase in bioclastic sand up-sequence such that the higher beds become glauconitic, bioclastic sparites. At Chicksgrove Quarry these medial beds are about 12 metres thick. Throughout the outcrop these medial beds constitute the principal source of building stone in the district and were termed the Tisbury Freestone by Blake (1880).

The upper unit of the member is equivalent to the Ragstone of Wimbledon (1976). It comprises, at the Chicksgrove Quarry, a basal hard micrite with large bivalves up to 0.85 metres thick overlain by up to 2.5 metres of micritic peloidal limestone with common bivalves and ammonites. This ‘Ragstone’ unit is commonly quarried but is considered too shelly to be worked extensively as a freestone and is probably used only locally for building.

4.2.2.2 Wockley Member

The Wockley Member as defined by Bristow et al. (1999) comprises 4 to 8 metres of chalky micritic limestones with common large bivalves and equates to the Chalky Series of Woodward (1895). The member varies markedly laterally and is known from field brash to include hard, porcellanous micritic limestones with many gastropod moulds in the west of the district adjacent to the Nadder valley. Wimbledon (1976) describes this unit as “poorly bedded, chalky lime mudstones with scattered bivalves, notably *Laevitrigonia*”. This unit also contains much chert in its upper half and is thickest in the Chilmark Quarries.

Where the Chilmark Member is absent from the succession the junction with overlying Purbeck Group is clear-cut.

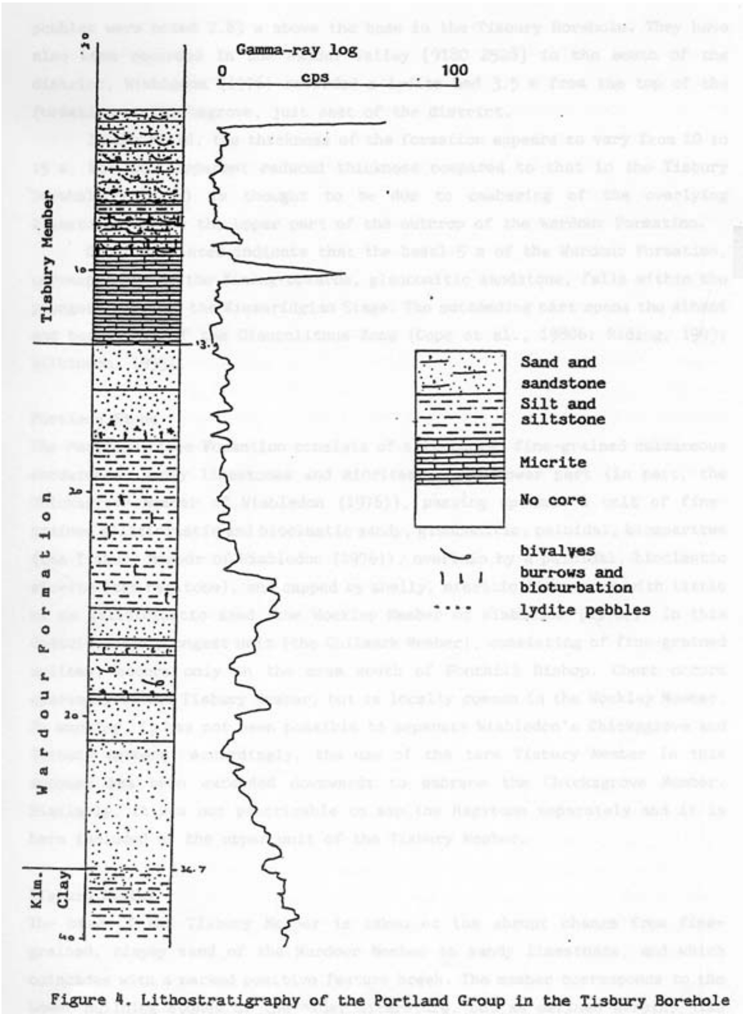


Figure 4. Lithostratigraphy of the Portland Group in the Tisbury Borehole

Figure 24: Lithostratigraphy of the Portland Group in the Tisbury Borehole from Bristow (1995, fig 4)

4.2.2.3 Chilmark Member

This member is thought by Wimbledon (1976) to be restricted to the Chilmark ravine but recent mapping shows that the unit can be followed westwards from north of Lower Chicksgrove along the south side of Lady Down and into the Tisbury area. On the south flank of the Nadder valley the member dies out east of Wallmead Farm [ST 9447 2844].

The member comprises about 6 metres of “cross-bedded ooid sands with occasional thin shell bands with, in addition to the usual large bivalves, *Astarte* sp. the gastropods *Ampulspira ceres* and the ‘Portlandian Screw’ *Aptyxiella portlandica.* Two chert beds, up to 0.25 metres in thickness, are seen in the upper part of the section now visible in the old Upper Quarry [ST 975 314]” (Wimbledon, 1976).

The junction of this member with the overlying Purbeck Group is not clear-cut and here stromatolitic ‘tufas’ are seen interbedded with ooid sands.

Details

Much of the detailed descriptions below are taken from Bristow and Lott (1995,1996) and related to localities (localities 32 to 65) identified during the survey. Some of this material is derived from earlier texts including the work of Wimbledon (1976), Woodward (1895) and Blake (1881). Reid (1903) in the old Salisbury Memoir included details from the earlier workers but also included some details from the geological surveying that preceded the publication of the Salisbury Geological Sheet and Memoir. Wimbledon (1976) added a great deal of new information from quarries still open at the time. Bristow and Lott (1994) reported on the same succession west of easting ^{3}95 and describe localities identified (localities 1 to 31). Three of these sites (localities 23 to 25) fall within the Salisbury district and are included herein. The remainder fall on the Wincanton Sheet 297 to the west and the most instructive of these were described in the memoir for that sheet (Bristow et al., 1999). Petrographic samples collected in a 'V' series were described by G Lott in the Bristow and Lott reports (1994, 1995, 1996).

Where sections are quoted from the literature they have been metricated for inclusion herein.

Locality 23 [ST 9455 2890] Tisbury Station.

Formation/Member	Lithology	Thickness (m)
	Biosparite, fine-grained sandy, crumbly, shelly including *Myophorella*	0.75
	Biosparite, shelly with ammonites	0.30
Tisbury Member	Biosparite, sandy, crumbly	0.35
	Micrite, sandy, shelly, rubbly weathering with large bivalves, including *Myophorella*	0.80
	Marl, orange brown	0.05
	Micrite, sandy, shelly, rubbly weathering	0.80
	Micrite, hard, sandy, shelly (particularly at base)	0.63
	Sandstone, fine-grained, glauconitic	0.18
Wardour Formation	Sand and sandstone, fine-grained, glauconitic in eight alternating beds up to 0.25m thick	0.90
	Sandstone, fine-grained, soft	0.60

Locality 24 [ST 9465 2890]. This is probably T P Lilly's Chantrey Quarry 'above Tisbury Station' which is described in Woodward (1895, p.207) and was still working in 1893. The description was repeated by Reid (1903, fig. 13), (Figure 25 herein).

Formation/Member	Lithology	Thickness (m)
	Rubbly stone and marl with seams of clay (Woodward's bed 5)	1.22
Wockley Member	Shelly limestone (Roach) with *Trigonia incurva* [*Myophorella incurva*] on impure shelly and tufaceous limestone (Woodward's bed 3 and 4)	1.22 to 1.52
	Compact, but rotten, chalky limestone, much shattered with gastropods (Woodward's bed 2)	0.91 to 1.22
Tisbury Member	Greenish glauconitic sandy limestone with lenticular seams of oolitic chert, three layers seen (Woodward's bed 1)	3.05 to 3.66

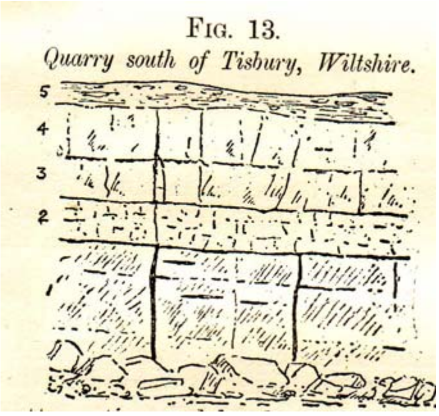


Figure 25:Diagrammatic section of quarry south of Tisbury as described by Reid, 1903 (above), Locality 24 [ST 9465 2890]

Locality 25 [ST 9469 2901]. This is located 100 metres NNE of Chantrey Quarry.

Formation/Member	Lithology	Thickness (m)
	Limestone, fine-grained sandy (24%), glauconitic (2%), bioclastic (20%), porous (20%), peloidal (6%) and with a sparry cement (30%)	0.30
Tisbury Member	Limestone, fine-grained sandy (30%), glauconitic (3%), bioclastic (22%), porous (15%), peloidal (11%) and with a sparry cement (18%)	0.20
	Limestone, fine-grained sandy (18%), glauconitic (3%), bioclastic (31%), porous (20%), peloidal (8%) and with a sparry cement (18%)	0.35
	Limestone, fine-grained sandy (18%), glauconitic (6%), bioclastic (16%), porous (7%), peloidal (6%) and with a sparry cement (43%), massive with a 0.1 m thick chert bed at base	0.55

These limestone units were studied by thin section thus permitting the approximations of constituent materials. The lowest bed is tentatively correlated with the Tisbury Freestone.

North of the River Nadder, and northeast of Tisbury, the Tisbury Member has a wide outcrop (200 to 400 metres). There are few exposures but a common brash of glauconitic, oolitic and bioclastic sandstone occurs widely. The beds were worked in a small quarry numbered locality 32 [ST 9532 3029] but the site was a shallow ploughed over depression at the time of the 1994 survey.

At Quarry Farm, Upper Chicksgrove an old quarry, locality 33 [ST 9633 2982], exposes 4.3 m of glauconitic bioclastic sandstone. This is presumed to be the pit referred to by Reid (1903, p. 12) as on “the north side of the River Nadder by Chicksgrove Mill”. The section logged in 1994 is: -

Formation/Member	Lithology	Thickness (m)
	Sandstone, bioclastic, glauconitic	0.15
	Sandstone, massive, cross-bedded, glauconitic, bioclastic, with a flaggy top	0.60
	Sandstone, laminated, bioclastic, glauconitic, with thin 2 cm chert nodules	0.10
Tisbury Member	Sandstone, bioclastic, glauconitic, planar-bedded	0.20
	Sandstone, massive, glauconitic, bioclastic	0.30
	Sandstone, massive, very hard, glauconitic, bioclastic	0.35
	Sandstone, massive, glauconitic, bioclastic	0.37
	Sandstone, laminated passing into nodular chert	0.14
	Sandstone, massive, friable, glauconitic, bioclastic	1.00
	Sandstone, massive, glauconitic, bioclastic	1.10

The face is cut by prominent open joints trending 030° and 120° but there is no evidence for valley cambering locally.

On the north side of the main road, locality 34 [ST 9635 2994] is a worn track that exposes a hard limestone equated with the 'Spangle' part of the Ragstone.

West of the un-named northward-flowing stream which joins the River Nadder at Tisbury Mill [ST 9530 2957] between 15 and 20 metres of glauconitic sandstones of the Tisbury Member crop out. There are exposures of glauconitic, bioclastic sandstones in the track, locality 35 [ST 9524 2929 to 9527 2918], leading up to the old quarry (locality 36 [ST 9528 2908]) at Dumplings Down. This site, according to Donovan (1992), was worked in medieval times. This quarry must have been within the Tisbury Freestone and is said to have provided the stones for the spire of Salisbury Cathedral (Miles, 1920). There is no exposure but the floor of the pit is covered in large grassy mounds presumed to be spoil. A similar overgrown pit, locality 37 [ST 9526 2898], exists to the south.

Another small overgrown pit, locality 38 [ST 9540 2852], is encountered 600 m further south but there are no recorded details. Oolitic sparry limestone occurs as brash close by and it is thought probable that the pit largely exposed Ragstone with the lower part of the Tisbury Member exposed at the base.

On the east side of the un-named stream valley is the old Oakley or Wockley Quarry, locality 39 [ST 9555 2870]. Bristow and Lott (1995) describe this locality as… "there is an overburden of some 7 m of Purbeck Beds (Group herein) and up to 4.5 m of the Wockley Member, on 7.6 m of 'Freestone' ". This is the section described in Andrews and Jukes-Browne (1894, p. 49), based on a succession logged in 1890 when the pit was still working, and further described by Woodward (1895) which was repeated by Reid (1903, p13-14). The two sections are given below with the original imperial measurements converted to metric.

Andrews and Jukes-Browne

Formation/Member	Lithology	Thickness (m)
	Hard, flaggy, oolitic limestone with Cyprids	0.46
	Soft marly stone passing down into argillaceous marl	0.46
	Sandy brown clay	0.08
	Grey oolitic stone with Cyprids	0.10
	Laminated, grey, sandy marl passing down into soft yellow sandy marl: Cyprids	0.51
	Layer of brown clay	0.05
	Hard tuffaceous limestone	0.30
	Soft, white, silty marl, interlaminated in the upper part with layers of brown sandy clay	0.53
Lower Purbeck (Lulworth Formation)	Parting of black and brown clay	0.03
	Rather, hard whitish, laminated marl	0.36
	Dark-grey, sandy and earthy clay	0.22
	Buff-coloured, laminated, marly limestone	0.76
	Black laminated clay, including a layer of grey limestone at base	0.46
	Yellow ferruginous stone	0.30
	Soft, yellowish, sandy marl, overlying an undulating bed of grey marly limestone, beneath which is disturbed tough grey marl	1.52
	Laminated brown and grey clay, with patches of black clay: rests on the uneven surface of the bed next below	0.10
	Hard, whitish, chalky limestone with Cyprids, and a layer of cherty stone with small lenticules of flint at the top	0.38
	Soft, grey and white, laminated marl	0.15
Portland (Wockley Member)	Hard flaggy limestone with black flints at the top, passing down into chalky and shelly limestone	0.69
	Chalky limestone, with Portland fossils	4.27

The Woodward (1896) and Reid section (1903) varies somewhat in detail and measurements: -

Formation/Member	Lithology	Thickness (m)
	Loamy soil	0.15 to 0.30
	Fissile limestones, some oolitic; and marls and clays with layers of sandy limestone and sand; about	5.49
Lower Purbeck Beds (Purbeck Group, Lulworth Formation)	Hard marly limestone	0.20
	Banded limestones and marl	0.61
	Dark clays	0.30
	Sandy limestone	0.29
	Earthy marl with irregular (? concretionary) masses of stone	0.91
	Fissile limestones	0.61 to 0.91
	Dark shaley clay, much squeezed up in places	
	Compact limestones	0.61
Upper Portland Beds (Wockley and ? Tisbury Member)	Bed of Roach, with lenticular mass of chert at top; *Trigonia gibbosa* [*Laevitrigonia gibbosa*]	
	Chalky limestones obliquely bedded, with *Ammonites biplex*, *Pleurotomaria rugata*, *Ostrea expansa*, *Pecten lamellosus* [*Camptonectes lamellosus*]	3.05 to 4.57
	Buff and greenish, glauconitic sandy limestone	0.61 to 1.22
	Compact and very shelly limestone, passing down into sandy limestone (quarried for freestone)	1.22 to 1.52

Reid (1903) also states "At the Oakley or Wockley Quarry [ST 9555 2870], south-east of Tisbury, the beds {in this case he is talking about the Portland Group strata only} are much reduced in thickness, and their character, especially in the lower beds, is altered, the Ragstones (uppermost Tisbury Member) seen at Chilmark being absent. The individual layers of rock also vary much in thickness. On top there is from 18 to 20 feet (5.5 to 6.1 m) of Lower Purbeck Strata {Lulworth Formation, Purbeck Group}"

Some 500 metres north of the Wockley Quarry a small exposure, locality 40 [ST 9550 2924], showed about 3 m of the Wockley Member, on 1 m of Ragstone and about 6 m of glauconitic sandstone with thin chert beds of the Tisbury Member. Reid in an undated manuscript held at BGS recorded 9 m of Lower Building Stones at this site. Samples were collected during the 1994 survey 1.7 m and 4.0 m below the top of the Tisbury Member and they are described as fine- to coarse-grained glauconitic, bioclastic sandstone and very fine-grained sandstone respectively. Despite its position at the top of a steep-sided valley the exposure shows no signs of cambering.

East and north of North Barn another old pit, locality 41 [ST 956 295], has a face over 200 m long orientated east to west from which the Tisbury Member, with the Wockley Member as overburden, was worked. Donovan (1992) recorded that the quarry was disused by c. 1838. A small section [9544 2951] was seen during the 1994 survey on the west side of the quarry that exposed about 2.5 m of bioclastic, glauconitic, very fine-grained sandstone.

Reid (1903) described a cutting for the railway west of Chicksgrove Mill and this was reinterpreted during the 1994 survey as locality 42 [ST 9556 2964]. Reid described the beds in terms of the upper and lower Portland Beds but Bristow and Lott (1995) regarded the exposure as demonstrating Tisbury Member overlying the Wardour Formation as follows: -

Formation/Member	Lithology	Thickness (m)
	Greenish sandy bed	0.30
	Hard, grey sandy limestone, weathering white, with *Trigonia* and *Ammonites*	0.38
Tisbury Member	Greenish and grey beds of more or less calcareous sandstone or sandy limestone	0.76
	Shelly limestone with *Serpula*	0.76
	Sandy and shelly limestone with *Serpula*	0.76

	Sandy marl with *Ostrea*, *Serpula*, spine of *Echinus*	0.10
	Grey shelly limestones	1.22
Wardour Formation	Brown and greenish brown sand with clay seams and bands of indurated sand; scattered casts of shells, thin beds of stone near top	4.60 to 6.10

East of this cutting is the Chicksgrove Quarry [ST 960 296] that includes seven localities identified during the 1994 survey, and a further two reported upon by Bristow and Lott (1996). The quarry is worked in two parts separated by a valley that reflects an underlying north-south orientated fault which downthrows to the east. The original quarries [ST 9640 2957 and 9648 2960] form localities 43 and 44 respectively in the east. It is probably the latter, now backfilled, that was seen by Miss E Bennett in 1818 (reported by Sowerby, 1818) and by Fitton (1836). Reid (1903) reported that the open quarry (locality 43) was extended eastwards in underground workings. These were re-exposed during c.1993 but have subsequently been backfilled.

Wimbledon (1976) gave the following section [ST 962 297] for the Chicksgrove Quarry: -

Formation/Member	Lithology	Thickness (m)
Purbeck Limestone Formation (Purbeck Group, Lulworth Formation)	Beds 34 to 37. Stromatolitic tufas and thinly bedded limestones.	c. 2.6
Wockley Member (Chalky Series) (is the Wockley Member of Bristow and Lott)	Beds 31 to 33. Poorly bedded, chalky lime mudstones (micrites) with scattered bivalves notably *Laevitrigonia*.	c. 5.0 to 8.0
Wockley Member (Ragstone portion) (Upper part of the Tisbury Formation of Bristow and Lott)	Beds 25 to 30. Well-bedded, shelly beds with intervening soft, white and sometimes green marls. The basal bed is a grey bioclast sand with much obvious quartz and glauconite containing abundant plant remains. It lenses-out eastward and rests on highly irregular erosion surface.	c. 3.20
Tisbury Member (part of the Tisbury Formation of Bristow & Lott	Beds 8 to 24. Grey-green, glauconitic and quartzose bioclast sands. They show variability in the relative proportions of these three components and in their degree of cementation. Glauconite persists throughout. The lower half of the member is well-bedded with some softer, uncemented units whilst the upper half shows small and large-scale trough cross-bedding and occasional symmetrical mud-drape ripples. Chert nodules seen in the cross-bedded portion. Fauna limited to a few horizons and dominated by Trigonids with serpulids and oysters.	c. 12.0
Chicksgrove Member (part of the Tisbury Formation of Bristow & Lott)	Beds 2 to 7. Well-bedded, pink-grey micrites with much bioturbation and occasional lignite. Most bed contain abundant bivalves including *Myophorella incurva*, *Isognomon bouchardi*, *Nanogyra* sp. and *Plicatula* sp.	2.0 to 4.0
Wardour Member (Wardour Formation of Bristow & Lott)	Bed 1. Alternations of clays and bioturbated siltstones with minor more sandy units. Graphic log shows 12 beds within this unit but none are described separately	10.0 +

Note: Thicknesses are approximations from the graphic log of Chicksgrove presented in Wimbledon's Fig 1 and the lithological descriptors are applicable to both his Chicksgrove and Chilmark sections presented in that figure.

The A and B beds (see locality 45) currently worked in the main quarry to the west were dug with others from these underground workings. This eastern part of the Chicksgrove site is now backfilled but there are still some exposures on the southern face. One such, locality 45 [ST 9630 2953] gave the following section; -

Formation/Member	Lithology	Thickness (m)
Ragstone (Tisbury Member pars)	Limestone, massive, fine-grained peloidal	1.30
	Micrite, shelly, hard	0.50
	Marl, green	0.03 to 0.10
Tisbury Member	Sandstone, very fine-grained, bioclastic; towards top becomes shell fragmental	1.20
	Sandstone, bioclastic, hard. Bed A	0.90
	Sandstone, bioclastic, glauconitic, hard. Bed B	1.20

Above the Ragstone there is about 4 m of chalky micrite with common *Camptonectes lamellosus* and *Protocardia* attributable to the Wockley Member. Beds A and B were also sampled at locality 46 [ST 9634 2953] within the eastern quarry.

Quarrying in the site formerly known as the Quarry Copse recommenced in 1968, ceased in 1980 and resumed in 1994. This is locality 47 [ST 960 296]. Wimbledon (1976, Fig 1) shows a 32.5 m section in this quarry which shows (using the Wimbledon terminology) about 13.6 m of the Wockley Member resting on 20.5 m of the Tisbury Member and Chicksgrove Member combined and a further 10 m of the Wardour Member. The Ragstone part of the succession is include by Wimbledon in the Wockley Member and this amounts to about 4.3 m. Insole (1970) shows an 11 m section within the Tisbury Member. A section, locality 48 [ST 9599 2955], in the western quarry exposes: -

Formation/Member	Lithology	Thickness (m)
	Sandstone, glauconitic, cross-bedded, flaggy weathering	1.2
Tisbury Member	Sandstone, massive, glauconitic, bioclastic with thin (up to 10 cms) chert lenses. Bed A	1.1
	Sandstone, glauconitic, massive, bioclastic with stringers of large bivalves. Bed B	1.2
	Sandstone, glauconitic, cross-bedded, fine-grained with a shelly top (mostly bivalves but one ammonite)	0.9

The top of this section must be very close to the base of the Ragstone.

A nearby section, locality 49 [ST 9596 2955], extended the succession at locality 48 upwards.

Formation/Member	Lithology	Thickness (m)
	Limestone, peloidal, irregular splitting	0.70
Ragstone (pars Tisbury Member)	Micrite, porcellanous, hard, shelly	0.85
	Marl, greenish grey	0.10 to 0.20
Tisbury Member	Sandstone, bioclastic, glauconitic	0.60

Two further sections were logged in February 1996 and reported upon by Bristow and Lott (1996, Fig. 1) (Figure 26 herein). In the east of the quarry [ST 9630 2953] a section exposed a 9 m succession divisible into 11 beds. Further excavations in the west [ST 9599 2955] provided a new 21 m section divisible into 18 beds. Both sections contain the marker Bed B at the top. Both sections are shown graphically in Figure 21 below with the eastern section given in more detail in tabulated form. This is probably the most comprehensive description of the Tisbury Member available in the literature.

Formation/Member	Lithology	Thickness (m)
	BED B ABOVE	
	1. Sandstone, very fine-grained, well-sorted, glauconitic, calcareous, friable, pale yellow grey with sporadic dark laminae; the top 0.15 m finely laminated. The base irregular decalcified into a sand.	0.46
	2. Sandstone, very fine-grained, well-sorted, massive, glauconitic, calcareous, friable, pale yellow grey.	0.23

	3. Sandstone, very fine-grained, well-sorted, massive, glauconitic (more so than beds 1, 2, 4-6), friable, pale yellow grey; impersistent ferruginous clay (up to 10 mm thick) at base. The base is irregular (up to 20 cm above base) decalcified into sand	0.35
	4. Sandstone, very fine-grained, hard, well-cemented, strongly calcareous, fossiliferous with scattered white, sparry shell debris; some orange-brown ferruginous staining; top irregularly (to a depth of 10 cm) decalcified into sand.	0.50
Portland Stone Formation Tisbury Member	5. Sandstone, very fine-grained, glauconitic, pale yellowish grey, moderately hard, strongly calcareous with white sparry shell debris; basal 0.1-0.15 m very shelly (including '*Trigonia*'); top more friable.	0.30
	6. Sandstone, very fine-grained, well-sorted, massive, glauconitic, moderately hard, sparse pyritic bivalve ghosts.	0.50
	7. Sandstone, very fine-grained, moderately cemented, glauconitic (more so than in beds 1, 2, 4-6), sparse, sparry white bioclasts.	0.25
	8. Sandstone, fine-grained, glauconitic, friable.	0.20
	Break in section to lower level	
	9. Sandstone, very fine-grained, well-sorted, hard, well cemented, bioclastic with abundant coarse shell debris and small, spar-filled fractures; basal 0.2 m very hard and shelly, including '*Trigonia*'.	0.55
	Sand, fine-grained, orange.	0.02
	10. Sandstone, very fine-grained, well-sorted, moderately hard, massive, glauconitic, calcareous with sparse, sparry, white calcite bioclasts.	0.40
	11. Sandstone, very fine-grained, well sorted, hard, well cemented, strongly calcareous with common spar calcite bioclastic debris; some ochreous, orange-brown, ferruginous staining.	0.60

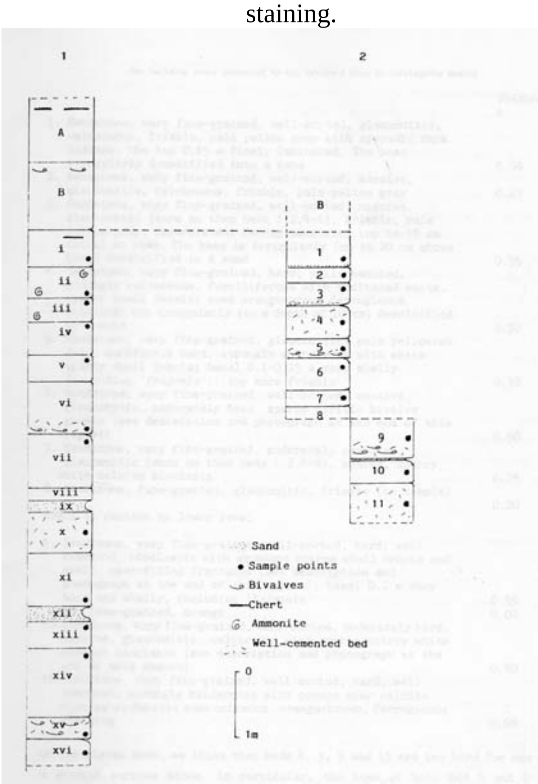


Figure 1. New sections in the Portland Stone Formation, Chicksgrove Quarry

Figure 26: Sections in the Portland Stone Formation, Chicksgrove Quarry (Bristow and Lott, 1996)

To the north of Chicksgrove within the Chilmark Ravine the Portland Group appears as an inlier. This area has long supplied building stone under the general name of Chilmark Stone. Numerous quarries have been opened over the centuries (Donovan, 1992) to exploit beds within the Tisbury, Wockley and Chilmark Members together with the basal beds of the Lulworth Formation of the Purbeck Group. There is an extensive geological literature from the time of Barry et al. (1839) onwards culminating with the privately printed work of Towlson (1991). Most of the valley sides have been worked as open quarries and several sections remained at the time of the surveys (Bristow and Lott, 1994,1995,1996). There are also several adits leading into extensive underground workings a number of which were used until recently by the Ministry of Defence as storage.

The Geologists' Association visited the area in 1911 and the excursion was reported upon by Ord and Reader (1912). They gave a general section of the strata as a composite from both sides of the ravine and elsewhere in the district as follows: -

Formation/Member	Lithology	Thickness (m)
	Subsoil and soil	
Lower Purbeck Beds (Lulworth Formation	Flaggy limestones, dirt beds, and peculiar oolitic beds	2.44 to 4.88
Upper Building Stones (Chilmark Member, Portland Limestone Formation)	Buff sandy and oolitic limestone, compact limestone, and occasional chert seams in lower part	3.05 to 4.88
Chalky Series (Wockley Member, Portland limestone Formation)	Soft, white, chalky limestone with chert	1.22 to 7.32
Ragstone (Tisbury Member, Portland Limestone Formation)	Brown, gritty and shelly limestone	1.22 to 1.83
	Pale, shelly and oolitic limestone	0.61 to 1.22
Lower Building Stones (Tisbury Member, Portland Limestone Formation)	Trough Bed	0.53 to 1.22
	Green Bed	0.61 to 1.52
	Slant Bed	0.30
	Pinney Beds	2.44 to 3.66
	Cleaving or Hard Bed	0.30
	Fretting Bed	1.01
	Under Beds	0.91
Lower Portland Beds and Kimmeridge Clay Formation	39 feet of Lower Portland Beds were passed through in a well sunk at the Teffont Quarry, Chilmark	11.89

The most extensive of these underground workings, locality 50 [ST 975 310], Chilmark Main Quarry Mine, Chilmark Ravine was worked over an area of four hectares. One of the earliest descriptions of these workings was by G F Harris in a manuscript dated 1893 in BGS records who gave the following section.

Formation/Member	Lithology	Thickness (m)
Tisbury Member (Lower Building Stones)	Trough Bed	Roof
	Green Bed	0 to 1.16
	Soft Pinney	0.91
	Hard Pinney	1.22

This locality is probably the largest source of building stone in the area with an estimate of 119 000 tons of the Pinney Beds removed until its closure in 1937 when it was taken over by the Ministry of defence as a bomb store for the RAF. The site was cleared in 1994 and subsequently sold. It is unlikely that extraction will be restarted as the roof has not been maintained for some time, the mine is known to have high values of Radon gas and is now a nationally important bat roosting site.

To the northwest of the Chilmark Main Quarry is a working, locality 51 [ST 9740 3114], known as the Levi Bowles Quarry (Wagon Quarry of the RAF). It is presumed that this is the pit referred to by Crowley (1987) as commencing operations in 1875 and ceasing in 1920. Most of the pit is overgrown but two adits lead to underground workings that were not available for observation in 1994. Harris (Ms, BGS, 1893) referred to open works (presumably the quarry) in which the Trough Bed was the principal bed worked. The underground workings are not extensive, covering about 0.5 hectare. The adit mouth is presumably capped by the Trough Bed and the Pinney Beds were the principal resource quarried. Contours on the floor of the mine show a dip to the south at about 2° towards the Chilmark Main Quarry and mine but it is clear that there is a ENE trending fault with a southerly throw of about 9 m which must form the underground boundary between the two mine systems.

The northernmost quarry, locality 52 [ST 9731 3130] and locality 53 [ST 9727 3127], on the west side of the ravine are known as Chilmark Open Quarry (Radiac Quarry to the RAF) [ST 9731 3130]. The quarry visible in 1994 has essentially the same outline as the Survey's previous survey of 1890 and large-scale quarrying must have ceased prior to this date. The fresh face visible in 1994 on the northeast side of the quarry (locality 52) shows 5 m of massive, glauconitic, bioclastic, fine-grained sandstone (Tisbury Member) in units 0.3 to 0.7 m thick which include some thin (2 cm) chert beds. On the west face (locality 53) the following section was noted in 1994: -

Formation/Member	Lithology	Thickness (m)
	Sandstone, bioclastic, massive	1.00
Ragstone (Tisbury Member)	Sandstone, bioclastic, soft	0.25
	Sandstone, bioclastic, glauconitic	1.00
	Biosparite, sandy, glauconitic, shelly, hard	0.40
	Sandstone, shelly, bioclastic hard	0.60
Lower Building Stones (Tisbury Member)	Sandstone, bioclastic, friable	0.30
	Sandstone, bioclastic, glauconitic, massive	1.00

Wimbledon (1976) gave a section for the Chilmark area base on two localities at [ST 973 313 and ST 975 314] and divided by him into 23 beds. He notes a significant stratal gap above and below his bed 12 within the middle of his Wockley Member. Beds 1 and 2 are within his Tisbury Member. Beds 3 to 12 are within his Wockley Member (and include the Ragstone) whilst beds 13 to 18 are within his Chilmark Member. He notes in his beds 19 to 23 (attributed to the Purbeck Limestone Formation) that there is no clear-cut division between lithologies characteristic of the Portland from those of the Purbeck Group.

The Teffont Evias, east, side of the ravine has also been extensively worked for both the Lower and Upper Building stones. The main quarry, locality 54 [ST 9755 3125], is referred to as the Lower Quarry (Teffont) but also known as Harris' Chilmark No2, Teffont Evias (Chilmark) Quarry, Chilmark (Teffont) Quarry and Teffont Quarry 1991 (Mine). The floor of the old quarry was built-over at the time of the 1994 survey and there are no exposures on the quarry sides. There is little published detail other than a brief mention of a "bed of white stone within the chalky beds" (Wockley Member) quarried for hearthstone in Ord and Reader (1912). Harris (Ms, BGS, 1893), who visited the quarry when production had ceased, included a section recorded by T P Lilly in 1876: -

Formation/Member	Lithology	Thickness (m)
Ragstone (Tisbury Member)	Rag (in two beds)	0.76
		0.61
	Trough Bed (in two beds)	1.07
Lower Building Stones (Tisbury Member)		0.91
	Green Bed (in three beds)	0.76
		0.76
		0.30

Pinney Bed (in three beds)	0.61
	0.61
	0.61
Fretting Bed (in two beds)	0.76
	0.46

Ord and Reader refer to the Ragstone in the quarry as 0.76 m thick and composed chiefly of shells of *Cyrena* (*Cytherea*) *rugosa* this lithology is known locally as the Chilmark Cyrena Marble. The entrance to the underground workings, locality 55 [ST 9758 3122], is in the southeast of the quarry. Underground working ceased in 1937 when the RAF took over the site. Mining recommenced in 1983 and the workings were known to extend 100 m to the northeast. In 1994 between 3.6 and 4.5 m of the Pinney Beds were worked with the roof formed of the Trough Bed.

Close to the existing mine is an old quarry, locality 56 [ST 976 312], exposing about 7.4 m of the Wockley Member. A note on the geological field slip of 1900 by C Reid shows the position of a shaft [ST 9766 3123] in the bottom of the pit. For some 400 m north-westward from the Lower Quarry, the Tisbury Member has been extensively quarried. Within the former RAF compound there is no exposure but outside, in Quarry Copse, the back face [ST 9746 3139 to 9733 3156] is clearly seen and there were still small exposures of massive, glauconitic, bioclastic sandstone visible in 1995.

Just outside Quarry Copse is an old pit, locality 57 [ST 973 316], which is largely backfilled. Jukes-Browne recorded 6 m of sand beds and chert of the Lower Building stone in 1890. About 5 m of bioclastic, glauconitic sandy sparite is was still visible in 1994.

The only published section (Wimbledon, 1976) of the Chilmark Member is from the Upper Quarry, locality 58 [ST 9755 3137], also known as Harris's Teffont Quarry No. 74 (although this may be an erroneous correlation due to the inaccuracy of the original sketch map of this site) and Teffont (Chilmark) Quarry. The graphical log depicts units numbered 13 to 18 with higher beds 19 to 23 attributed to the Purbeck Limestone Formation. There is no bed-by-bed description published but the general description is... " the base (of the Chilmark Member) is rarely seen. Some 6 metres are now visible. This consists of cross-bedded ooid sands with occasional, thin shell bands with, in addition to the usual large bivalves *Astarte* sp. and the gastropods *Ampullospira ceres* de Loriol and the 'Portland Screw' *Aptyxiella portlandica*. Two chert 'beds', up to 0.25 metres in thickness, are seen in the upper part of the section now visible in the old Upper Quarry [ST 975 314]."

Reid (1903) published the following section from the Teffont (Chilmark) Quarry [ST 9755 3137], which also included a detailed section of the overlying 'Lower Purbeck Beds' (see Purbeck Group herein). The lower building-stones (Trough Bed and below) are the lower part of the Tisbury Member of Bristow (1995 WA/95/82).

Formation/Member	Lithology	Thickness (m)
	Chalky Series.	
Upper Portland Beds (Chilmark, Wockley and Tisbury Members)	White Bed: gritty limestone, used for hearthstone.	0.46 to 1.22
	Rubbly marl (Rag).	0.15
	Shelly Limestone	1.07
	Trough Bed: pale shelly oolitic limestone	0.38
	Rubbly marl passing into Roach	0.15
	Green Beds: hard buff or pale greenish-grey oolite merging into bed below	0.79 to 0.84
	Pinney Bed: brown glauconitic and oolitic sandy limestone in three or four layers	3.66

A section at the same site recorded in 1876 by T P Lily (Harris, Ms, BGS, 1893) showed the following:

Formation/Member	Lithology	Thickness (m)
Lower Purbeck	Rag	1.37

Beds (Lulworth Formation)	Dirt Bed	0.15
Chilmark Member	Brown- upper	0.91
	White- upper	0.76
	Chert	0.15
	White- upper in three equal beds	1.82
	White- upper (the above beds worked in the Upper Quarry)	1.68
Wockley Member	Rubble, soft broken stuff	5.79
	White lower	1.07

Details for the Tisbury Member are given under locality 54 above.

Woodward (1895) described the Chilmark Member in the Upper Quarry [ST 9755 3137] as 0.9 m of buff oolitic stone forming the roof bed of the mine, with a marly bed at the base, on 3.6 m of buff compact, Oolite and in places rather sandy limestones, the lowest bed containing chert.

There are a number of small exposures along the upper part of the eastern side of the ravine that were not accessible during the 1994 survey. They are, locality 59 [ST 9742 3153], locality 60 [ST 9743 3147 and 9744 3145], locality 61 [ST 9771 3125], locality 62 [ST 9774 3118], locality 63 [ST 9779 3112], and locality 64 [ST 9782 3108].

Away from the outcrop the Portland Group is identified in all four deep hydrocarbon wells. The general succession of a sandy lower part and limestone-rich upper part can be discerned in all four boreholes. Yarnbury and Shrewton describe Portland Sand and Portland Stone. General descriptions of the strata are given below: -

Portland Sand, sandstone, grey to light brown, very fine- to fine-grained, hard, well-sorted grading down into siltstone. Glauconitic and dolomitic in part.

Portland Stone, limestone, light grey to grey, hard, crystalline and oolitic becomes arenaceous with depth.

4.3 Purbeck Group

The Purbeck Group is divided on the Salisbury sheet into a lower Lulworth Formation and an upper Durlston Formation. No attempt has been made during the survey to divide the succession further and the members described from the type area of the Isle of Purbeck have not been identified. Indeed it is uncertain whether such divisions could be made this distance from the type area and there is insufficient exposure to erect a local member scheme.

Traditionally in this area the Purbeck Beds have been divided into three which Andrews and Jukes-Browne (1894) termed their Lower, Middle and Upper Purbeck ‘groups’ which they showed as a map, Figure 27 herein, and as correlated sections, Figures 28 and 29 herein. Reid (1903) in the old Salisbury memoir divided the Purbeck Beds into similar ‘divisions’. Bristow (1994) in his mapping centred around Tisbury, and concentrating mainly on the variations in the underlying Portland Group, maintained the Lower, Middle and Upper Purbeck Beds as mapping units. His manuscript field maps include the outcrop of the Cinder Bed (within the Middle Purbeck Beds), a widespread marker in southern England, and it is this bed and its continuation into the surrounding area mapped during 2003 that marks the boundary between the Lulworth and Durlston formations of modern usage. A comparison of the old and new terms used to describe the Purbeck Group of this district is given in Table 8.

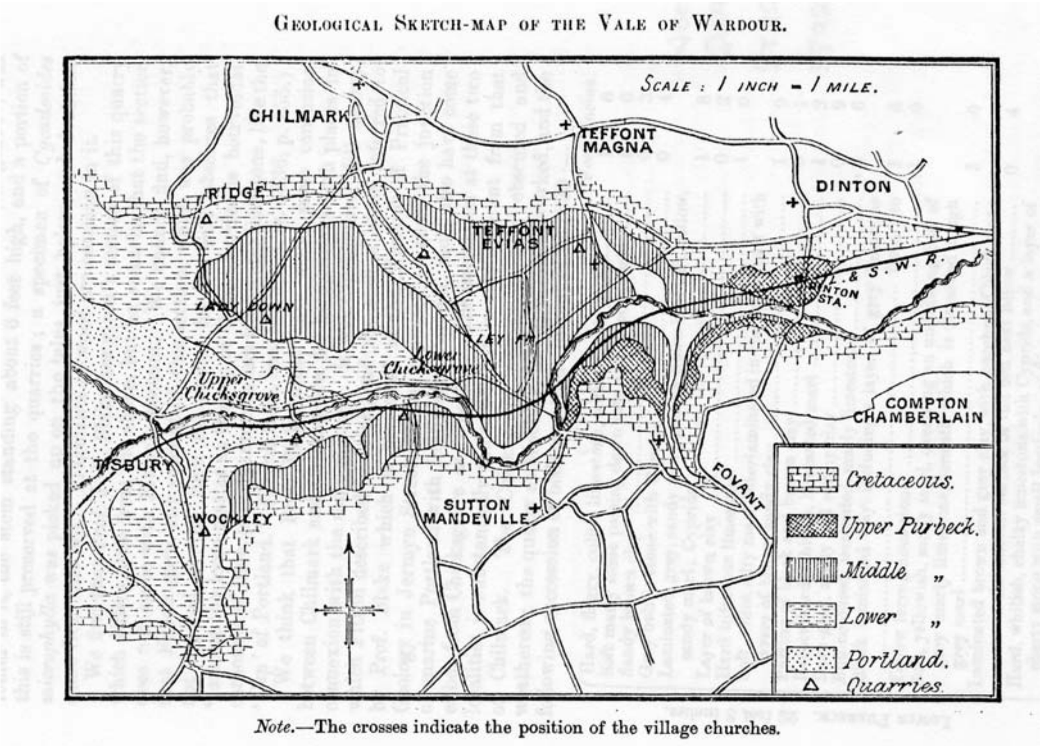


Figure 27: Map of the Purbeck Groups and section location, after Andrews and Jukes-Browne (1894).

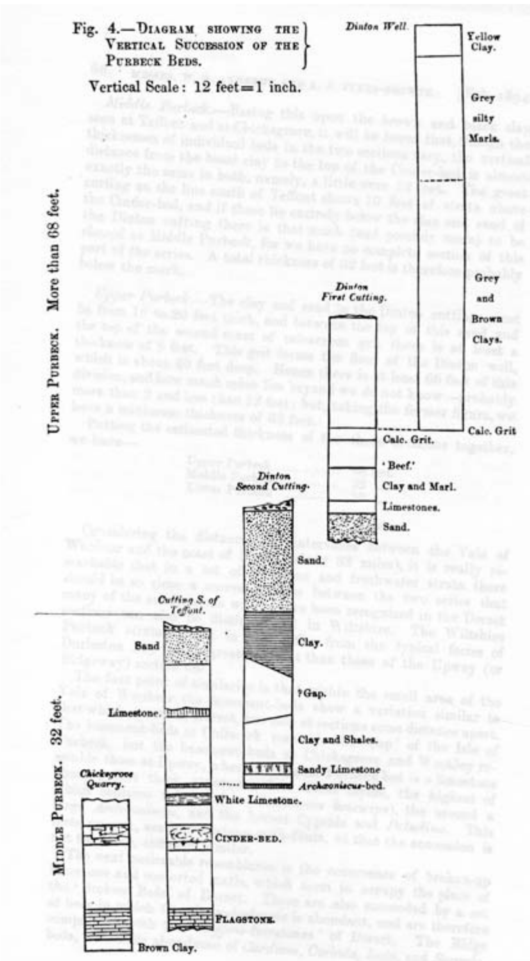


Figure 28: Correlation of the Middle and Upper Purbeck 'Groups', after Andrews and Jukes-Browne (1894).

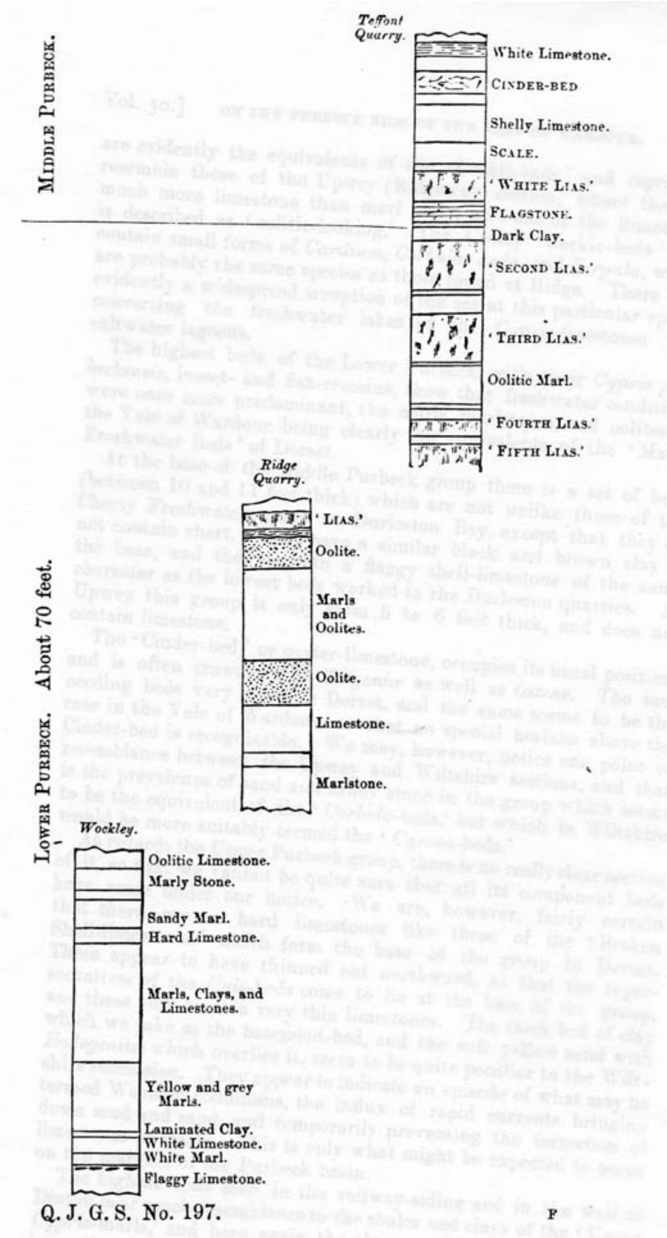


Figure 29: Correlation of Lower and Middle Purbeck 'Groups' after Andrews and Jukes-Browne (1894).

Table 8: Comparison of the traditional and present stratigraphical schemes for the Purbeck Group

<table>
<tr><th colspan="3">Traditional divisions</th><th colspan="2">Divisions used herein and on map face</th></tr>
<tr><td rowspan="5">Purbeck Beds or Series</td><td>Upper Purbeck Beds or 'Group'</td><td rowspan="2"></td><td rowspan="3">Durlston Formation</td><td rowspan="5">Purbeck Group</td></tr>
<tr><td rowspan="3">Middle Purbeck Beds or 'Group'</td></tr>
<tr><td>Cinder Bed</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Lulworth Formation</td></tr>
<tr><td>Lower Purbeck Beds or 'Group'</td></tr>
</table>

Woodward (1895) gives a general succession for the Purbeck Beds and this is repeated by Reid (1903):-

				ft	in	m
Purbeck Beds	Upper	Shell-marls, clays and marls, with 'beef', and sandy layers with bands of calcareous sandstone		20	0	6.10
	Middle	Marls and sandy rocks, with 'beef', limestone with *Archaeoniscus*, Cinder Bed, and other calcareous bands	- - -	12	0	3.66
	Lower	Limestone and shales ('Lias,' &c.)	- -	18	0	5.49
		Limestone, clay, and oolitic beds		15	0	4.57
		Fissile limestones, tufaceous beds and dirt-beds, with chert nodules, &c.	- -	20	0*	6.10
				85	0	25.91

* This figure was omitted from both accounts

The details below rely heavily on exposures noted by earlier workers as most of these no longer present as clear sections.

Details

Where sections are quoted from the literature they have been metricated for inclusion herein.

ST93SW
On the Wincanton Sheet to the west only the very lowest beds of the Purbeck Group occur beneath the Lower Greensand unconformity. They are classified in the memoir for that sheet as the Oakley Marl Member within the Purbeck Formation and described as buff and dark grey marly clay with thin beds of limestone. The more extensive outcrop on the Salisbury sheet would suggest that the Oakley Marl Member is an unnecessary complication to the lithostratigraphy and that they should be considered as the lowest part of the Lulworth Formation of the Purbeck Group. Indeed it has not proved possible to divide the larger outcrops of the Purbeck Group, on the Salisbury sheet, beyond formation level because of the paucity of exposure and the lateral variability of the surface brash. Rocks attributed to the Oakley Marl Member crop out south of Fonthill House [ST 944 317] but the outcrop is substantially obscured by a cover of sandy downwash derived from the Lower Greensand.

ST93SE
Within this sheet area there are few significant exposures remaining within the Purbeck Group. Two minor exposures [ST 9901 3101 and ST 9910 3101], in the larger excavation on the west side of the valley that passes through Teffont Evias, show between 2.1 m and 1.1 m of Durlston Formation and Lulworth Formation respectively close to the 'Cinder Bed' boundary.

Andrews and Jukes-Browne (1894) gave a section "west of Teffont Evias Church" with an approximate grid reference estimated at [ST 989 312] and incorporates the limited exposures seen in 2003 (see above). This is probably the same exposure (but probably further south in the quarry) as that given by Woodward (1895). Both are given below because of differences that demonstrate the variable nature of these beds. It is not clear from these early texts whether these sections are specific to the location given or whether they refer to a composite built-up from the larger exposure that must have existed at the turn of the 19th/20th centuries. Their imperial measurements have been metricated.

Andrews and Jukes-Browne (1894)

Formation/Member	Lithology	Thickness (m)
	Rubble of white limestone	0.30
	Marly shale, with a layer of 'beef' and lenticular seams of chert, crowded with silicified shells of *Cyclas*.	0.30

	Rough, greyish, sandy limestone (Cinder Bed), with *Ostrea distorta* [*Praeexogyra distorta*], *Trigonia gibbosa* [*Laevitrigonia gibbosa*], and a spine of *Cidaris purbeckensis* [*Hemicidaris purbeckensis*].	0.46
	Yellowish, calcareous, sandy shale.	0.23
Middle Purbeck	Hard, grey, shelly limestone in three courses, with shaley partings; Chelonian bones, *Hybodus*-spines, *Estheria subquadrata*, *Cypridea punctata*, *Cyprione bristovii*, *Cyprione* sp. and *Metacypris* sp.	0.84
	Dry, buff-coloured, sandy and calcareous shales (Scale) full of *Modiolae*; pycnodont teeth.	0.46
	Buff-coloured marly clay.	0.20
	Hard, compact, grey marlstone (White Lias), jointed vertically, no fossils found.	0.61
	Dark grey or black shale, with *Mesodon macropterus*, *Estheria andrewsii*, *Cypridea fasciculate,* and *C. punctata.*	0.05
	Hard, grey, shelly limestone, showing ripple-marks and sun-cracks, splitting into slabs which are used as flagstones; *Cypridea fasciculate*, *Cyclas*, fish-vertebrae and scale (Tilestone or Flagstone).	0.46
	Yellowish laminated shale, with layers of crushed shells.	0.18
	Brown and black, shaly clay, contains *Cypris purbeckensis* [*Mantelliana purbeckensis*] plentifully, *C. fasciculate* [?*Cypridea fasciculata*] (less common), *Estheria andrewsii*?, *Cyclas* and scales of *Lepidotus* [*Lepidotes*].	0.30
	Very hard, compact, grey marlstone (Lias no. 2); fish-remains: *Leptolepis*, *Coccolepis*, and *Pleuropholis*, with *Archaeoniscus* and wing-cases of Coleoptera.	1.07
	Brown clay.	0.15
	Soft, yellowish, marly sand.	0.46
Lower Purbeck	Hard grey marlstone, very heavy (Lias no. 3), with *Cypris purbeckensis*, *Pleuropholis*, insect remains (Coleoptera and *Libellula*), and plants (*Palaecyparis*).	1.07
	Brown clay (generally the floor of the quarry)	0.10
	Yellowish sandy marl, with oolitic grains and a thin layer of compact marlstone near the top, contains Cyprids (?*purbeckensis*) and crocodile scales.	0.76
	Grey marly limestone.	0.15
	Soft yellowish marl.	0.20
	Grey marlstone (or Lias), with vertical jointing.	0.38
	Soft sandy marl.	0.15
	Hard grey and brown marlstone, compact and heavy with ochreous patches and markings.	0.60+

The section by Woodward (1895) is given below and he states: - “To the south-west of Teffont Evias Church there is a long excavation in the Purbeck stone-beds which present a general resemblance to Lower Lias Limestones, and many beds are known to the quarrymen as 'Lias'. The best section is near the Limekiln at the northern end… [ST 9893 3131] …of the workings; this was noted as follows”. See Plates 5 and 6

Formation/Member	Lithology	Thickness (m)
	Brashy soil brown sandy loam	
	Cherty layer with many bivalves [*Cyclas*]	
Middle Purbeck Beds	**CINDER BED**: hard greyish brown limestone, much broken up; *Ostrea distorta*, [*Trigonia* allied to *gibbosa*, and spine of *Hemicidaris*]	0.30
	Clay and rubble	0.20
	Hard grey limestone with dendritic markings	0.36

	Grey shelly limestones, splitting up irregularly; the bottom bed called **WHITE BED** (6 ins. to 1 ft.) [Chelonian bones, *Hybodu*s, Cyprides]	0.69
	Shaly limestone, with curious concretionary projections from base of White Bed, which disturb this stratum [*Modiola*]	0.15
	Pale grey rubbly marls	0.10
	White Limestone [**Lias No.1**]	0.46
	Sandy marl and clay [*Mesodon, Estheria* and Cyprides]	0.10
Lower Purbeck Beds	Sandy shell-limestone [**BLUE ROCK or FLAGSTONE**]; blue-hearted stone, weathering buff, with brown ferruginous base called SCALE, showing tridactyl markings on under surface. *Cyrena* [fish remains]	0.69
	Clays and Shales with *Cypridea granulosa*, [*Cypris purbeckensis*]	0.30
	Hard white marl [**Lias No.2**]	0.38
	Soft Marl [**Lias No.2**]	0.30
	Hard marly limestone [**Lias No.2**]	0.38
	Soft white marl	0.38
	Hard white marly limestone [**Lias No. 3**]	0.38

The Cinder Bed noted in both descriptions marks the base of the Durlston Formation with the Lulworth Formation below. Terms in bold are those used by the quarrymen.

Plate 5. Teffont Evias Limekiln Pit [ST 9893 3131]. Junction of Middle and Lower Purbeck. Photo P 250100

Plate 6. Teffont Evias Limekiln Pit [ST 9893 3131]. Middle and Lower Purbeck. Photo P250101

Woodward also describes a pit in the Chilmark Ravine (Figure 30 and see also Plate 7) and on its northeast side (? The Upper Quarry at an estimated location of [ST 9756 3142]) as follows: -

Formation/Member	Lithology	Thickness (m)
Lower Purbeck Beds (Lulworth Formation)	9. Flaggy limestone and marly clay	
	8. Dirt Bed, 1 ft. to 18 ins, thick, like the Great Dirt Bed of Portland, a carbonaceous clay with remains of Cycads, and with rounded lumps of limestone and decomposed chert	
	7. White marly rock and clay of irregular thickness	
	6. Dirt Bed, marly and carbonaceous clay with stones	
	5. Marly clay and irregular earthy limestone	
	4. Tufaceous and granular oolitic stone, irregular	2.44 to 3.05
	3. Earthy tufaceous limestone with chert seams, passing down into pale fissile and earthy limestone	1.83
Portland Beds (Portland Stone Formation, Chilmark Member)	2. Buff oolitic stone, forming roof-bed of mine, with marly band at base: *Cerithium*, *Cytherea*	0.91
	1. Buff compact oolitic, and in places rather sandy limestones. (Upper Building Stones.) Seen to depth of 12 feet (3.66 m), the lowest bed containing chert	

Plate 7. Teffont side of Chilmark Ravine [? ST 9756 3142]. Lower Purbecks on Portlands. P250097

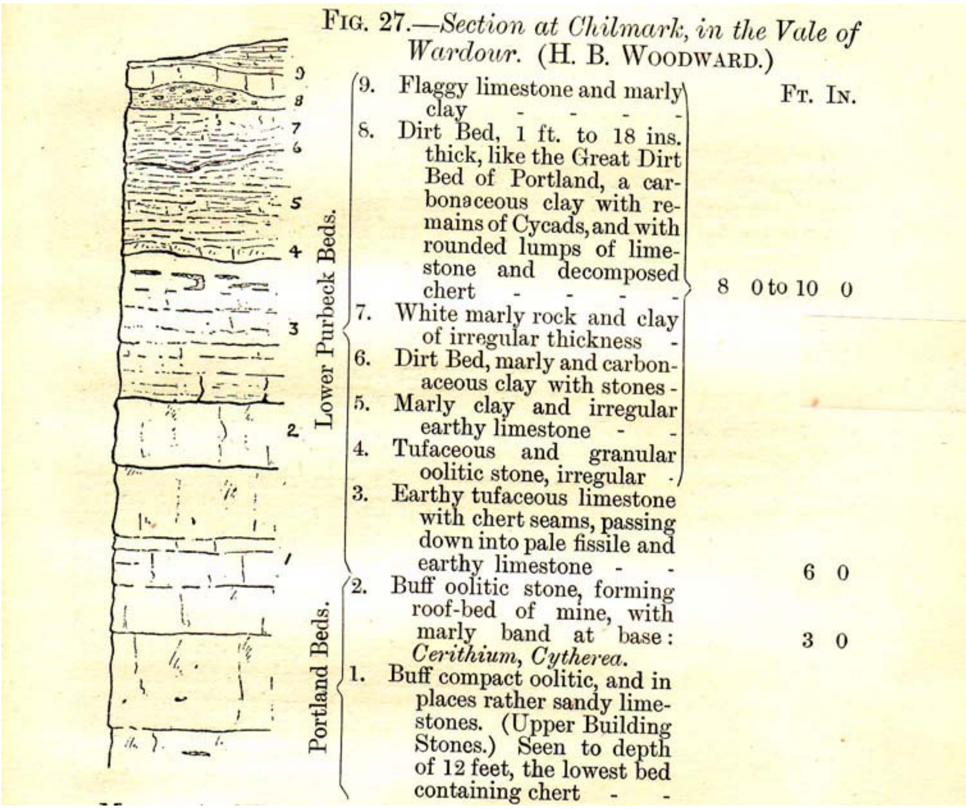


Figure 30: Section at Chilmark (from Reid, 1903; Woodward, 1895, Fig 27)

Andrews and Jukes-Browne (1894) gave a different section but ostensibly from the same locality as follows: -

Formation/Member	Lithology	Thickness (m)
	Shaley marl, with lenticular beds of soft limestone, bedding wavy.	0.61
	Yellowish tufaceous limestone.	0.20
	Soft, white, chalky limestone.	0.30
Lower Purbeck (Lulworth Formation)	Stiff grey clay, containing pebbles of whiteish limestone and many pieces of wood; base uneven.	0.30 to 0.51
	Tufaceous marly limestone, very soft in places irregularly bedded.	1.52 to 1.98
	Yellowish Oolite, with lenticular layers of brown oolitic flint at the top.	0.38
	Course of clear brown glassy flint.	0.08
	Hard, compact tufaceous limestone.	1.22
	Soft, dark grey, marly clay: purplish in places.	0.08
Portland (Chilmark Member)	Firm, yellowish Oolite in thick beds the upper surface rather uneven	4.88
Portland (Wockley Member)	White chalk, with flints, in quarry below.	7.31

An interesting section to the south-east of Ridge has been noted by Messrs. Andrews and Jukes-Browne as follows showed 6.81 m of the Lulworth Formation: -

Formation/Member	Lithology	Thickness (m)
	Dark brown soil	0.30
	Weathered marlstone or 'lias'	0.30
	Buff-coloured marl, with two seams of grey clay	0.15
	Soft, fine-grained, marly oolite, with thin layers of harder compact marlstone in the lower part	0.69
	Soft yellowish calcareous oolitic sand	0.23
Lower Purbeck Group (Lulworth Formation)	Very hard limestone, consisting of shelly layers alternating with seams of compact marlstone -	0.25
	Soft marl in thin layers.	0.20
	Soft yellowish, oolitic stone. With thin layers of marl	0.76
	Hard grey limestone full of shells	0.71
	Firm oolitic stone, almost a pisolite in places, with interlaminated layers of marl in the lower part and a 2-inch layer of brown marly clay at the base	0.99
	Soft calcareous stone, passing down into hard limestone with vertical joints, and lying in thick courses (added note from Reid 1903 text: pseudomorphous crystals of rock-salt: *Corbula alata, Perna, Cardium, Nuculana, Serpula,*).	0.99
	Soft, grey laminated, argillaceous marl	0.30
	Firm buff coloured marlstone, breaking with semiconchoidal fracture; base no seen	0.91

This site was visited during the 2003 survey but was entirely overgrown with the eastern face degraded. The surface brash adjacent to the pit showed a few examples of micritic and peloidal limestones within a marly soil.

South of Teffont Evias is a section described by Andrews and Jukes-Browne (1894) as “ the section exposed in the railway cutting, half a mile south of Teffont and on the southern side of the river” and by Andrews (1881, 1884) as “one and a quarter miles west of Dinton Station” (Figure 31).

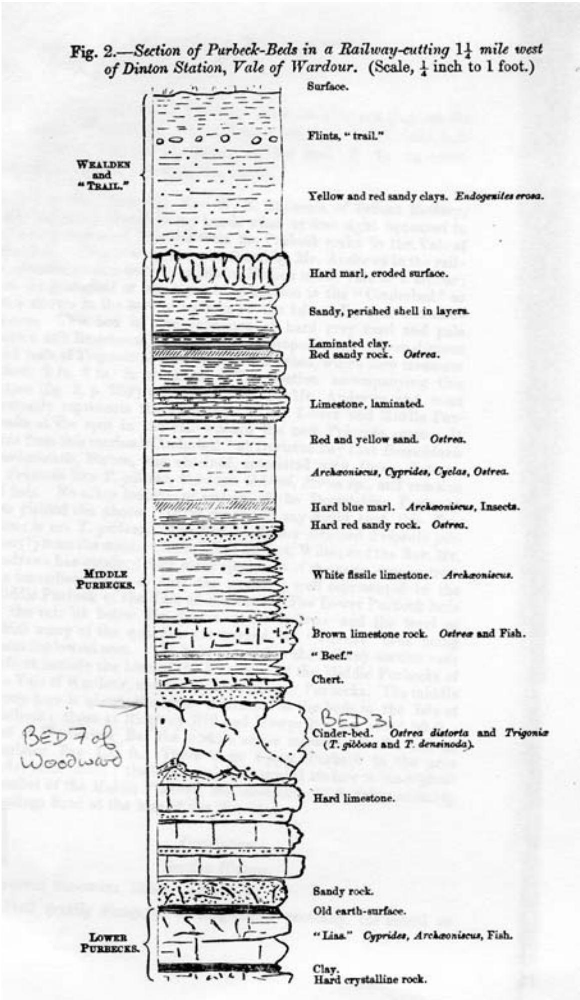


Figure 31. The section "one and a quarter miles west of Dinton Station" of Andrews and Jukes-Browne (1881, 1884).

This must undoubtedly be the cutting between [ST 9937 3057 and ST 9908 3033] that formerly exposed the Lower, Middle and Upper Purbeck Beds. There are three slightly different sections in existence from these authors, that can however be correlated, and the following is an amalgamation of these. The numbered beds are from Andrews (1881), with the bed numbers from Andrews (1884) (he omitted the Hastings or Wealden Beds from this account, but see discussion below) in brackets. Where there is a different lithology or additional data given in Andrews and Jukes-Browne (1894) this is included as bold text. Modern mapping would suggest that the cutting does not include the Wealden as these are mapped higher on the slope south of the exposure. Thus suggesting that the majority of the beds described above bed 9 are equivalent to the Upper Purbeck Beds and can be reasonably correlated therefore with the section further east along the railway towards Dinton Station (see details for SU 03SW below). The highest beds described below may well be a slope deposit of Quaternary age (? Beds 1 and 2). Such a correlation would remove much of the confusion created by Woodward (1895) in his misidentification of the correct railway cutting "west of Dinton Station". There appear to be two cutting sites described north of the river and west of the station (700 yards and 400 yards respectively west of the station, see also Plate 12) and that described by Andrews and Jukes-Browne being the third and south of the river.

Formation/Member	Lithology	Thickness (m)
	1. Brown earth with scattered flints, passing into.	0.61
	2. Red and yellow sand, with a few scattered flints. **Beds 1 and 2 together described as wet grey and yellow sand (0.91 to 1.22 m).**	0.61
Hastings or	3. Grey sand with red streaks, passing into.	0.46

Wealden Beds (Probably Upper Purbeck Beds)	4. Grey sandy clay, red and yellow layers. **Beds 3 and 4 together described as light-grey sticky clay (0.51 m).**	0.30
	5. Purplish red clay, laminated.	0.05
	6. Green clay, light-red lines.	0.15
	7. Layer of iron laminae. **Beds 5, 6 and 7 described together as soft marly clays, with thin, brown, iron-stained layers (0.61)**	0.02
	8. Green clay, red irony lines of variable thickness, resting unconformably on the bed below, and running down amongst the lumps. **Light buff marl (0.10 m)**	0.03
	9. (1) Worn flint-shaped lumps of hard marl, vertical fracture. **Hard, whitish, grey-hearted silty limestone, weathering into angular blocks with vertical fracture.**	0.30
	10. (2) Sandy with perished shells in layers. *	0.46
	11. (3) Clay, red and grey in laminae. *	0.15
	12. (4) Very red sandy rock, sometimes blue and grey, with large bivalve, *Ostrea*. *	0.05
	13. (5) Limestone layers in sandy clay. *	0.30
	14. (6) Thin Laminated brown sandy limestone*	0.23
	15. (7) Hard sandy stone, often red outside, ripple-marks on the top. *	0.30
	16. (8) Composed of perished shells, thin layers of limestone and a line of 'beef' about the middle. *	0.30
	17. (9) Red and yellow sand in layers. *Ostrea*. *	0.41
	18. (10) Clay, with thin-laminated, soft and yellow; impressions of *Archaeoniscus*. **Laminated shelly marls, brown, yellow, and whitish, very hard in parts, full of bivalve shells**.	0.03
Middle Purbeck Beds	19. (11) Hard blue and brown marl, *Archaeoniscus*, *Cyprides*, *Cyclas*, *Ostrea*, insect wings. **Hard, grey, marly limestone (*Archaeoniscus* Bed), containing also *Ostrea distorta*, *Corbulae*, and a *Cardium*.**	0.23
	20. (12) Laminated thin white limestone and sand. **Grey sandy limestone.**	0.08
	21. (13) Hard red sand rock. Occasional streaks of blue; oysters and impressions of large bivalves. **Dark brown ferruginous sandstone**.	0.08
	22. (14) Soft sandy limestone	0.05
	23. (15) Soft white limestone, laminated, 'White Bed'. *Archaeoniscus*. **White fissile limestone, splitting into layers 0.03 to 0.05 m thick.**	0.41
	24. (16) Brown rock shelly, large bivalves, oysters, fish remains. **Hard shelly limestone here very thin (0.03 m).**	0.30
	25. (17) Oolitic stone, brown.	0.15
	26. (18) Soft limestone, vertical fracture. **Soft whitish limestone**.	0.30
	27. (19) 'Beef'.	0.05
	28. (20) Sand and Limestone in layers. **Soft, laminated, shelly limestone, full of crushed shells.**	0.15
	29. (21) Chert. **Chalcedonic chert full of *Cyclas*.**	0.05
	30. (22) Sandy clay, dark brown, shelly. **Brown clay**.	0.05
	31. (23) Hard grey marl, and brown soft rock, very varying in their proportions, sometimes the hard marl taking up all the space and vice versa. 'Cinder' containing scattered *Ostrea distorta*, and *Trigonia*. **Cinder Bed, very hard in places, loose and soft in others; *Ostrea distorta*, *Trigonia gibbosa* and *Tr. densinoda***	0.74
	32. (24) Hard crystalline limestone, in 1, 2 or 3 layers, with thin sand or clay between, blue outside, and containing lumps of chert. *Cyclades* in clay parting with vegetable remains and *Paluinae*. *Cyclades* and *Ostrea* in the chert. **Hard blue-hearted limestone in two or three courses, with marly partings, *Ostrea* and univalves**.	0.91
	33. (25) Sandy Rock, yellow. **Yellowish sandy limestone**.	0.30
	34. (26) Dark clay.	0.05

Lower Purbeck Beds	35. (27) Hard grey marl. Insect beds of Purbeck. **'First Lias'**.	0.46
	36. (28) Clay. **Grey.**	0.05
	37. (29) Hard crystalline rock, shelly. **The 'Flagstone'**	0.61

*The succession of Beds 10 to 17 in Andrews (1881) is somewhat differently described in the Andrews and Jukes-Browne (1894) paper and is given below.

Formation/Member	Lithology	Thickness (m)
Middle Purbeck Beds Equivalent to beds 10 to 17 in the above section	Soft laminated, grey and brown, sandy marls and clays with some shelly layers and a seam of 'beef'.	0.61
	Rather hard, brown and grey, sandy stone	0.05
	Brownish sandy clay, with irregular and lenticular seams of sandy limestone.	0.30
	Hard, buff-coloured, sandy limestone, laminated at the top and bottom; contains large *Cyrenae*.	0.30
	Soft shaly marl, with crushed shells.	0.15
	Layer of 'beef'.	0.03

Andrews and Jukes-Browne (1894) described one further site within the Middle Purbeck Beds on Lady Down (see also Plates 8 and 9). There are three sites of made ground identified during the 2003 survey and it is not certain which of these is the site mentioned by these authors. However the description suggesting that the exposure is above the Cinder Bed but below the Upper Purbeck Beds would favour the most southerly and smallest quarry now completely backfilled at [ST 961 307]. Their description is given below.

Plate 8. Ladydown, near Tisbury [? ST 961 307]. Middle Purbeck rocks. Photo P 238833

Formation/Member	Lithology	Thickness (m)
	Dark brown sandy soil	0.61
	Traces of limestone, with *Archaeoniscus*.	0.05
Middle Purbeck Beds (Durlston	Yellowish, calcareous, gritty sand, with layer of reddish-brown sandstone at the base.	0.15
	Whitish fissile limestone, in thin layers.	0.10

Formation)	Hard shelly limestone, in one massive course.	0.38
	Compact white limestone, passing down into flaggy oolitic and shelly limestone.	0.46
	Laminated marly beds, yellowish and brownish, with layers of ‘beef’ and whitish shell marl. Cinder Bed below.	0.41

Plate 9. Ladydown, near Tisbury [? ST 961 307]. Purbeck section. Photo P 252816.

ST92NE
The Oakley Marl Member (part of the Lulworth Formation as mapped on the Salisbury Sheet) is named after the old Oakley (or Wockley or Shavers Bridge) Quarry [ST 9555 2870] southeast of Tisbury (see also Plates 10 and 11). (Andrews and Jukes-Browne, 1894) where 6.78 m of interbedded ‘marls’, clays and limestones occur. The section is described, in full, within the details for the Portland Group above. These Portland beds form the lower part of the succession exposed there.

Andrews and Jukes-Browne (1894) describe a quarry section “southwest of Lower Chicksgrove on the southern side of the railway” which is thought to be the pair of quarries south of Coleman’s Farm at [ST 974 297]. This exposes a succession equated with the Teffont Evias exposure and contains the Cinder Bed. An interpretation of the text given for this exposure gives the following section: -

Formation/Member	Lithology	Thickness (m)
	Hard, marly, oolitic limestone with *Cyclas* and *Cyrena*	0.25
	Soft grey clay, with a lenticular layer of whitish limestone and a thin layer of beef	0.23
Middle Purbeck Beds	Soft, brown, marly clay with yellowish shaly marl	0.20
	Cinder Bed in two courses, the lower course hard grey marly limestone without *Ostrea* but with *Cyrena*? *media* and an upper course variable hard and ‘loose’, rubbly, with *Ostrea distorta*, *Trigonia gibbosa* and *Cyrena media*.	

	Grey shelly limestone, very pure, made up almost entirely of Cypidd and Cyclas-shells, *Cypridea fasciculate* and *C. punctata* being abundant.	0.53
	Beds including the Scale with *Modiolae*	
Lower Purbeck	White Lias	0.61
Beds	Thin Shale	
	Two courses of hard shelly fissile limestone (Flagstone) containing *Cyrena media*, *Paludina carinifera*?, *Cypridea fasciculate*, *Estheria subquadrata* with branches of *Thuyites* and impressions of reed-like leaves.	0.91
	Brown and black shaly clay	
	Marly Limestone	

The Cinder Bed marking the base of the Durlston Formation of modern usage.

Plate 10. Wockley, near Tisbury [? ST 9555 2870]. Lower Purbeck Beds. Photo P 250094.

Plate 11. Wockley, near Tisbury [? ST 9555 2870]. Lower Purbeck Beds. Photo P 250095

SU03SW

The following is the section exposed in the railway-cuttings west of Dinton railway-station described by Woodward (1895) and reproduced in Reid (1903) (Figure 32, see also Plate 12). This section is from the most easterly cutting and sidings as shown in his figure 136 (p. 273) from [SU 0026 3081 to SU 0080 3090].

Formation/Member	Lithology	Thickness (m)
	34. Irregular gravel passing down into whitish stony clay	1.52
Wealden Beds	33. White, grey, and mottled clay, passing down into white and ochreous clay with seam of greenish sand	0.91
	32. Laminated yellow ochreous clay and sandy seams	0.69
	31. Brown, black, and white sand, and thin layer of laminated clay	0.15
	30. White marl passing down into clay; with *Cyprides*	0.41
	29. Shelly calcareous grit	0.04 to 0.08
Upper Purbeck Beds	28. Gritty marl	0.08
	27. White marl with black (carbonaceous?) matter on top	0.10 to 0.20
	26. Blue clay	0.13
	25. Bluish-grey calcareous sandstone	0.08
	24. Marls and clays, with thin bands of 'beef', and thin impersistent layers of sandstone	0.53 to 0.76
	23. White shell-marl, with thicker bands of 'beef'	0.91
	22. Dark blue clays, with shell-marl, 'beef', and ferruginous matter	0.76 to 0.99
	21. Blue-hearted shelly and sandy lime-stone with greenish earth in places, lignite, *Unio, Paludina*. Brown calcareous sandstone. The whole passing into sand with ferruginous layers	0.81

	20. Yellowish sands and laminated sands and clays, passing downwards and laterally into stiff blue clay	1.22 to 1.83
	19. Hard-jointed white marl, the surface eroded and the hollows filled with clay (like Bed 27)	0.04 to 0.38
	18. Thin laminated marl, with layers of clay and sand, shelly bands and 'beef'	0.46
	17. Calcareous sandstone passing into sand	0.30 to 0.46
	16. Clay with shelly bands	0.38
Middle Purbeck	15. Brown sandy rock with *Cyrena*	0.15
Beds	14. Shell-marl with greenish tinges	0.30
	13. Smooth-grained grey limestone with *Archaeoniscus*	0.08
	12. Sandy shell-marl	0.08
	11. Grey marly and ferruginous limestones	0.22
	10. White limestones	0.38
	9. Shelly and sandy limestones. Fish-remains	0.13
	8. Shell-marl with 'beef'	0.13
	7. Cinder Bed: earthly limestone with *Ostrea distorta*	0.38
	6. Marly and sandy layer with 'beef'	0.13
	5. Marly and sandy layer with 'beef'	0.30
	4. White limestone	0.20
	3. White limestone	0.15
Lower Purbeck	2. Marly bed	0.18
Beds	1. Brown sandy limestone	0.30

Plate 12. Teffont Mill, near Dinton [? SU 0026 3081 to 0080 3090]. Contorted Purbeck Beds. Photo P 232123

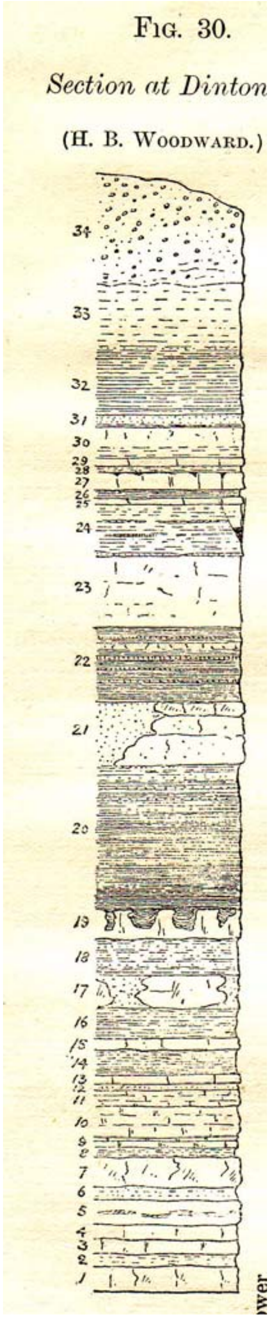


Figure 32: Section at Dinton (from Reid, 1903; Woodward, 1895, Fig 30)

Beds below the level of those shown in the cutting were noted by the Rev. O. Fisher in 1853 as follows, in the adjacent quarries.

Formation/Member	Lithology	Thickness (m)
	Ribbon clays and sands, with compressed shells	0.30
	Hard crystalline limestone, with comminuted shells, *Cypris* and *Cyrena*	0.46
Lower Purbeck Beds	Brown sand, full of crushed bivalves and Serpulae	0.23
	Blue and grey laminated clay with limestone nodules, thin 'beef', and crushed bivalves	0.30
	Hard grey marl limestone	1.07
	Dirt-bed	0.08
	Laminated clay and soft and hard marls	0.46
	Hard marl with conchoidal fracture	0.20

Andrews and Jukes-Browne (1894) published a section "about 700 yards west of Dinton Station" [ST 9975 3071 to SU 0037 3083] that must be entirely within the Middle Purbeck Beds (although the cutting also the Lower Purbeck Beds at it western end. They correlated this closely with the cutting south of Teffont given above. If their identification of the '*Archaeoniscus* Bed' is correct then it can also be correlated with bed 13 and up to bed 20 in the Woodward succession in the cutting further east. Their succession is given below.

Formation/Member	Lithology	Thickness (m)
?Basal bed of Upper Purbeck Beds	Sticky grey clay seen for	0.15
	Brownish clay, passing down into whitish marly clays with irregular lumps of hard shelly limestone at intervals.	0.30
	Layer of fibrous carbonate of lime ('beef') up to	0.05
Middle Purbeck Beds	Layers of grey shaly clay, sandy shale, and yellow sand with crushed shells.	0.76
	Lenticules of sandy limestone and beef in brownish sandy shale.	0.15
	Hard buff-coloured, sandy limestone, solid in the upper part. Laminated in the lower part.	0.30
	Brown sandy shale and clay, with crushed shells.	0.20
	Hard crystalline, shelly limestone.	0.04
	Compact, grey, marly limestone (*Archaeoniscus* Bed) with many specimens of *Archaeoniscus.*	0.10

The clay at the top of the succession was thought to be about 8 feet (2.44 m) thick and topped by soft yellow sand and can be correlated with bed 20 of the Woodward section.

Andrews and Jukes-Browne gave a further section "in a wood southeast of the quarried cutting near Dinton there are old stone-workings". They identified the '*Archaeoniscus* Bed' adjacent to the River Nadder at "the bottom of " this wood and their section is a trench cut in the northeast of the wood and estimated to be at [SU 0079 3080]. They regarded the beds as "quite different from any exposed in the railway-cuttings" but a comparison of their log with that of Woodward would suggest that the beds described below cover beds 15 to 20 in Woodward's section.

Formation/Member	Lithology	Thickness (m)
? Equivalent to Bed 20 of Woodward and base of Upper Purbeck	Yellow and grey sand, with lumps of brownish calcareous sandstone containing Cyrena and Melanopsis; thin layers of grey clay occur in the lower part, which passes down into the next	0.61
	Stiff grey clay, with thin layers of grey sand and thicker layers of yellow sand	0.30
	Stiff grey clay, yellowish near the base	0.61
Middle Purbeck Beds (= beds 19 to 17 of Woodward?)	Hard, whitish, silty limestone, breaking vertically into sharp splintery fragments	0.13
	Soft, buff-coloured, shaly marl with *Cypridea punctata*	0.18
	Hard, buff-coloured, grey hearted, sandy limestone	0.18
	Flaggy and shelly stone, with layers of 'beef'	0.10
	Grey marly clay, with layers of whitish shell-marl	0.30
	Sandy and shelly limestone with *Cyrena*	0.10
	Floor of hard stone	

During the survey in 2003 Dr Farrant noted a thick bed of 'beef' in a stream [SU 0050 3101] north of the old Dinton Station cutting. This exposure is immediately south of the mapped Wealden/Purbeck boundary and the most likely correlation therefore with beds 22 to 24 within Woodward's (1895) section.

Andrews and Jukes-Browne (1894) gave two further sections in the cutting (Figure 33) that they regarded as within the Upper Purbeck Beds but may include the beds identified as Wealden by Woodward.

80 yards east of the watercourse [? SU 0035 3084] the following beds were logged;

Formation/Member	Lithology	Thickness (m)
	'Beef' (fibrous carbonate of lime)	0.07
? Equivalent to Bed 20 of Woodward and base of Upper Purbeck	Brown sandy clay	0.10
	Soft calcareous shelly marl	0.15
	Stiff blue clay	0.23
	Sandy clay with layers of 'beef'	0.10
	Grey shaly clay	0.07
	Soft yellow marl with crushed shells	0.20
	'Beef' 2cm and brown sandy clay	0.10
	Hard shelly limestone, grey inside weathering yellowish, with *Unio*	0.15
	Buf or brownish nodular limestone, with *Cyrena media* and *Paludina*	0.07
	'Beef' and sandy stone	0.10
	Yellow and grey sand with a log of endogenous wood in place	0.91

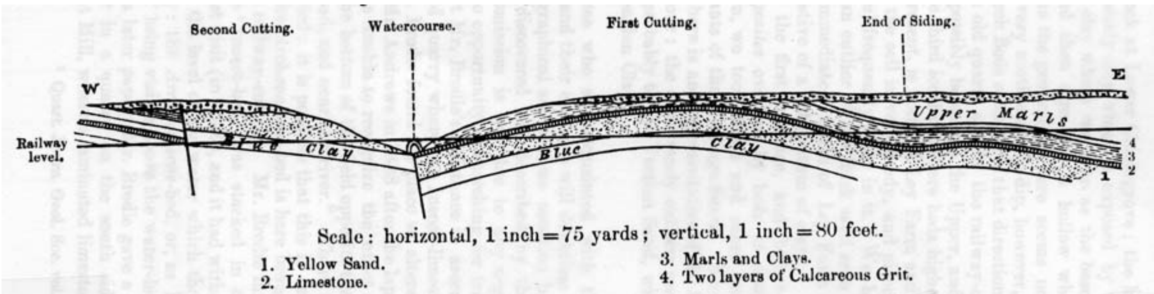


Figure 33: Section along the railway cutting, west of Dinton Station.

Where the back is cut back for the railway siding [? SU 0058 3087], a different set of beds was recorded, dipping at an angle of 18° to N 30° to E. The section is:

Formation/Member	Lithology	Thickness (m)
	13. Loam and gravel	1.22
? Equivalent to Wealden Beds of Woodward	12. Light grey marly and silty shale	1.22
	11. Grey clays with thin layers of yellow sand	0.60
	10. Grey marly clay	0.30
	9. Hard dark grey calcareous grit	0.05
	8. Sandy marl	0.05
	7. Yellowish marly limestone, breaking vertically	0.13
	6. Yellow marly clay passing down into dark grey shale	0.15
	5. Hard dark grey calcareous grit	0.07
	4. Light bluish grey clay	0.15
	3. Grey and brown sandy marl with stoney nodules near the top	0.22
	2. Grey sandy marl with thin layer of 'beef'	0.07
	1. Yellowish white shelly marl	0.22
? Equivalent to Bed 20 of Woodward and base of Upper Purbeck		

Away from the outcrop the Purbeck Group has been identified in the Yarnbury, Netherhampton and Farley South deep hydrocarbon wells. The group is absent in the Shrewton borehole and the description in the Yarnbury borehole would indicate that hereto the succession is eroded beneath the Lower Greensand unconformity. The traditional Lower, Middle and Upper divisions are recognised in the other two boreholes and their lithologies reflect the general succession seen at outcrop to the southwest.

5 LOWER CRETACEOUS

A correlation of the Cretaceous strata encountered in the four deep wells within the district with key boreholes to the north sand south is given in Figure 34.

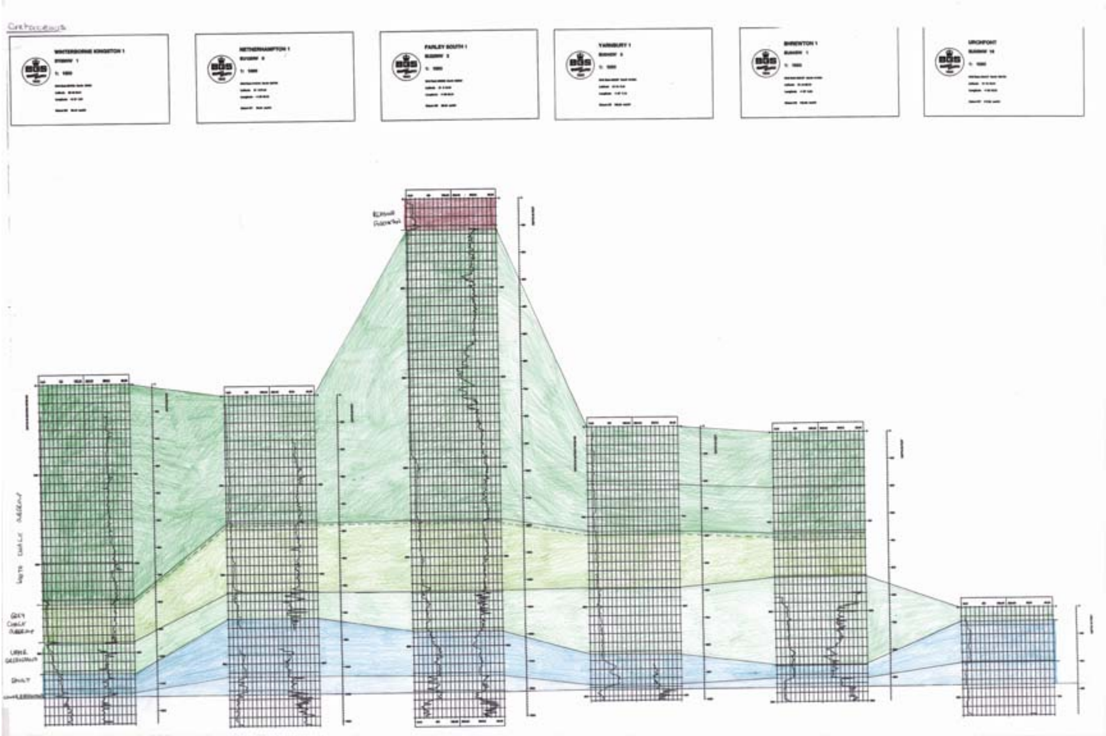


Figure 34. A correlation of the Cretaceous strata proven in deep wells within and adjacent to the district.

5.1 Wealden Group

Beds attributed to the Wealden Group have an arcuate outcrop in the Nadder valley. From near Teffont Lodge [ST 9985 3130] on the northern flank (where the outcrop is limited by the overstepping Lower Greensand Group) the outcrop expands to about 800 metres in width south of Dinton [SU 0150 3150]. The outcrop is limited to the east where the Lower Greensand Group overlies the Wealden Group as the Vale of Wardour anticlinal structure plunges beneath the valley floor. In the subcrop to the east it is believed that the presence of the Wealden Group is also limited by erosion prior to the deposition of the Lower Greensand (Chadwick and Kirby, 1982) (Figures 16 and 17 herein). For much of this broad valley floor the beds are hidden beneath terrace and alluvial deposits. On the southern flank of the valley the group is again seen as a narrow outcrop extending from east of Catherine Ford Cottages [SU 0085 3055] until it is lost beneath the overstepping Lower Greensand at Panter's Bridge [ST9880 2958] to the west. Estimates from the outcrop would suggest that at most there is 10 m of the Wealden Group present in the district.

Their age is not known within the district but in the Farley South Borehole (SU22NW2) a thin succession (17.68 m) questionably identified as Lower Greensand/ Wealden is given a pre-Albian to post-Lower Valanginian age. Beneath these beds a pale grey to pale brown, fissile, calcareous shale (6.71 m) is included within the Upper Purbeck and has Purbeck ostracods identified at its base. The higher part being given a Lower Valanginian age, which suggests that part, at least is related to the Wealden Group. This tenuous evidence could suggest that there is little depositional overstep of the higher beds within the Wealden Group as it progresses west from the Weald and that the significant break is erosional at the top of the succession beneath the Lower Greensand Group

Other than the limited exposure of the basal beds described by Woodward (1895) in the Dinton railway cutting the Wealden Group is not described in detail in this district (see above). Jukes-Browne and Andrews (1891) described the deposits of the 'Lower Cretaceous Series' and confirmed the existence of both 'Wealden Beds' and 'Vectian Beds' (Lower Greensand) as stated by Fitton (1836). The original one-inch scale survey by Bristow in 1853 did not recognise a separate Lower Greensand and mapped the whole as Wealden Beds. The six-inch scale resurvey in the late 19th century did however recognise sand between the Gault Clay and the clays attributed to the Wealden.

Andrews and Jukes-Browne (1894) give details of a well (SU03SW04 [SU 0101 3109]) sunk at cottages north of Dinton Station as entirely within Upper Purbeck Beds but Woodward (1895) regarded the upper beds above the “stiff grey clay” as Wealden and presumably equivalent to his beds 31 to 33 in the Dinton cutting section (see above). The details of this borehole were repeated in Reid (1903).

Formation/Member	Lithology	Thickness (m)
Wealden	Yellow clay	0.91 or 1.22
	Light-grey silty marl	3.35 or 3.66
	Stiff grey clay	1.52 or 1.83
Upper Purbeck Beds (Durlston Formation)	Very stiff, grey and brown clays with *Paludina carinifera* [*Viviparus cariniferus*], *Unio*, *Cypridea punctata*	6.10
	Hard gritty stone at the bottom; this being punched through, water rose at once	touched

[comment: As Anderson (1971) pointed out, most of the species identified as *Cypridea punctata* (Forbes) during the first half of the 20th century should probably be placed in *C. propunctata* Sylvester-Bradley (Sylvester-Bradley, 1949), the two species being almost indistinguishable. The latter species first appears towards the top of the Middle Purbeck, but is particularly common in the Upper Purbeck (Anderson 1985) and hence is early Valanginian in age].

Details

ST93SE

The Wealden clay outcrops south of the River Nadder, on the spur just north of Daslett Farm [ST 9910 3000]. There are no exposures, but augering proves an outcrop of stiff grey clay that can be traced over the hillside. A small patch of Wealden clay exists north of the river in Teffont Evias Park Lodge [ST 9990 3125]; only a limited expanse is preserved here before the outcrop is overstepped, to the west, by the Lower Greensand Group.

ST92NE

The Wealden Clay has a limited outcrop in this area, and is mostly concealed beneath the floodplain of the River Nadder. Auger holes prove up to a metre of stiff grey clay.

Reid (1903) reports an exposure in a deep cutting at Panthurst which, from historic maps (1890), is located adjacent to Panter’s Bridge at [ST 9880 2958] where a deep cutting (presumably the significant drain marked passing under the road) showed 3.05 of blue-black sand with the road above showing blue clay and sand. This succession is close to the upper boundary of the Wealden Group as mapped in 2003.

SU03SW

There are no exposures of Wealden Clay in this area, but the outcrop has been proved by augering. The Wealden was formerly exposed in a railway cutting at Dinton (see above), and in a well 300 m northeast of the station (Reid, 1903). The valley of the Nadder widens considerably on reaching the outcrop of the Wealden Group.

In a well at Dinton (possibly at Wrights Farm, see Lower Greensand Group description below), Jukes-Browne and Andrews (1891) identified a succession that included at its base deposits described as “Vectian” (i.e. Lower Greensand Group), which also included a basal unit of stiff black clay. They went on to describe a “brook section at Teffont” in which they identified a similar unit of black clay. This Teffont section is not certainly located and could be either the brook that runs from Teffont Lodge [ST 9984 3127 to 9998 3114] and on south-eastward to the railway cutting (the “watercourse” shown on sections along the cutting e.g. in Woodward, 1895) or a tributary of that brook west of Park Farm

[SU 0014 3134]. Beneath the 1.83 m of black clay the stream section exposed black glauconitic sand, overlying mottled clays with yellow loamy sands below that. These were considered to be of Wealden age.

5.2 Lower Greensand Group

The Lower Greensand of the Vale of Wardour consists usually of 4.5 to 6.1 m of glauconitic very fine- to medium-grained sand with rare masses of cherty sandstone or chert and small polished pebbles. At depth towards the north and east of the district up to 20 m has been proven in deep wells. In the Netherhampton borehole it is described as sandstone, very fine- to medium-grained, moderately to well-sorted, angular to subangular, light grey to green and with calcite, pyrite and lignitic fragments. The Lower Greensand Group is identified in the other three hydrocarbon wells but less well described.

The age of the group in this area is open to debate but they are considered to be equivalent to the Folkestone Formation of the Weald and by implication therefore of youngest Upper Aptian to lowest Albian in age. Jukes-Browne and Hill (1900) suggest that the sands at Dinton are of *mammillatum* Zone age.

Details

ST93SW

The outcrop in this area is narrow and forms northward-dipping slopes around Fonthill House. There are no exposures but orange-brown or glauconitic pale green coarse-grained silt to medium-grained sand can be augered.

ST92NW

Reid (1903) reported that at Totterdale Cottage (now Farm [ST 9495 2815]) a thin seam of quartz and lydite pebbles occurs at the base of the Lower Greensand (this was refuted by Bristow, 1995, who believed the pebbles to be a surface wash derived from the basal Gault Clay pebble bed), and that the strata above are ferruginous or glauconitic coarse sands and cherty sandstones apparently with some intercalated seams of loam. Above these comes another thin pebble-bed in brown loam, forming the base of the Gault. About 400 metres southeast of Totterdale Farm [ST 9495 2815], a small section of the upper beds can be seen where brown sandy loam with numerous scattered pebbles (the base of the Gault) overlies ten feet of glauconitic sand. Reid (1903) found *Pecten quinquecostatus* [*Neithea quinquecostata*] and *P. orbicularis* [*Entolium orbiculare*] in the Lower Greensand of this area but this does not confirm the presumed Aptian age of the rocks.

The total thickness of the Lower Greensand around Totterdale appears to be nearly 9.14 m.

ST93SE

A track section at Red Hill [ST 9801 3158] showed up to 5 m of coarse, reddish glauconitic pebbly sand dipping quite steeply (c. 10°) to the north. Adjacent field brash has many small rounded quartz pebbles. However, much of the outcrop is along the base of valley where it is concealed by head deposits. The contact between the Lower Greensand and the underlying Purbeck strata is marked by a series of small stream sinks and sinkholes in the Park east of Teffont Evias, just north of the B3089.

Further west of the Chilmark ravine the Lower Greensand continues to be obscured by head in the tributary valley trending west-east beneath the Upper Greensand scarp. Indeed this valley follows an east to west northward throwing fault that probably cuts-out the Lower Greensand entirely in the vicinity of Underhill Copse [ST 967 318]. Further west towards Ridge slopes beneath a minor feature marking the base of the Gault, are in pasture and wet clayey sand can be augered. West of Ridge a low spur south of the road to Fonthill House shows very sandy pale brown soils with few pebbles.

ST92NE

The Lower Greensand can be traced as a narrow outcrop across this sheet from Manor Farm [ST 9960 2962] in the east to Totterdale Farm [ST 9470 2792] in the west. Stream sinks and suffusion dolines often mark the sharp erosional contact with the underlying Purbeck strata. There are few exposures, but augering proves it consists of coarse grained, greyish blue, glauconitic sand, which weathers to a greenish yellow colour. Surface brash often contains many small, well-rounded black and grey chert, and quartz pebbles ('lydite'), which were observed at several localities. Locally, the Lower Greensand is cemented forming harder sandstone. This is apparent just west of Sutton Mandeville Mill where glauconitic sandstone is exposed in a drainage ditch [ST 9800 2935]. A section in coarse sand formerly existed immediately east of Haredene Wood (Reid, 1903) but its exact location is difficult to determine [? ST 9702 2894]. The basement beds of the Lower Greensand resting on the Purbeck Group were seen (Reid, 1903) in the side of a sinkhole (probably at [ST 9635 2902]).

SU03SW

The Lower Greensand can be traced as a narrow outcrop that closes into the Nadder valley about 1 km east of Catherine Ford Bridge [SU 010 306]. There are few exposures, but surface outcrops can be seen around the edge of the lake in the parkland south of Philips House, Dinton [SU 0086 3145] and in the riverbank near Compton Wood [SU 0150 3140]. Fitton noted an exposure near the road south of Catherine Ford Bridge.

To the north of the River Nadder the Lower Greensand first rises above the marsh-level west of Dinton Mill [SU 0252 3111] as a coarse-grained glauconitic sand with concretionary masses of cherty sandstone, the whole deposit being apparently about 6.10 m thick. Material of this sort was formerly dug over a piece of rough ground half a mile west of the Mill; but the section is now overgrown (Reid, 1903).

At Dinton a well sunk in 1890 gave Jukes-Browne and Andrews (1891) the following section: -

Group/Formation/ Member	Lithology	Thickness (m)
Gault Clay Formation	Yellow, brown, and blue clay (with fossils)	6.55
	Sandy rock with a layer of small pebbles at the base (fossils)	4.42
Lower Greensand Group	Brown, grey, and yellow sands, with lumps and layers of ferruginous sandstone (*Exogyra sinuata* [*Exogyra latissima*])	8.08
	Light grey sandy clay, becoming darker and passing down into stiff black clay	2.13

They remark that "in this well the base of the group is evidently not reached, but most fortunately it is completed by a brook section at Teffont, which begins in a black clay exactly like that found at the bottom of the well. This black clay is about six feet thick (1.83 m), and passes down into a nearly black sand, which has a green streak when cut, and consists mainly of dark-green grains of glauconite."

This well is thought to be one of a number here and a later logged section at the site (SU03SW1 [SU 0095 3175], at Wrights Farm) at a later date, gave a similar but more detailed description.

Group/Formation/ Member	Lithology	Thickness (m)
Gault Clay Formation	Soil	0.46
	Yellow and grey clays	1.52
	Hard ferruginous stone	0.20
	Brown clay with layer of brown stone	4.57
	Dark grey clay with selenite, some fossils and a few small phosphatic nodules	1.52
Basement Beds*	Hard grey ferruginous sandy rock; fossils	1.73
	Reddish brown sandstone with scattered pebbles, fossils and fragments of wood.	0.76
	Layer of small pebbles	0.15
Lower Greensand Group	Brown and grey sands and stone-beds	8.13
	Grey and black clays	2.13

* These three beds were considered to be the basement beds of the Gault Clay but it is probable that the band of phosphatic nodules would now be considered as the lithological base of the Gault Formation in this district.

SU02NW

The Lower Greensand outcrops in the extreme northwest of this sheet. No exposures were seen, but coarse, occasionally pebbly glauconitic sand was proved by augering in a disused railway cutting at [SU 0004 2999].

5.3 Gault Formation

The Gault Formation has an outcrop in the Nadder valley between Fonthill and Baverstock on the northern flank and between Hurdcott House [SU 0443 3117] and Anstey on the southern flank. The wide outcrop of the formation is masked by a broad tract of alluvium and terrace deposits between Hurdcott House and Dinton Mill [SU 0252 3111] as the Wardour Anticline plunges eastward beneath the river level. The Gault Formation is believed to underlie the remainder of the district and is proven in all four of the deep hydrocarbon wells. The northern outcrop is narrow west of Teffont Evias as the steeper northerly dips on the northern flank of the Wardour Anticline are approached and it is here also intimately associated with elements of the Mere Fault Complex. On the southern flank the dips are low towards the south and the outcrop is broad.

At outcrop the thickness is estimated at between 30.48 and 32.92 m by Reid (1903) but there are no boreholes that penetrate the whole succession locally. The outcrop pattern to the west in the Ridge area would suggest that there may be as little as 25 m of deposit here although this is difficult to judge over this steeply dipping part of the Wardour Anticline where strike-parallel faulting is known to be present. At Ridge, Jukes-Browne and Hill (1900) calculated a thickness in excess of “90 feet” (27.43 m) based on the exposure there and the outcrop. In the deep wells to the north and east of the district the Gault Formation varies between 33.8 and 58 m thick.

Lithologically the Gault Formation comprises soft mudstone, light grey to dark grey, slightly calcareous with disseminated glauconite and mica grains. It is pyriteous throughout with some bright sand-sized pyrite crystals when unweathered and pyrite nodules with a radial crystal structure. It is shelly in part. Phosphatic nodules in layers are a feature of the basal part and frequently mark the base. The older literature places the so called ‘Basement Bed’ of ferruginous fine to medium-grained sand and fine pebbles interbedded with argillaceous sand within the Gault Formation although this may well be considered as part of the Lower Greensand locally. No modern core materials are available to settle this fact.

Together with the Upper Greensand these beds were formerly described as the ‘Selbornian’ and Reid (1903) gave the following general section for the Vale of Wardour.

Member/Formation /Group	Zone	Lithology	Thickness m
Upper Greensand	Zone of *Pecten asper**	Green sand or sandstone	3.05
		Sands with layers of cherts	7.62
		Glauconitic sandstone	4.57
	Zone of *Ammonites rostratus**	Greenish grey sands	12.19
		Fine buff-coloured sands	15.24
		Sandy malmstone	6.10
Gault	Zone of *Ammonites (Hoplites) interruptus**	Sandy micaceous clay	30.48
		Grey and brown clays	
		Ironstone and pebble bed	0.91 to 2.44

* These zonal terms are inappropriate for modern usage and are replaced by the *Stoliczkaia dispar*, *Mortonoceras inflatum* (together essentially the Upper Albian) and *Hoplites dentatus* (the lower part of the Lower Albian) zones in descending order. This of course implies considerable gaps in the succession and confirms the presence of argillaceous beds representing only the Lower Gault of the Weald area [comment: although *Ammonites interruptus* is equivalent to *H. dentatus*, the concept of the *A. interrruptus* Zone was probably much broader than the modern concept of the *H. dentatus* Zone.It cannot therefore be simply inferred from the modern name equivalents that there are large gaps in the succession. In fact, there is only one zone of the old nomenclature which is not listed by Reid (1903), which is the *Ammonites lautus* Zone of Jukes-Browne & Hill (1900). There may well be more hiatuses

than indicated by this simplified old nomenclature]. Reid (1903) went on to quote the text for the only exposure, at Ridge, in the district directly from Jukes-Browne and Hill (1900), see details for ST 93 SE. He also repeats the succession for the borehole (SU03SW1) at Wrights Farm, Dinton (see above).

Details

ST93SW

Only one small exposure in a stream bank near Totterdale Farm [ST 9475 2768] was identified during the survey for the Wincanton sheet. Here 0.5 m of glauconitic and ferruginous clay was seen. Elsewhere grey or more commonly unctuous yellow clay was augered across the outcrop.

ST92NW

An old pit [ST 9343 2673], outside the district at Ark Farm, exposed 0.9 m of blue clay with nodules, on 0.4 to 0.5 m of a nodular ferruginous layer, on 0.35 m of blue clay with small quartz pebbles towards the base. This rested upon Lower Greensand (Mottram, 1957).

ST93SE

The only excavation in the Gault along the north side of the Vale is that of a brickyard [ST 9526 3173] at Ridge, west of Chilmark. Here about 12.19 m of dark grey micaceous silty clay is seen containing nearly continuous or silty sandstone. Small ovoid dark-coloured septarian stones are scattered throughout the clay. This quarry was visited during the 2003 survey and was found to be a complex of small embayments and gullies on both sides of the road that are completely overgrown and only show limited sections in grey silty clay (Jukes-Browne and Hill, 1900).

ST92NE

The Gault Formation forms a broad outcrop in front of the Upper Greensand scarp. However, there are very few exposures and the area is mapped by the presence of heavy clay soils with rushy vegetation, a spring line and small negative feature at the base of the Upper Greensand. A small outcrop of Gault Clay was seen in a stream section at Swallowcliffe Mill [ST 9605 2749]. A small outcrop at the base of the Gault clay revealed 0.2 m of ferruginous hard pebbly clay, which probably represents the basal pebble bed described by Reid (1903).

The contact between the Gault Formation and the Cann Sand Member of the Upper Greensand Formation is exposed in a 6 m deep cutting [ST 9602 2816] behind a barn at Withyslade Farm. Here 2 to 3 m of grey, occasionally ferruginous, silty clay of the Gault is overlain by 3 to 4 m of buff fine-grained sand attributed to the Cann Sand Member.

SU03SW

The Gault Formation is poorly exposed in this area and is mainly covered in pasture, but can be proved by augering. The Gault clay was worked at the Dinton brickworks [SU 018 318], but these are now flooded and overgrown. A good section was formerly exposed in a well at Dinton (Reid, 1903) that demonstrated at least 9 m of brown, blue and grey mudstone with phosphatic nodules.

A borehole SU03SW8 [SU 0182 3143] at the brick and tile works in Dinton gave a succession of gravel 3.96 m, on dark clay and sand 13.72 m on coarse sand 0.15 m. The middle clay unit is considered to be the Gault. Other boreholes within this set for the brickworks indicate thin red gravel at the base of the formation.

SU02NW

There are no exposures within the small outcrops on this sheet.

5.4 Upper Greensand Formation

The Upper Greensand Formation forms a significant scarp around the core of the Wardour Anticline in the Nadder valley. To the north of the river from Ridge Hill [ST 952 321] to The Hanging [SU 040 316] east of Baverstock, the formation forms a narrow outcrop with a southward-facing 25 to 35 m high scarp. Northward away from the scarp crest the land slopes moderately steeply northward, indicating the significant northward dip of the strata, to the faulted scarp (the Mere Fault) founded in Chalk. In general these steeper northward-dipping slopes are founded on the highest Boyne Hollow Chert Member of the formation with the steep face of the scarp formed of the Shaftesbury Sandstone Member and the lower shallower slopes founded on the Cann Sand Member.

To the south a similar scarp, founded on the same members, trends from Hurdcott House [SU 0443 3117] to Anstey Coombe [ST 948 262]. This scarp, that becomes higher towards the southwest, is broken by re-entrants at Compton Chamberlayne [SU 030 295], Fovant [SU 005 290], Swallowcliffe [ST 965 269] and Ansty [ST 955 265] that accommodate northward flowing tributary streams of the River Nadder. Southward away from the scarp a broad shallow slope founded on the Boyne Hollow Chert Member reflects the change in regional dip to a few degrees to the south.

In the extreme southwest of the district the Upper Greensand Formation is again seen in the anticlinal core associated with the Ferne Park Fault and the headwaters of the River Ebble.

The Upper Greensand Formation is known from boreholes in the River Wylye and Chitterne Brook valleys in the northwest of the district but there is no outcrop. The formation is considered to underlie the whole district beneath the Chalk and is proven in the four deep hydrocarbon wells.

In these deep wells the formation is undivided but the downhole geophysical log returns would suggest that there is some variation in the lithologies with a general reduction in the gamma signal upwards (generally indicating a less argillaceous lithology) and some marked peaks on the SP logs (perhaps indicating indurated sandstones or chert beds). The Yarnbury borehole, Table 9, gives the most comprehensive description with a three-fold division.

Member	Description
Upper Greensand Formation (Boyne Hollow Chert and Shaftesbury Sandstone members)	Sandstone, clear, fine- to medium-grained, moderately sorted, subrounded to moderate sphericity, unconsolidated, good porosity with pyrite and glauconitic
	Sandstone, light grey, very fine- to medium-grained, poor to moderate sorting, subrounded to subangular, friable, argillaceous cement with glauconite
Upper Greensand Formation (Cann Sand Member?)	Sandstone, medium to dark grey, very fine-grained subangular, grading to siltstone. Glauconitic, pyriteous and micaceous

Table 9: Threefold divisions of the Upper Greensand in the Yarnbury Borehole

As noted above the Upper Greensand and Gault were described as the 'Selbornian' in texts around the turn of the 19th/20th century and the thickness of the Upper Greensand part was considered to be around 50 m. The term Selborne Group may well be considered an apt amalgamation to cover both formations. Modern mapping suggests that in this district up to 75 m of beds are present in the Vale of Wardour and at depth towards the north. Westward at outcrop in the Vale of Wardour the thickness reduces to about 65m on the Wincanton Sheet. Towards the east and northwest in this district, at depth, the formation is known to be around 35 to 45 m in thickness. This is reflected in the thicknesses proven in deep wells where the Netherhampton and Farley South only show thicknesses of 37 and 44 m respectively whilst in the north Shrewton and Yarnbury show 68 and 74 m respectively. In the northwest the formation is recorded in ST94SE51 [ST 9740 4130] at an unbottomed 42 m whilst at the level crossing north of Boyton the deepest of four boreholes ST94SE74 [ST 954 401] gives a full thickness of 40 m beneath the Chalk, with Gault Clay identified at the base.

Traditionally the Upper Greensand in Wiltshire was divided into five subdivisions based on gross lithology (Jukes-Browne and Hill, 1900). They gave a general description of the Upper Greensand of the Vale of Wardour divided into two units that they associated with the characteristic fossils of *Ammonites rostratus* below and zone of *Pecten asper* and *Cardiaster fossarius* above.

Unit	Lithology	Thickness m
Zone of *Pecten asper* and *Cardiaster fossarius*. (13.72 m on average)	Green sand or sandstone	1.83 to 3.05
	Chert Beds	6.10 to 9.14
	Glauconitic sandstone	2.74 to 4.88
Zone of *Ammonites rostratus* (between 32.00 to 36.58 m)	Soft greenish-grey sand with hard irregular calciferous concretions (no chert)	2.74
	Fine greenish-grey sand, often laminated and current bedded	About 9.14
	Buff coloured sands, becoming micaceous below and passing into soft micaceous sandstone	15.24
	Impure sandy malmstone	4.57 to 9.14

During the surveys for the Shaftesbury Sheet 313 and Wincanton Sheet 297 a new scheme was adopted based similarly on gross lithology. Table 11 below gives a correlation of the old and new schemes as determined by Bristow (1995) for the Tisbury area. He gave a slightly different interpretation of Jukes-Browne and Hill (1900).

<table>
<tr><th>Bristow et al. 1989, 1995</th><th>Thickness m</th><th colspan="2">Jukes-Browne and Hill, 1900</th><th>Thickness m</th></tr>
<tr><td>Melbury Sandstone Member</td><td>c.2 to 3</td><td rowspan="3">Warminster Beds Zone of Pecten asper and Cardiaster fossarius)</td><td>Greensand, fossiliferous with nodules and layers of calcareous stone</td><td>c. 1.2 to 3</td></tr>
<tr><td>Boyne Hollow Chert Member</td><td>10 to 15</td><td>Chert beds, sandstone and sand</td><td>7.5</td></tr>
<tr><td rowspan="2">Shaftesbury Sandstone Member</td><td rowspan="2">15 to 30</td><td>Green sands with layers of glauconitic limestone or greensand-rock</td><td>2.1 to 3.6</td></tr>
<tr><td rowspan="2">Devizes Beds (Zone of Ammonites rostratus)</td><td>Green, grey and buff sands more or less micaceous, with Exogyra conica and passing down into soft micaceous sand-stone with large ‘burrstones’ sands</td><td>21 to 30</td></tr>
<tr><td>Cann Sand Member</td><td>10 to 15</td><td>Pale grey malmstone</td><td>6</td></tr>
</table>

Table 10: correlation of the old and new schemes as determined by Bristow (1995) for the Tisbury area.

The Melbury Sandstone Member is now considered to be equivalent to the Glauconitic Marl Member and therefore forms the basal member of the West Melbury Marly Chalk Formation in the Chalk Group. That member is described in the relevant section below in Chapter 6.

5.4.1 Cann Sand Member

This member is dominantly glauconitic, poorly sorted, very sandy silt to very fine-grained micaceous sand and for the most part unconsolidated. It equates to the ‘malmstone’ of Jukes-Browne and Hill (1900) within which they identified some consolidated beds of sandstone. The type area of the member is the around the village of Cann [ST 872 213] on the Shaftesbury sheet to the southwest of the district. The beds at the junction of the Gault and the Cann Sand at Fovant [SU 002 290] yielded a fauna from the *inflatum* Zone, *varicosum* Subzone (Bristow and Owen, 1991; Mottram, 1957). Bristow et al. (1999) suggest that the fauna of the basal Shaftesbury Sandstone Member above indicates that the top of the Cann Sand Member is also in the *varicosum* Subzone.

At outcrop in the Vale of Wardour the Cann Sand forms the narrow bench and shallow slopes at the base of the Upper Greensand scarp. Its base is frequently marked by springs and seepages on top of the underlying Gault. Such springs can be seen in the fields [ST 9555 3190] below Chapel Copse near Ridge and along much of the scarp south of the River Nadder. Because of these seepages the member is frequently involved in small-scale slides and disturbed ground.

5.4.2 Shaftesbury Sandstone Member

The Shaftesbury Sandstone Member consists of alternating beds of coarse siltstone and fine-grained sandstone and unconsolidated sands. All are poorly to moderately sorted, weakly calcite-cemented and contain appreciable amounts of glauconite. The top of the succession is marked by the Ragstone (Beds or Freestone Beds of some authors) and comprises between one and two metres of hard grey to green, medium- to coarse-grained calcareous, glauconitic sandstone packed with shells. Most notable amongst which are *Pycnodonte* (*Phygraea*?) *vesiculosum*, *Merklinia* cf. *aspera* and *Neithia gibbosa*. The member falls within the top of the *varicosum* Subzone with the Ragstone probably being in the *auritus* Subzone.

This member forms the steep Upper Greensand scarp-face with the Ragstone frequently being seen in sections and brash immediately below the crest at the maximum break of slope.

5.4.3 Boyne Hollow Chert Member

This member consists of green, highly glauconitic, quartz sand and sandstone with cherty and siliceous concretions and in places significant chert beds. A basal bed recognised to the east on the Wincanton Sheet is about 1 m thick and includes phosphatic nodules and fossil debris. In the Salisbury district the chert beds are well developed in the lower part of the member and are conspicuous in the field brash around Ridge Hill [ST 9530 3205] and north of Underhill Copse [ST 966 320] and are frequently seen elsewhere as accumulations of field-picked stones in hedge bottoms. The beds include a fauna suggesting a *dispar* Zone age for the member.

The member forms the crest of the scarp and the dipslopes behind. On the northern flank of the Vale of Wardour these dipslopes are steep up to 15° to 20° northward whilst on the southern flank they are only 2° to 5° southeastward.

Details

ST93SW

Bristow (1995) noted silicified sandstone within glauconitic, clayey fine-grained sand near Fonthill House. Cherty brash is common along the ridge between [ST 936 322 to 950 320]. Both occurrences are attributed to the Boyne Hollow Chert Member.

ST92NW

There are no significant exposures within the district on this sheet and the beds are recognised from their geomorphology and surface brash. Just west of the sheet boundary there are poor exposures of dominantly silty beds within the Shaftesbury Sandstone Member in the track [ST 9410 2630] climbing the scarp face near Old Wardour Castle. There is considerable chert and silicified sandstone brash attributed to the Boyne Hollow Chert Member in the fields around Horwood Farm [ST 943 257].

ST92SW

There are no significant exposures within the Salisbury district part of this sheet. However a little to the southwest on the Shaftesbury sheet area the following was noted by Bristow (1990) within the Boyne Hollow Chert Member outcrop. In the northeasterly draining valley that flows through Berwick St John, grey and black chert fragments are particularly common in the fields on the north side of the valley. There is a poor exposure [ST 9436 2181] of black chert in Blind Lane. Northeastwards from Blind Lane, large grey cherts up to 0.3 m thick are common on the northern edge of the valley side around [ST 9450 2195 and 9457 2212]. In the banks [ST 9461 2228] of Luke Street, Berwick St John, black splintery chert is exposed at one point.

ST93SE

Along the north side of the Vale the sandstone was well exposed in the lane by Knap Farm near Ridge [ST 9530 3192]. Only poor exposures of the Cann Sand and Shaftesbury Sandstone members were visible during the survey of 2003.

To the north of Ridge the lane that cuts diagonally down the scarp from [ST 9555 3205 to ST 9575 3198] shows numerous exposures of the Shaftesbury Sandstone Member. At the top of the hill the cutting on the north side of this lane shows cross-bedded and planar-bedded fine- to medium-grained glauconitic sandstone in steep clean faces of between 1 and 3 m in height. In tree roots some distance above these beds dark brown to brownish green friable extremely shelly coarse-grained sandstone (the Ragstone) can be extracted. To the north of this lane and accessed from it, is a small pit [ST 9573 3203] cut deeply back into the scarp. It must formerly have exposed most of the Shaftesbury Sandstone Member but is now degraded and only shows a vertical 3 to 5 m high face of massive, cross-bedded units of fine-to medium-grained weakly glauconitic sandstone. A deep gully excavated by water from a field drain at the rear of this exposure shows that these sandstones continue upward for another few metres until at which point an extremely fossiliferous buff friable sandstone (Ragstone) is seen amongst tree roots.

Plate 13. Ridge Hill: Quarry between road to Ridge Farm and Underhill Copse. Boyne Hollow Chert Member overlying Shaftesbury Sandstone Member. [SU 9559 3204]. Photo P 598793

Both Reid (1903) and Jukes-Browne and Hill (1900) identify a “sand-pit in Upper Holt, north-west of Teffont”. There are numerous small excavations in the vicinity of the woodland called Upper Holt [ST 984 317] and it is presumed that one of these is the locality mentioned. All were degraded during the 2003 survey.

As mentioned above in the general section there are a great many black, grey and dark brown chert fragments in the northward-sloping fields to the north of the Upper Greensand scarp. Their occurrence suggests that the lower part of the Boyne Hollow Chert Member contains significant numbers of chert beds some of which are up to 30 cm thick. Their presence makes the ploughing of these fields very difficult and much of the steeply dipping northern outcrop is in pasture.

ST92NE

The Cann Sand forms the slack beneath the main scarp. There are very few exposures, except at the base of the unit. A small 2 m section of fine-grained glauconitic sand is exposed in a cliff behind a spring at Swallowcliffe [9842 2895]. The basal Cann Sand overlying the Gault Formation is exposed in a cutting for a barn at Withyslade Farm (see Gault Formation details).

Jukes-Browne and Hill (1900) state that there is “a good section of the malmstone in a deep fosse-way by Sutton Mandeville church [ST 9860 2886]. The beds dip at about 12° to the south and the top is not seen, but there seems to be a thickness of about 9.14 m mostly in light grey stone.” Two exposures seen during the 2003 survey identified 4 m of soft glauconitic silty fine sandstone with a clayey base at [ST 9862 2893] and at a higher level in the lane 4 m of silty sandstone [ST 9861 2888]. Both are within the Cann Sand Member. Another small roadside exposure [ST 9868 2882] nearby and south of Larkham’s Farm shows up to 5 m of buff fine-grained silty glauconitic sandstone in the same member

The Shaftesbury Sandstone forms the main scarp face. Many small sections can be seen in the lanes and footpaths that traverse the scarp. A particularly fossiliferous bed of hard cemented cherty glauconitic sandstone, 2-3 m thick with abundant *Pycnodonte vesiculosum* occurs at the top of the Shaftesbury Sandstone Member and forms the top of the main Upper Greensand Scarp. This bed (the Shaftesbury ‘Ragstone’) is exposed in many places along the scarp, and was noted at Sutton Mandeville [ST 9875 2863], Chicksgrove [ST 9770 2860], [ST 9724 2845], Dean Lane [ST 9957, 2827], Ansty [ST 9577 2644] and Swallowcliffe [ST 9670 2706].

Reid (1903) mentions “another excellent section of these strata will be found in the sand-pit opposite the church [ST 9566 2630] at Ansty, which shows 35 feet (10.67 m) of fine glauconitic sandy loam, with a few masses of concretionary sandstone, *Exogyra conica* [this could be a variety of oyster, but probably including *Amphidonte obliquatum*] in the upper part and *Pecten* (*Neithia*) *quinquecostatus* [*Neithea quinquecostata*] and a large *Serpula* in the lower.” This would suggest that the pit was within the Shaftesbury Sandstone Member but its exact location is not known. A track cutting climbing the scarp at [ST 3538 2645] shows numerous small exposures of weakly cemented sandstone within the member.

The Boyne Hollow Chert is well exposed as field brash on the scarp dip slope, but is nowhere exposed in any pits or quarries, although up to 2 m of poorly exposed glauconitic cherty sandstone was observed in a sunken lane at Ansty [9548 2630] and at [9750 2760].

SU03SW

The Upper Greensand forms a major scarp feature in this area, both north and south of the River Nadder around the closure of the plunging Vale of Wardour Anticline. A former exposure through the higher part of the Upper Greensand in the railway cutting east of Baverstock [SU 0408 3161 to SU 0426 3164] is described in the memoir (Reid, 1903; Jukes-Browne and Hill, 1900) (Figure 35). Up to 17 m of strata was exposed in this cutting including about 6 to 8 m of Boyne Hollow Chert and about 9 to 11 m of Shaftesbury Sandstone. It still constitutes the most significant exposure in the Salisbury district. Reid’s description given below recognises a bed of abundant *Ostrea vesiculosa* (now *Pycnodonte vesiculosum*) in the middle of his bed 2 and this can be fairly readily equated with the Ragstone marking the top of the Shaftesbury Sandstone Member. The beds are seen with a dip of about 10° to the northeast.

<table>
<tr><th>Member</th><th>Lithology</th><th>Thickness m</th></tr>
<tr><td></td><td>Soil</td><td></td></tr>
<tr><td rowspan="4">Boyne Hollow Chert Member</td><td>Fine grey sand with layers of black chert and white porous stone</td><td>1.83</td></tr>
<tr><td>Fine grey sand, with irregular layers of porous stone, and doggers of hard calcareous stone</td><td>2.44</td></tr>
<tr><td>Light greenish grey marly sand, with a layer of grey calcareous stone at the base</td><td>0.46</td></tr>
<tr><td rowspan="2">Firm greenish sandstone, with vertical joints. Ostrea vesiculosa (now Pycnodonte vesiculosum) abundant about the middle</td><td>3.96</td></tr>
<tr><td rowspan="2">Shaftesbury Sandstone Member</td><td></td></tr>
<tr><td>Soft grey sands with lenticular layers of hard siliceous stone in the upper part</td><td>7.62</td></tr>
</table>

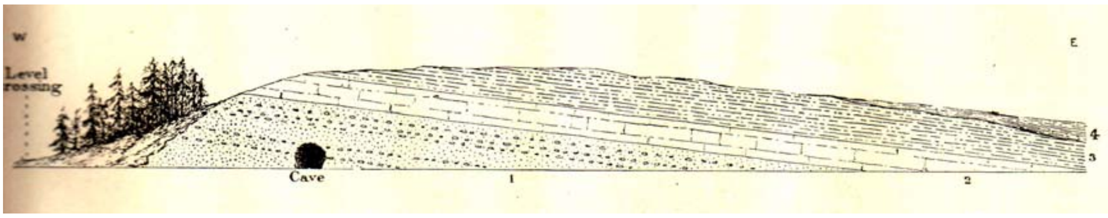


Figure 35: Section of railway cutting at Baverstock, Wiltshire (length of cutting c. ¼ of a mile). [SU 0408 3161 to SU 0426 3164]

The Cann Sand Member forms the slack beneath the main scarp. There are very few exposures, except for occasion small weathered scrapes in sunken lands and tracks most notably at Steep hollow [SU 0093 3206], north of Dinton [ST 01313190] and [ST 0204 3191].

The Shaftesbury Sandstone forms the main scarp face. Many small sections can be seen in the lanes and footpaths that traverse the scarp, especially north of Dinton [SU 0091 3117] and in former large sand-pits by the road (the Hangings) [SU 0187 3188 to 0175 3193] north-west of Dinton Manor Farm
A particularly fossiliferous bed of hard, cemented, cherty, glauconitic sandstone, 0.5 -2 m thick, with abundant *Pycnodonte vesiculosum,* occurs at the top of the Shaftesbury Sandstone Member and forms the top of the main Upper Greensand Scarp. This bed (the Shaftesbury 'Ragstone') is exposed in many places along the scarp, and was noted in several outcrops in a quarry and small track cutting near the upper entrance to Phillips House [SU 0063 3216], Steep Hollow [SU 0080 3222] where it is exposed in the roadside immediately south of the cross roads, and in the Doctors Hollow 200 m to the east, in several exposures in and around the quarry in The Hanging [SU 0179 3192]. This quarry has an excellent exposure of up to 6 m of Shaftesbury Sandstone. Most of the section comprises 5m of massive glauconitic med-coarse grained sandstone with occasional calcareous bedding parallel, laterally impersistent, sandstone concretions up to c. 0.5 m thick. Above is 0.5 m of very shelly glauconitic sandstone with abundant *Pycnodonte vesiculosum,* (the Ragstone) which grades into approximately 2 hard glauconitic sandstones with Chert nodules (the Boyne Hollow Chert Member). The Ragstone was also observed in the base a small quarry 8 m deep near Baverstock Manor [SU 0272 3228]. No exposures were noted on the south side of the river, which is mainly in woodland, but 1.5 – 2 m of hard glauconitic sandstone was exposed in the drive to Hurdcott Home Farm [SU 0428 3082].

The Boyne Hollow Chert outcrops extensively on the scarp dip slope, both north and especially south of the River Nadder near Hurdcott Home Farm [SU 0420 3030] but is nowhere exposed in any pits or quarries. The brash is consistently of a brown sandy silty soil with many fragments of silicified, fine- to medium-grained sandstone and chert

SU02NW

Field brash consists of a green sandy soil with occasional glauconitic sandstone. There are no good sections through the Cann Sand but brash is often a very fine dark grey sandy soil. A section comprising the Shaftesbury Sandstone Member can be seen at [SU 0057 2973] where a bluff of friable weathered sandstone containing a 30 cm band of glauconitic, highly patchily cemented, fossiliferous sandstone crops out. The principal fauna is of abundant *Pycnodonte vesiculosum* indicating the Ragstone. The Boyne Hollow Chert Member is typically seen as a fine sandy soil with occasional to abundant siliceous sub-rounded pebbles and small fragments of sandstone.

Jukes-Browne and Hill (1900) gave a section which they regarded as "the best section on the south side of the Vale is that of the old quarry [SU 0074 2867] at Fovant near the Pembroke Arms." The log is given below. Mapping in 2003 indicated that the pit has been infilled.

Member	Lithology	Thickness m
	Soil and rubble	0.91
Boyne Hollow Chert Member	Fine grey silty sand, with layers of chert and white porous siliceous stone	2.44
	Soft grey sand, with two layers of greenish calcareous stone	1.22
	Soft grey sand, with nodular lumps of calcareous grit, passing down into tough greenish sandstone with regular lumps of hard grit	1.83

Shaftesbury Sandstone Member	Firm greenish sandstone, standing with a vertical face and weathering yellowish brown	3.05

SU02SW

Only a limited outcrop south of the Ferne Park Fault is present within the district. There are no exposures

SU02NE

The Upper Hurdcott Farm active sandstone pit [SU 0504 2990] provides quite extensive exposure of the upper part of the Upper Greensand (Figure 36). The section is capped by 2 m of mobilized sand, which overlies 4 m of the Boyne Hollow Chert Member and is underlain by 5 m of the Shaftsbury Sandstone, which is not bottomed.

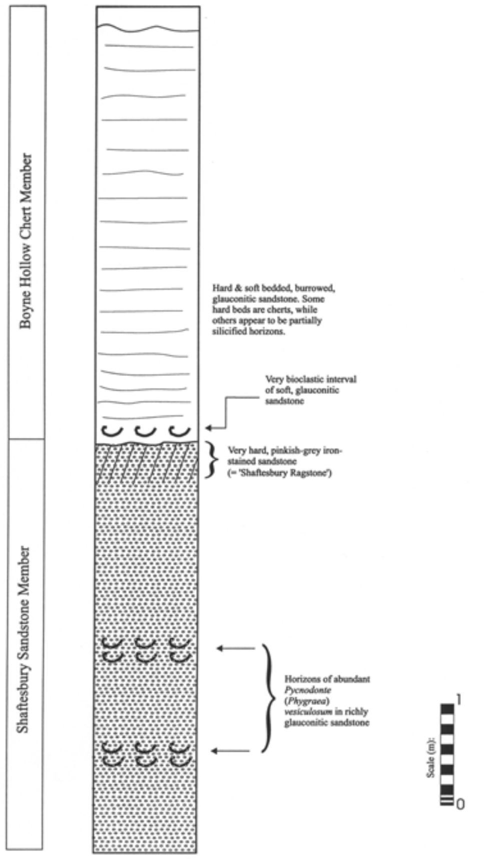


FIGURE 9. The Upper Greensand Formation at SU 0504 2990 ((**36**) of report)

Figure 36: The Upper Greensand Formation section at Hurdcott Farm [SU 0504 2990]

Plate 14. Hurdcott Farm, abundant Pycnodonte (Phygraea) vesiculosum in Shaftesbury Sandstone Member (Upper Greensand Formation) [SU 05040 29900]. Photo P584747

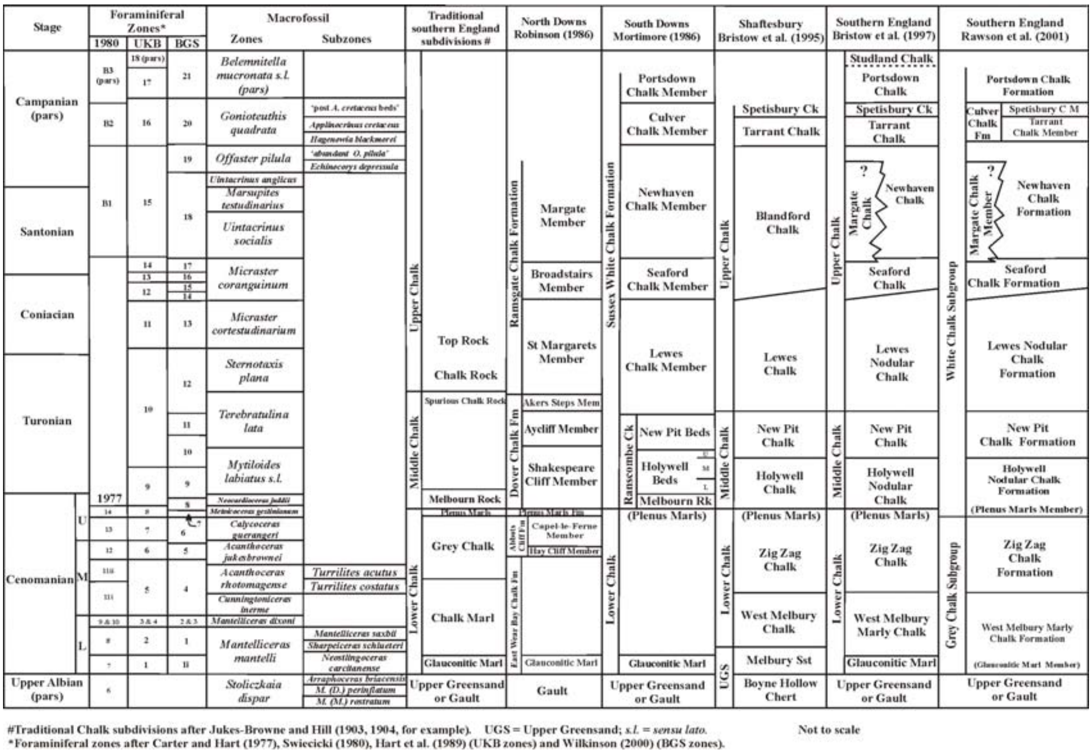
The Boyne Hollow Chert weathers to a yellow brown generally weakly consolidated fine to medium-grained glauconitic sandstone with some hard beds and numerous bands of well-developed chert, which forms the brash in the sandy soils of the surrounding arable fields. The Shaftsbury Sandstone weathers to a pale green moderately consolidated massive fine- to medium-grained glauconitic sandstone. The subrounded to rounded sand grains consist of a minority of dark glauconite grains with a majority of quartz grains. There are beds of bivalves, and current bedding is evident and secondary iron staining is present

Plate 15. Hurdcott Farm, view of contact of Shaftesbury Sandstone and Boyne Hollow Chert members (Upper Greensand Formation). [SU05040 29900]. Photo P 584757

6 UPPER CRETACEOUS

Rocks of Upper Cretaceous age, overwhelmingly in Chalk facies, underlie the majority of the Salisbury (298) Sheet. The nomenclature for the Upper Cretaceous utilised in this district is shown in Table 11, where its relationship to the traditional scheme is also given. The current nomenclature is a development of the schemes devised by Mortimore (1983, 1986) and by Bristow et al. (1995, 1997) and adopted by the Geological Society Stratigraphy Committee in 1999 (Rawson et al., 2001).

Table 11: Chalk Group correlation chart for the Southern Chalk Province.



Traditionally in this area the Chalk has been discussed in terms of its biostratigraphical zonation related to two conspicuous hard bands in the succession that divide the Chalk into three unequal parts. The zones and their estimated thicknesses are given in Reid (1903) and in Table 12 below.

The thickness estimate of Reid (1903) for the Chalk is about 330 m but a little over 400 m was proven in the Farley South borehole just to the east of the district. The presence of the Portsdown Chalk Formation in the southeast of the district would suggest that the thickness encountered in the Farley South borehole also pertains in this area and that Reid's zonal thicknesses are throughout underestimates. An outline correlation of the Chalk Group identified in the deep wells within and adjacent to the district is given in Figure 34.

A correlation chart for the inceptions and extinctions of microfossils (foraminifera), a zonal scheme based on those fossils and its relationship to the lithostratigraphical scheme and known markers is given in Table 13.

Table 12: The traditional zonal scheme applied to the Chalk Group of the Salisbury district and its approximate relationship to the new lithostratigraphical scheme. Note: The Newhaven Chalk is partially equivalent to the old zone of *A. quadratus*.

Approximate in new scheme	Traditional division	Zone	Thickness
Portsdown and Culver Chalk formations	Upper Chalk (with Chalk Rock at its base).	*Belemnitella mucronata*	24.38
		Actinocamax quadratus	51.82
Newhaven Chalk Formation		*Marsupites testudinarius*	70.10
Seaford Chalk Formation		*Micraster coranguinum*	73.15
Lewes Nodular Chalk Formation		*Micraster cortestudinarium*	
		Holaster planus	21.34
Lewes Nodular Chalk and New Pit Chalk formations	Middle Chalk (with Melbourn Rock at its base)	*Terebratulina*	24.38 to 30.48
Holywell Nodular Chalk Formation*		*Rhynchonella cuvieri* (=zone of *Inoceramus labiatus*)	
Zig Zag Chalk Formation	Lower Chalk (with Chloritic Marl at its base)	*Holaster subglobosus*	27.43
West Melbury Marly Chalk Formation		*Ammonites varians (Schloenbachia varians)*	30.48

*Basal member of this formation, the Plenus Marls Member, is traditionally included in the *Holaster subglobosus* Zone. For the most part these zones and their exact interpretation with respect to the lithostratigraphy of the Chalk Group have been modified since the publication of the Salisbury Memoir. Readers should defer to Table 11 for the most modern interpretation.

6.1 Grey Chalk Subgroup

This is essentially equivalent to the Lower Chalk Formation of Bristow et al., (1997), but the youngest unit, the Plenus Marls Member is now included with the overlying Holywell Nodular Chalk Formation. The Grey Chalk is divided into two formations, the West Melbury Marly Chalk and the Zig Zag Chalk.

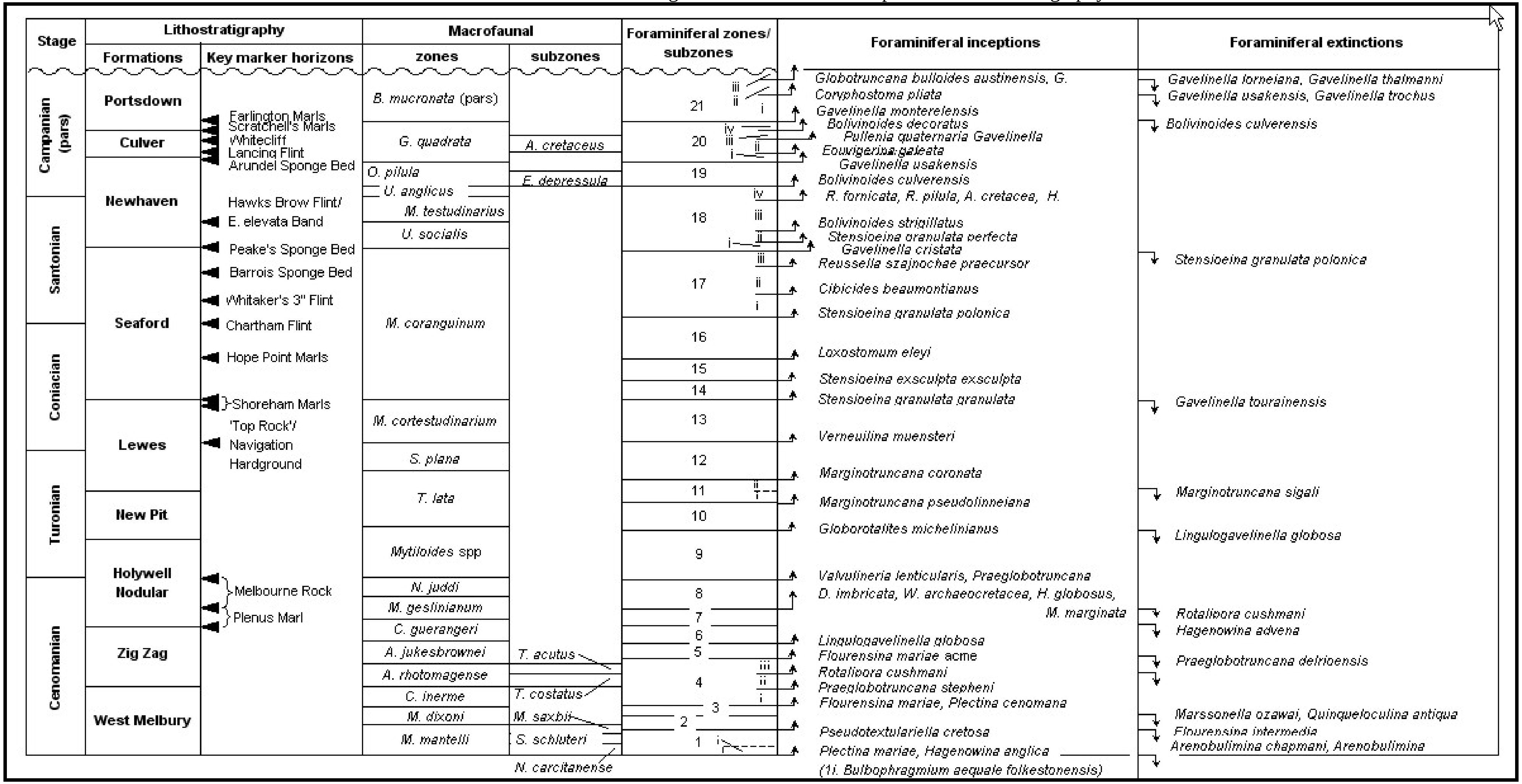
6.1.1 West Melbury Marly Chalk Formation

In this district the West Melbury Marly Chalk is between 25 – 40 m in thickness and crops out, in the south in the Vale of Wardour, as three inliers within the River Ebble valley; and in the northwest of the district within the Wylye valley. In general the formation forms the shallow sloping ramp at the base of the Chalk scarp between two strongly developed negative breaks of slope. This geomorphological featuring is clearly seen on the southern flank of the Vale of Wardour between Barford St Mary [SU 05 31] and Ansty [ST 95 26] and again in the Wylye valley around Codford [ST 96 40].

Elsewhere in the south of the district the formation forms the floor of the inliers at Alvediston [ST 97 23], near Mead Farm [SU 025 237]; and around Stoke Farthing [SU 055 255] and Croucheston [SU 068 255] all within the River Ebble valley system. The upper negative break of slope marking the top of the formation is evident in places but often becomes obscured by superficial deposits particularly in the Stoke Farthing to Croucheston area. North of the River Nadder the outcrop is narrow and steeply dipping, and the formation is frequently absent where the Mere Fault cuts through the chalk succession. On Ridge Hill [ST 95 32] outliers of the very basal part of the formation were identified during the 2003 survey resting on the steeply inclined top of the Upper Greensand Formation.

The West Melbury Chalk consists predominantly of rhythmically bedded, pale to medium grey marly chalks with thin grey to brown limestones. The base of the succession is marked by grey marl with variable proportions of glauconite and glauconitic calcareous sandstone, the Melbury Sandstone Member. The base may be transitional with the Upper Greensand Formation in this district but elsewhere in southern England the boundary is placed at a strongly burrowed surface associated with a development of phosphatic nodules. Glauconite grains are common in the lower 3 to 5 m of the chalks above the basal unit locally. The top of the formation is taken as the top of the Tenuis Limestone where

Table 13 Late Cretaceous foraminiferal and macrofaunal schemes in Southern England and their relationship to Chalk lithostratigraphy.



that bed is present but normally at the base of the ‘Cast Bed’ Bristow et al., (1995,1997), a distinctive pale brown silty chalk containing abundant small brachiopods. The limestones in the basal part of the succession are often spongiferous and occasionally contain glauconite grains. A limestone rich in *Schloenbachia* occurs in the middle of the sequence and is thought to be equivalent to the M3 limestone (sensu Gale, 1989) at Folkestone. The upper limestones of the West Melbury Chalk are generally poorly fossiliferous and sponge free. The glauconite sandstone and glauconite-rich argillaceous chalk in the basal few metres of the sequence in this district, is called the Melbury Sandstone Member as described in the Shaftsbury district (Bristow, et al., 1995). It is of lowest Cenomanian age and directly equivalent to the Glauconitic Marl Member further east in Hampshire and Sussex.

The West Melbury Marly Chalk includes all the chalk of the Cenomanian *M. mantelli*, *M. dixoni* and *C. inerme* zones and the basal part of the *T. costatus* Subzone (*A. rhotomagense* Zone). Biostratigraphically the Tenuis Limestone is placed at the base of the *Turrilites costatus* Subzone of the *Acanthoceras rhotomagense* Zone. The West Melbury Marly Chalk generally forms an aquitard between the Upper Greensand and the Zig Zag Chalk due to its high clay content.

Details

ST94SW

The formation crops out over broad shallow slopes adjacent to the superficial deposits of the Wylye Valley. A borehole (ST94SW31 [ST 9476 4085]) near Manor Farm, Upton Lovell penetrates chalk to a depth of 36.6 m. The whole succession of grey and white blocky chalk is all attributed to the formation. This must be almost the entire thickness of the formation. The considerable quantity of water obtained and the almost immediate recovery of the water table would indicate that the source is the Upper Greensand immediately below the indicated base of the bore.

ST94SE

The West Melbury Marly Chalk Formation is identified on the basis of the marly clay brown soils with fragments of grey limestone and rare soft grey marly chalk. There are no exposures but boreholes along the line of the A36 indicate soft white to grey blocky chalk. Four deeper bores at the level crossing [ST 954 401] adjacent to the Crop Research Centre indicate that the thickness of the formation is about 40 m in this area.

ST93NW

The formation is present beneath head west of Boynton within this district but there are no exposures.

ST93NE

There is a limited outcrop on this sheet south of Codford St Peter north of the Wylye floodplain deposits. Boreholes for the bypass indicate grey moderately hard and weathered chalk. The spoil from a deep drain for the bypass at [ST 9632 3999] comprised off white, marly, soft, blocky chalk.

Borehole ST93NE14b [ST 974 395] gave the following representative log of the West Melbury Marly Chalk Formation; -

Deposit	Lithology	Thickness m
Alluvium	Topsoil	0.30
	Soft, brown, slightly sandy, silty clay with fine chalk gravel	0.70
	Medium dense black and white slightly sandy fine- to coarse-grained subangular to angular flint gravel with cobbles. Top of gravel is clay-bound.	1.30
	Soft, greyish white, chalky, clayey silt with occasional fine angular flint gravel	0.90

Chalk (West Melbury Marly Chalk Formation)	Moderately weak to weak, grey white, medium jointed, moderately weathered chalk with moderately strong to firm 'bands' at 3.40 to 3.48, 3.70 to 3.86, 7.00 to 7.20 and 8.95 to 9.25.	7.00
	Moderately weak to moderately strong, grey white, coarsely jointed chalk with moderately weak to very weak calcareous 'siltstone bands' at 10.20 to 10.40, 12.00 to 12.20, 13.55 to 13.75, 14.75 to 14.80, 15.10 to 15.15, 15.40 to 15.60, 15.80 to 16.00, 16.75 to 17.05 and 19.55 to 20.15	10.25
	Core recovery between 20.45 and 37.30 in undescribed chalk	16.85
Upper Greensand Formation	Bluish green, fine- to medium- occasionally coarse-grained sandstone to 40.30 m	3.00

ST93SW

Within this district the West Melbury Marly Chalk Formation is absent at outcrop being cut-out by the Mere Fault.

ST93SE

There are three outliers of the West Melbury Marly Chalk Formation in the vicinity of Ridge Hill [ST 953 321] and Chapel Copse [ST 9580 3215] west of the Chilmark Brook. The most easterly is bounded to the north by a small fault throwing to the south. In all three cases the lowest part of the formation is identified in brash resting on the steeply dipping top of the Boyne Hollow Chert Member of the underlying Upper Greensand Formation. A thin marly and glauconitic soil with glauconitic limestone fragments is superposed above an orange weathering silty fine- to medium-grained sandstone with a marly matrix. When augered this lower bed is seen to be pale greenish brown, calcareous, glauconitic friable sandstone. There is no confirmation of age from biostratigraphy but the succession is regarded as the Melbury Sandstone Member overlain by the basal beds of the rest of the formation.

The formation is recognised east of Manor Farm [ST 989 326], Teffont Magna where shallow slopes of pale grey marly soil with a brash including soft to hard marly limestone and limestones with *Schloenbachia varians* are seen. This outcrop is bounded to the north and south by elements of the Mere Fault. On the eastern margin of this sheet a succession of Boyne Hollow Chert Member overlain by the glauconite-rich Melbury Sandstone Member and the remainder of the West Melbury Marly Chalk Formation is identified south of the Mere Fault at [ST 9995 3265].

ST92NW

Within the district a very limited outcrop of the formation is identified in the shallow slopes beneath the Chalk scarp in the southeast corner of this sheet. There are no exposures but to the west on the Wincanton sheet area a pit at [ST 9435 2507] has a surface brash of soft white chalk with *Inoceramus* fragments.

ST92NE

The West Melbury Marly Chalk Formation outcrops in a broad band in the low ground between the primary Chalk escarpment and the Upper Greensand dip slope. It is generally very poorly exposed. Although several old pits do exist, notably to the northeast of Buxbury Hill [e.g. ST 9904 2731], most are overgrown and provide little or no exposure. However, field brash in these pits and other localities have provided fossil material indicative of the West Melbury Marly Chalk. A pit formerly existed at the base of Buxbury Hill [ST 9806 2687] and is described in the Memoir (Reid, 1903). It exposed about 7 m of marly chalk and thin limestone, which dip at 4° to the south. Jukes-Browne and Hill (1900) gave the following section from this locality (it was repeated by Reid, 1903).

Member	Lithology	Thickness m
	Two courses of hard rough grey chalk separated by loose marly chalk	0.76

West Melbury Marly Chalk Formation	Dark grey argillaceous marl	0.15
	Loose grey marly chalk	0.38
	Hard grey chalk	0.23 to 0.46
	Marly grey chalk, weathering into loose fragments, with here and there patches of darker blue grey chalk (many fossils)	4.27
	Very hard rocky grey chalk	0.46
	Dark grey tough marly chalk	0.30 +

These beds have a southerly dip of 4° and contain a fauna indicative of the now defunct *Schloenbachia varians* Zone including *Grasirhynchia martini*, *Grasirhynchia grasiana*, *Plagiostoma globosum*, *Lima aspera* and the index fossil itself.

Elsewhere the field brash of grey soft to splintery hard limestones in a pale grey brown marly soil also contains many examples of *Schloenbachia varians*, other ammonite species and common sponges

ST92SW

The formation is noted in the headwater valleys of the River Ebble in the extreme northeast of this sheet within the district

ST92SE

The West Melbury Marly Chalk Formation floors the headwater valleys of the River Ebble around Alvediston in this district. No exposures were noted.

SU03SW

The West Melbury Marly Chalk outcrops in a narrow band across this sheet just north of the Upper Greensand ridge on the northern side of the River Nadder, but is locally cut out against the Mere Fault. It is generally very poorly exposed. Although several old pits do exist (e.g. [SU 0162 3238] and [SU 0460 3162]), most are overgrown and provide no exposure. However, field brash in these pits and other localities have provided fossil material indicative of the formation.

SU03SE

The formation has a limited outcrop at the base of the Chalk scarp. There are no exposures as the formation is mostly concealed beneath an extensive spread of head.

SU02NW

Field brash consists of cream to grey coloured marls and grey-buff limestones. Ploughed fields are often waterlogged after heavy rainfall and general drainage is slow. Large exposures are rare and only small sections are usually visible, mainly along sunken tracks leading up to the scarp. However, a footpath from East Farm, near Fovant, leads to a small, disused pit [SU 0142 2828] exposing hard grey slabby chalk with occasional fossil fragments together with softer grey chalk with the typical conchoidal fracture habit. The quarry includes the West Melbury Marly Chalk and Zig Zag Chalk boundary. From the descriptions in Jukes-Browne and Hill (1900) and Reid (1903) the quarry appears to have been worked on two levels.

“The upper part of the quarry is in firm, massive, whitish chalk, of which about 50 feet (15.24 m) is seen, and below this the following succession can be made out.”

Formation	Lithology	Thickness m
West Melbury Marly Chalk Formation (?Zig Zag Chalk Formation, see note below)	Hard greyish-white chalk in layers, having alternately a rough and a smooth fracture	1.82
	Layer of soft grey marl	-
	Hard grey chalk	0.91
	Soft dark grey marly chalk	0.30
	Dark grey sandy chalk, with visible grains of glauconite (many fossils)	4.57

	Very hard light grey limestone	0.30
	Soft grey marl below.	-

Note: Jukes-Browne and Hill noted that the dark grey sandy chalk was “not unlike Totternhoe Stone and contains many of the same fossils, but there are no phosphatic nodules or fragments in it”. However they did not give a faunal list for this locality and the thickness of the bed would be exceptional for any area other than the type area in the Chilterns within the Transitional Province.

During the 2003 survey M A Woods collected *Inoceramus reachensis* sensu Etheridge non Woods, *Inoceramus* ex gr. v*irgatus, Mantelliceras dixoni* and *Cunningtoniceras inerme* from this locality. The specimen of *C. inerme* was collected from a relatively higher stratigraphical horizon in the quarry. The fauna indicates a Lower and basal Middle Cenomanian age for the succession sampled. *Mantelliceras dixoni* and *C. inerme* are zonal indices in the higher part of the West Melbury Marly Chalk Formation. It seems likely that the Cast Bed (a lateral equivalent of the Totternhoe Stone in the Southern Province), the basal marker of the overlying Zig Zag Chalk Formation, may occur within the higher part of the pit, although this is inaccessible. This would seem to contradict Jukes-Browne and Hill’s correlation.

SU02NE

The formation is at outcrop in the northwest of the sheet and within the inlier at Stoke Farthing and Croucheston. There are no exposures and the formation is recognised beneath a negative break of slope by the clayey nature of the soil and the included grey limestone brash.

SU02SW & SU02SE

Only very limited outcrops of the formation exist within the district on these two sheets.

6.1.2 Zig Zag Chalk Formation

The Zig Zag Chalk is typically composed of 46-65 m of medium-hard, pale grey, blocky chalk with some thin limestones near the base. The lower part of the formation has a higher marl content and contains some thin limestones. Some distance above the base of the formation, hard, pale grey splintery limestones with conspicuous *Sciponoceras* may occur. The upper part of the Zig Zag Chalk tends to be paler grey to white, firm, marly chalk with common *Inoceramus atlanticus, I. pictus* and the echinoid *Holaster subglobosus.* No flints are recorded in this area. The upper limit of the Zig Zag Chalk is taken at the base of the Plenus Marls. The base of the formation falls within the basal *Turrilites costatus* Subzone and the top is coincident with the top of the *Calycoceras guerangeri* Zone.

In the south and southwest of the district the Zig Zag Chalk outcrops along the face of the faulted Chalk escarpment on the northern flank of the Vale of Wardour, as a narrow outcrop along the Chalk escarpment forming the southern flank of the vale and as inliers around Alvediston, Mead Farm, Stoke Farthing and Bishopstone [SU 07 26]. The formation is seen again in the northwest of the district as an arcuate outcrop in the River Wylye valley from Boyton eastward to Wylye and thence northwestward to the Codfords’ and Upton Lovell. Much of the formation outcrop is obscured by superficial deposits.

The base of the Zig Zag Chalk Formation is commonly at a strong negative slope break at the base of the Chalk escarpment. This abrupt change in slope appears to correspond with the incoming of thick beds of firm to hard blocky chalk above the gently sloping ground underlain by the West Melbury Marly Chalk. The top of the formation is placed below the Plenus Marls Member of the succeeding formation and this is frequently identified as a weak negative slope break beneath the strong bluff developed on the Melbourn Rock Member.

Details

ST94SW

Within the district there are no exposures within the limited outcrop to the north of Upton Lovell. The formation is identified on the steep slopes below the strong positive feature covered in a copious

Melbourn Rock Member brash. Here the marly soils contain frequent fragments of grey an off-white soft to moderately hard limestone.

ST94SE

The Zig Zag Chalk forms the low angle slopes up to a negative feature break beneath steep bluffs founded on the Holywell Nodular Chalk Formation. In places this slope break is very strongly developed particularly in the minor valley from Well Bottom [ST 957 417] to Cleve House [ST 9574 4053] and at numerous localities in the Chitterne Brook valley. North of Cleve House this steep bluff may well be a true fault scarp in places. There are no clear exposures within the outcrop on this sheet. The small pit at [ST 9721 4002] is backfilled and a similar exposure of about 3 m at [ST 9735 4100] is completely obscured by talus and a building. Soils across the outcrop are generally pale brown clayey and calcareous with sporadic pale grey limestone brash. In a number of places towards the top of the formation a copious brash of off-white smooth large blocky chalk is brought up by ploughing.

ST93NW

The outcrop is confined to the low slopes below a strong negative feature break around Boynton Bottom [ST 945 393].

ST93NE

This sheet contains the most extensive outcrop of this formation in the Wylye valley. The formation again forms the shallow slopes beneath the strongly developed feature of the Melbourn Rock Member. In numerous places large blocky off-white to white, firm and blocky, marly chalk is brought up in the plough immediately beneath this Melbourn Rock feature.

There are no clear exposures within this sheet area but smooth grey marly and small blocky chalks can be seen in the sunken track [ST 9614 3895] south of Sherrington and in the brash from old degraded pits on the south side of the road [ST 9530 3938 and 9538 3936] near Boyton. Similar brash can be seen in the tributary valley near Starveall [ST 9945 3931].

ST93SW

The outcrop is limited to a narrow belt westward from Pitchpenny Clump [ST 949 326] below a steep scarp. Immediately to the south in this valley the formation is cut out against the Mere Fault and reappears to the south of this fault close to the sheet margin. There are no exposures.

ST93SE

The Zig Zag Chalk Formation occurs as an interrupted outcrop closely associated with the Mere Fault complex. The formation is cut out against this fault just to the east of Pitchpenny Clump but reappears between Chilmark [ST 970 325] and Teffont Magna [ST 988 325] within a fault-bounded block where two elements of the Mere Fault complex diverge. It reappears to the east as small outcrops bounded to the north by the northern element of the Mere Fault. Throughout its outcrop there are no exposures and the upper limit of the formation is indicated by the feature and brash associated with the Melbourn Rock Member.

ST92NW

There are only limited outcrops of this formation within the district on this sheet and no exposures.

ST92NE

The Zigzag Chalk outcrops in a narrow band at the base of the primary Chalk escarpment. It is generally, poorly exposed. Although there are several old pits [ST 9535 2505, 9638 2560, 9654 2575, 9667 2580, 9675 2585 and 9696 2587], none of these provide any clear sections.

A section was formerly exposed in two old pits at the base of Buxbury Hill [ST 9814 2691] and described in Jukes-Browne and Hill (1900) and Reid (1903). “By the road leading up to Buxbury Hill there are two excavations in the higher part of the Lower Chalk. The first of these is in the quarry [ST 9814 2687] above the exposure by the limekiln previously mentioned. This shows about 25 feet (7.62 m) of firm blocky greyish-white chalk, breaking as usual along more or less curved surfaces, so that the real planes of bedding are obscured." It included the following fossils that indicate that the floor of the quarry probably approximates to a part of the succession a little above the West Melbury Marly Chalk - Zig Zag Chalk boundary. *Acanthoceras rhotomagense*, *Inoceramus* sp., *Ostrea lateralis* [*?Gryphaeostrea canaliculata*], *Pecten beaveri* [*Euthymipecten* ['*Aequipecten*'] *beaveri*], *Gibbithyris semiglobosa* [this is a valid modern species, but does not occur in the 'Lower Chalk'; it is uncertain what this record of Jukes-Browne refers to], *Mantellicerus mantelli*, *Parapuzosia austeni* [*Parapuzosia* (*Austeniceras*) *austeni*], *Pycnodonte vesiculare*, *Entolium orbicularis* [*Entolium orbiculare*].

On the other side of the road, and at a little higher level, there is a second quarry [ST 9835 2680?], showing the following beds.

Formation	Lithology	Thickness m
Zig Zag Chalk Formation	Compact, white chalk, weathering into courses with looser chalk between them	1.52
	Rather rough greyish-white chalk	1.83
	Marly parting	-
	Hard greyish chalk, with indefinite bands of very hard nodular grey chalk	2.44
	Massive compact blocky chalk, parting along curved surfaces	2.13+

The lowest blocky chalk is regarded as a continuation of that in the lower quarry. The nodular beds contain *Parapuzosia austeni* [*Parapuzosia* (*Austeniceras*) *austeni*] and *Ammonites Sussexiensis* (?) [*Acanthoceras rhotomagense*]. The beds show a dip of 6° or 7° to the southeast.

ST92SW

Bristow (1990) describes an exposure [ST 9350 2395] just to the southwest of the district on White Sheet Hill. This is the pit briefly discussed by Jukes-Browne and Hill (1900) as…. "a large quarry on the western slope of White Sheet Hill, about four miles north-west of Shaftesbury, shows 70 or 80 feet (21.34 to 24.38 m) of greyish-white blocky chalk." These beds included *Parapuzosia (Austeniceras) austeni*, *Acanthoceras rhotomagense*, and *Cymatoceras deslongchampsianum*. Bristow states that this pit "must formerly have exposed almost the whole of the Zig Zag Chalk from just above its base to the lower part of the Holywell Chalk." He described a section at [ST 9352 2398] see below.

Formation	Lithology	Thickness m
Zig Zag Chalk Formation	Chalk, rubbly weathering, hard, slightly gritty with pycnodonteine oyster	c. 1.00
	Chalk, nodular and gritty, off-white; *Acanthoceras jukesbrownei* Spath together with '*Inoceramus*' *atlanticus*, occurs 0.65 and 1.45 above the base [=Jukes-Browne Bed 7]	2.50
	Marl, silty, pale grey with '*I*'. *atlanticus*; sharp junction [= marl marking lower limit of Jukes-Browne Bed 7]	0.15
	Chalk, massive, blocky weathering with conchoidal fracture, off-white with common '*I*' *atlanticus* for at least 1.5 m below the marl	c. 2.00

ST92SE

The formation forms the lower valley slopes around the inlier in the vicinity of Alvediston.

SU03NW

Moderately hard smooth white chalk is recognised in the valley from Deptford [SU 0090 3850 to 0000 3890] below a weak positive feature covered with Melbourn Rock Member brash. Brash from rabbit burrows of a similar nature was seen in the cutting for the A303 at Deptford Farm [SU 0125 3830].

SU03SW

The Zig Zag Chalk outcrops in a narrow, steeply dipping band across this sheet just north of the Upper Greensand ridge on the northern side of the River Nadder, but is locally cut out against the Mere Fault. It is generally very poorly exposed and there are no sections or old pits.

SU03SE

The only exposure is a degraded and disused pit [SU 0574 3072] just south of Four Winds. The exposure is limited to a short 2 m high face of massive soft grey chalk. There are also marl seams and hard limestone bands. The fossil assemblage of ammonites and oysters *Acanthoceras?*, *Pycnodonte vesiculare* and *Inoceramus pictus* puts this sequence in the lower middle Zig Zag Chalk. This sequence may be at the level of the 'oyster beds' of Jukes-Browne. The rocks dip at 15° to 40° east of north and there are two minor faults (probably part of the Mere Fault Complex), which have a general dip of 50° to 50° east of north with a downthrow to the southwest.

SU02NW

Field brash consists of grey to white, medium to hard chalks with Inoceramid bivalve debris. A large disused quarry [SU 0055 2735 to 0044 2723] adjacent to the main Fovant to Fifield Bavant road exposes a good c.15m of Zig Zag Chalk with occasional fossil debris.

Another old pit southeast of Compton Chamberlayne [SU 0396 2894] contained grey pellety and blocky, spongiferous Zig Zag Chalk within the middle of the formation. It contained *Inoceramus pictus, I. atlanticus?* , oysters (several) and *Acanthoceras jukesbrownei*.

A small trackside section [SU 0326 2830] reveals soft white and grey chalk with very little fossil fauna, typical of the uppermost Zig Zag Chalk Formation.

SU02NE

The only notable exposure is at Thorpe Bottom Cottage pit [SU 0850 2501] that has a face 4 m high in a 5 m by 5 m pit. The upper 2 m appears to be mobilized Plenus Marl, which is in the lower Holywell Nodular Chalk Formation. Below is mobilized massive non-fossiliferous soft chalk with numerous burrows filled with grey chalk and marcasite nodules, which is typical of the Zig Zag Chalk just below the Plenus Marl Member. ?*Inoceramus pictus* and thin tested echinoids are present, which would be indicative of the higher part of the formation. The grey soft massive Zig Zag Chalk is present as brash in the adjacent arable field.

SU02SW & SU02SE

Within the district the formation is identified beneath the Melbourn Rock feature near Mead Farm [SU 025 239], as a fault bounded outcrop in Church Bottom [SU 0043 247] and on the lower slopes in tributary valleys at [SU 066 247, 077 249 and 084 248]. There are no significant exposures.

6.2 White Chalk Subgroup

The White Chalk subgroup is essentially the combined Upper and Middle Chalk Formations of Bristow et al., (1997). The base of the White Chalk subgroup is taken at the base of the Holywell Nodular Chalk Formation, which in present practice includes the Plenus Marls (Chalk correlation Table 11). In general the White Chalk is characterised by white chalk with numerous flint seams, with nodular chalks in the lower part. The White Chalk is divided into seven formations (Table 11), all of which occur in this district. Up to 320 m of the White Chalk is estimated to outcrop in this district. The Netheravon borehole proves an estimated 138 m of the White Chalk Subgroup and is known to commence in the highest Seaford or lowest Newhaven Chalk, whilst the Farley South borehole is thought to penetrate almost the whole succession proven in this district.

6.2.1 Holywell Nodular Chalk Formation

The Holywell Chalk comprises generally hard, nodular chalks with flaser marl seams throughout. Three units can be identified. In ascending stratigraphical order, these are the Plenus Marls Member, the Melbourn Rock Member and an un-named sequence of hard nodular and grainy chalks with abundant shell debris most notably species of *Mytiloides*. It outcrops along the face of the primary Chalk escarpment and is between 15 and 25 m thick. The Melbourn Rock Member often forms a strong positive feature and characteristic brash that can be traced along the scarp front.

The Plenus Marls are rarely well exposed but are present along the whole outcrop of the White Chalk. The Plenus Marl Member consists of an alternating sequence of blocky white chalk and medium grey silty marl beds, mostly between 1and 20cm thick, though the highest, Jefferies' Bed 8 (Jefferies, 1963), can be up to 50cm thick (Bristow et al., 1995). The Plenus Marls, coextensive with the greater part of the *Metoicoceras geslinianum* Zone, contain common *Inoceramus pictus*, as well as the eponymous belemnite *Praeactinocamax plenus.*

Overlying the Plenus Marls is the Melbourn Rock Member, a very hard, grainy nodular chalk generally lacking in shell detritus. The top of the Melbourn Rock is recognised by the incoming of abundant bivalve shell debris. It is a feature-forming unit up to 3m thick. The overlying shell detrital and grainy chalks form a narrow outcrop in the face of the primary scarp. In places, mainly on the less steep slopes, they form a positive feature. The top of the Holywell Nodular Chalk Formation is characterised by the transition to smoother, softer New Pit Chalk, but in practice is taken at the highest recognisable shell detrital chalk during surveying.

Biostratigraphically, the Holywell Nodular Chalk spans the Cenomanian/Turonian boundary with the boundary close to the top of the Melbourn Rock Member. The greater part of the Holywell Nodular Chalk is in the *Mytiloides* spp. Zone (this usage follows Hopson et al., 1996). The base of Gaster's "*I. labiatus* Zone" coincides with base of the Melbourn Rock. The formation covers the *Metoicoceras geslinianum* Zone, the *Neocardioceras juddii* Zone (entirely in Melbourn Rock facies) and much of the *Mytiloides* spp. Zone.

Details

ST94SW

There is no exposure on this sheet. The outcrop is identified by the hard nodular and grainy chalks with much *Mytiloides* debris that can be traced around the valley, east of Knook Camp [ST 940 426] and on the middle slopes beneath Knook Horse Hill [ST 948 418].

ST94SE

The Holywell Nodular Chalk Formation has an outcrop on the middle slopes flanking the broad flattish valley of the River Wylye and for some distance northward in the Chitterne Brook valley. The outcrop is much broken by faulting; indeed it is the ease with which the brash can be identified that permits the initial identification of these faults. The intensely hard and frequently nodular chalk characteristic of the Melbourn Rock is noted in a number of localities as field brash and this gives way upslope to a hard grainy chalk brash containing varying proportions of shell debris. The Plenus Marls are not clearly seen anywhere on the sheet.

There are no extensive exposures but the beds can be easily recognised in worn and sunken lanes climbing the valley slopes at [ST 9603 4038 to 9608 4058], [ST 9730 4060 to 9737 4065] and around the track crossroads [ST 9718 4162] north of Manor Farm, Codford. Southwest of Manor Farm a heavily overgrown, degraded and partially backfilled deep cutting [ST 9623 4109 to 9640 4139], whose origins and purpose are unknown (perhaps a quarry for building stone), exhibits a copious brash and numerous small exposures of intensely hard porcellanous chalk from the Melbourn Rock Member.

ST93NW

The formation outcrops on the steep slopes surrounding Boyton Bottom [ST 945 394]. On the northwest side of this coombe the characteristic brash of the Melbourn Rock and the *Mytiloides*-rich grainy chalk can be seen. On the south side the steep grass-covered slopes offer little brash other than in rabbit burrows.

Just to the west of the district on the Wincanton sheet a degraded pit [ST 9442 3988] on the east side of Corton Hill shows nodular chalks of the Melbourn Rock Member at the top of an overgrown shallow face (the Plenus Marls were not seen). Nodular chalks with *Mytiloides* can be seen in the track leading up Barrow Hill south of the pit.

ST93NE

South of the River Wylye the formation can be traced from south of Boyton, around the coombe centred on The Falmhouse [ST 958 390] and on eastward and southward into the tributary valley around Sherrington Dairy [ST 960 383] and then northward to Stockton Dairy [ST 9725 3855]. Eastward along the southern flank of the Wylye valley to the A303, the characteristic brash of hard grainy chalk with *Mytiloides* indicating the higher part of the formation can be found on spur tops surrounded by superficial deposits.

North of the river the formation is clearly identified on features and brash from The Manor [ST 998 388] to Codford St Mary. The Plenus Marls were seen in plough at [ST 9822 3926].

There are few exposures but the characteristic brash is readily identifiable in plough throughout the area. A good worn track section is visible around Mount Pleasant [ST 9626 3887]. The railway cuttings near Stockton Dairy [ST 9702 38 53 to 9766 3815] and south of Cow Leaze Dairy [ST 9882 3785 to 9907 3784] were not observed closely during the 2003 survey due to access difficulties and they do not seem to have been reported upon in the older literature. Observation by binocular in 2003 indicated that there were only minor exposures of nodular-looking chalks along these cuttings but that in general they were heavily overgrown. Indeed the cutting at Stockton Dairy was in the process of being stripped of its larger trees during the survey but this failed to expose more in situ chalk along the degraded cutting.

ST93SW

Brash in the fields from Ponthill Clump to Pitchpenny Clump [ST 9388 3257 to 9480 3250] southeast of Fonthill Bishop consists of nodular chalk from which *Orbirhynchia* sp., *Mytiloides labiatus* (?) and common *M. mytiloides* have been collected along this steeply dipping narrow outcrop.

ST93SE

Steeply northward-dipping Holywell Nodular Chalk Formation is present at outcrop in the west, north of Ridge and again between Chilmark and Teffont Magna but is elsewhere cut out by the Mere Fault. It is readily identified from it characteristic brash but its outcrop is difficult to follow in steep slopes east of Cleeve Farm, Chilmark [ST 9732 3244]. The beds are visible in shallow laterally impersistent sections in the road cuttings north of this farm.

A quarry [ST 9513 3244] by Pitchpenny Clump, north of the hamlet of Ridge, formerly exposed the Melbourn Rock resting on a layer of grey marl, with greyish chalk below, but the rest of the section was obscured by talus. The pit is now heavily overgrown and there are no visible exposures. Brash confirms the occurrence of the Holywell Nodular Chalk Formation but that the highest beds within this quarry must be low in the succeeding New Pit Chalk Formation. This would suggest that the section shown in Jukes-Browne and Hill (1900) is only of the lowest part of this pit and that the dip locally is considerably more than the 15° to the north quoted.

Formation	Lithology	Thickness m
Holywell Nodular Chalk Formation	Hard bedded whitish chalk	4.57
	Hard yellowish nodular chalk in regular beds, with several layers of marl	3.05
	Marked layer of marly chalk	-
	Hard nodular yellowish chalk (Melbourn Rock)	1.52
	Greenish grey marl and marly chalk	1.83
?Zig Zag Chalk Formation	Talus concealing lower beds	-

ST92NE

The Holywell Chalk outcrops along the face of the primary Chalk escarpment and as three small inliers in the deep valleys incised into the chalk dipslope to the south. There are no old pits or sections exposed, although good brash yielding *Mytiloides* spp was found at two localities in the edges of tracks on the top of Buxbury Hill at [ST 9835 2675] and [ST 9860 2680]. The Plenus Marl was observed in the track on the east side of the hill at [ST 9868 2681].

ST92SW & ST92SE

The outcrop is narrow both on the main scarp to the northwest and within the inliers around Alvediston. The formation is traced by the incidence of its characteristic brash and a clear succession of nodular chalk overlain by shelly grainy chalks is discernable in brash on ploughed fields. The Plenus Marls Member was not seen but nodular fossiliferous hard chalks were noted in a small exposure at [ST 9690 2409].

SU03NW

The formation has a limited outcrop in a tributary valley south of the River Wylye, at Wylye and is seen again north of the river from near Great Bathampton Farm [SU 0159 3811], around the minor valley centred on Deptford Field Barn [SU 0155 3915] and westward towards Fisherton de la Mere [SU 000 386]. F J Bennett (see Jukes-Browne and Hill, 1900) saw hard, bedded chalks in the road cutting (now greatly expanded to take the interchange of the A36 and A303) and at Deptford Field Barn. Both sites are still visible but degraded.

The only exposure identified during the recent survey was at an old chalk pit [SU 0180 3834] NNE from Great Bathampton Farm. Here the degraded section showed hard, nodular chalk overlain by soft chalk. The lower beds contained *Mytiloides* spp. and *Orbirhynchia cuvieri* whilst the upper beds included *Mytiloides* ex gr. *hercynicus-subhercynicus*. This indicates that the Holywell Nodular Chalk and New Pit Chalk formation boundary is within the succession here.

SU03SW

The Holywell Chalk occurs in a narrow steeply dipping zone in the valley along the north side of the Greensand escarpment north of the River Nadder. In places it is cut out against the Mere Fault. Due to the steep dip and narrow outcrop, there are no sections or old pits currently exposed.

Jukes-Browne and Hill (1900) identified three localities in this sheet area but none of them were positively identified during the recent survey.

At a quarry to the north east of Baverstock, perhaps at [(?) SU 0335 3225], about 7.62 m of beds which were hard, rough, and nodular in the lower part and considered to be not far above Melbourn Rock were seen. The beds were reported to contain “two common fossils in the upper beds” and the dip is about 33° to the northeast.

“The Melbourn Rock, passing up into hardish bedded chalk containing *Rhynch. Cuvieri* [*Orbirhynchia cuvieri*], and *Inoceramus mytiloides* [*Mytiloides mytiloides*], is also exposed in a small pit three quarters of a mile northeast of Dinton [SU 0170 3262]. The dip here is about 20° north, and an old excavation close by must have shown the *Terebratulina* zone, as the Chalk Rock, which is still exposed at the northern end, dips at 45°.”

“A similar section is exposed in a chalk-pit [(?) SU 0213 3257] about a mile northeast of Dinton, grey blocky chalk succeeded by a broken layer of grey marl passing below the Melbourn Rock, which dips north at about 20°.”

SU03SE

There are no significant exposures in this sheet area and the outcrop is narrow. The identification of the characteristic brash is a key guide initially to the placement of the eastward continuation of the Mere

Fault south of Barford St Martin and particularly in the vicinity of Folly Clump [SU 066 303] and Punch Bowl Bottom [SU 070 302].

SU02NW

The sinuous outcrop on the Chalk scarp is readily identified in the steep mid slopes with a typical brash of abundant nodular buff-coloured hard chalk containing pink fragments of Inoceramid bivalves, most notably *Mytiloides.* Within the Vale of Broad Chalke the upper part of the formation floors the valley.

The Plenus Marls and Melbourn Rock members are not exposed in this area. However, brash fragments and small roadside cuttings (e.g. [SU 0037 2716]) are relatively common, exhibiting hard nodular and porcellanous chalks and with pink inoceramid fragments in grainy chalks at higher levels.

In the Vale of Broad Chalk, many exposures of Middle Chalk can be found, but, according to Mr F J Bennett, there are few large quarries in it. He saw the Melbourn Rock at Broad Chalke, at the top of a quarry north of Chalk Pyt House [SU 0377 2578], and again in the road south of Knighton.

SU02NE

The formation has a narrow outcrop in the northeast of the sheet along the middle slopes of the primary Chalk scarp at Hoop Side. To the south extensive outcrops are found within the inlier around Bishopstone. The formation is identified on the basis of its characteristic brash.

An exposure at Flamstone Farm Grain Plant [SU 0646 2635] consists of hard nodular Chalk with marl horizons. The dip is 10° to the north. There is abundant *Mytiloides* present indicative of upper/top Holywell Nodular Chalk (MW).

A small, disused pit at [SU 05016 26253] and along the adjacent track included common *Mytiloides* spp., including *M. mytiloides* within a brash of hard, nodular chalk.

Field brash collected at [SU 0825 2525] and [SU 0855 2550] recorded *Mytiloides* spp. and a questionable *Mytiloides hattini* in hard nodular chalks in the vicinity of Throope Bottom Cottages, near Bishopstone.

A burial pit [SU 0850 2510] southeast of Throope Bottom Cottages included (*?*) *Inoceramus pictus* and thin-tested echinoids in poorly fossiliferous white chalk. This was overlain by a thick, dark brown-grey weathering interval, possibly representing weathered Plenus Marls.

SU02SW & SU02SE

The formation outcrops on the flanks of the tributary valleys (e.g. Church Bottom Throope Down and Stratford Tony Down) opening northward into the River Ebble. The characteristic brash is recognised widely in ploughed fields and there is an indication of a north-westerly dip of 4°.

SU12NW

The outcrop is limited to the southern flank of the Ebble valley by the east – west trending Coombe Bissett Fault.

The Plenus Marls were seen at [SU 1109 2613] beneath three metres of shelly chalk and again at [SU 1239 2594] (see Plates 16 and 17 showing nearby sections) in a worn track south of Homington. Further south and upslope this track exposed very to moderately hard white chalk, and at [SU 1237 2587] a 2.0m section of very to moderately hard thickly bedded bioclastic chalk. This exposure continues southward up-track to [SU 1230 2568] in thinly bedded moderately hard white chalk. It is probably along this track that Jukes-Browne and Hill (1900) gave the following section.

Formation	Lithology	Thickness m
Holywell Nodular Chalk Formation	Hard chalk, broken and weathered, with two layers of greenish marl, *Mytiloides mytiloides*	1.83
	Hard whitish nodular limestone	1.83+

This section on the west side of the road was visited during the 2003 survey and gave the following interpretation based on the limited fauna collected. The section contains the junction of the Holywell Nodular Chalk and New Pit Chalk formations. The boundary is inferred to occur at [SU 1233 2576], based on the record of *Mytiloides* ex gr. *hercynicus – subhercynicus* in firm, non-nodular chalk. North of this to [SU 1234 2588], the chalk is all hard and nodular, with locally common *Mytiloides*. Only a little further south, near [SU 1230 2570], the chalk quickly becomes hard and dense, suggesting that the New Pit Chalk might be exceptionally thin hereabouts.

Jukes-Browne and Hill (1900) also noted "at Coombe Bissett there is a large pit (probably at [SU 1068 2639]) in the lower part of the 'Middle Chalk' about 40 feet deep (12.19 m); the chalk at the bottom is hard, and contains *Inoceramus mytiloides* [*Mytiloides mytiloides*]; higher up, it is tough and massive, with several layers of soft marl; and near the top are many grey flints. The beds are dipping to the north at about 4°." This indicates the top of the Holywell Nodular Chalk Formation and a considerable part of the succeeding New Pit Chalk Formation.

Plate 16. Holywell Nodular Chalk in Homington Road Cut. [SU12360, 25804]. Photo P 584743

Field brash at [SU 10733 25253] near Lower Coombe Farm, near Coombe Bissett, Wilts showed *Mytiloides*, including *M. labiatus* in hard, nodular chalk.

A temporary exposure at entrance to building site [SU 11056 26032] included *Mytiloides* spp. and *Orbirhynchia cuvieri* in. hard, nodular chalk.

Plate 17. Possible Plenus Marls in Homington Road Cut [SU 12370, 25936]. Photo P 584748

6.2.2 New Pit Chalk Formation

The New Pit Chalk, between 25 and 35m thick, consists of smooth, firm, white chalks, massively bedded, with marl seams. The top of the New Pit Chalk is marked by the incoming of nodularity that generally occurs between Glynde Marl 1 and Southerham Marl in the standard Sussex succession. The New Pit Chalk forms sloping ground within the primary Chalk escarpment, above the first positive feature. It is usually softer than both the Holywell and the Lewes Chalks, below and above respectively, and it often forms a slight negative feature in the scarp.

The base of the New Pit Chalk is marked by the disappearance of Inoceramid-rich nodular chalk. The upper limit is marked by the incoming of hard nodular chalks and flints. Flints in the New Pit Chalk are rare. Where present they are small and occur in the uppermost beds. The fauna is much sparser than in the Holywell Chalk and most comprises brachiopods (both terebratulids and rhynchonellids) rather than abundant inoceramid bivalves. Thin shelled *Mytiloides hercynicus / subhercynicus* are present but tend to be flattened and preserved as chalky moulds.

The New Pit Chalk belongs to the uppermost part of the *Mytiloides* spp. Zone and all but the highest part of the *Terebratulina lata* Zone. In the standard sections in Sussex, the Formation covers the interval between the Gun Garden Main Marl up to the base of Glynde Marl 1 (Mortimore, 1986) but following Mortimore & Pomerol (1996) BGS has mapped strata above Glynde Marl 1 as upper New Pit Chalk.

Details

ST94SW

The formation has an arcuate outcrop around Knook Camp valley and forms the middle to higher part of the slopes in this area. In general soft to firm white smooth chalk chalks with a poor fauna are recognised between the shelly chalks of the Holywell Nodular Chalk below and a well-marked outcrop of intensely hard porcellanous chalk of the Lewes Nodular Chalk Formation above. There are no exposures.

ST94SE

The formation outcrops as a narrow belt around the mid to higher valley slopes around Flowers Field Barn [ST 9525 4325], Well Bottom [ST 955 416] and in Chitterne Brook valley to the east. Poorly fossiliferous soft to firm white smooth and blocky chalks are seen in widely in brash and along worn tracks at [ST 9545 4180] and [ST 1240 6896].

There are two sections within these beds at [ST 98197 41936] (HP62) and Manor Farm [ST 96970 41669] (HP63) that give information on the upper and lower parts of the succession respectively (Figures 37 and 38 See also Plates 18, 19 and 20). Graphical logs and photographs of both pits are given below.

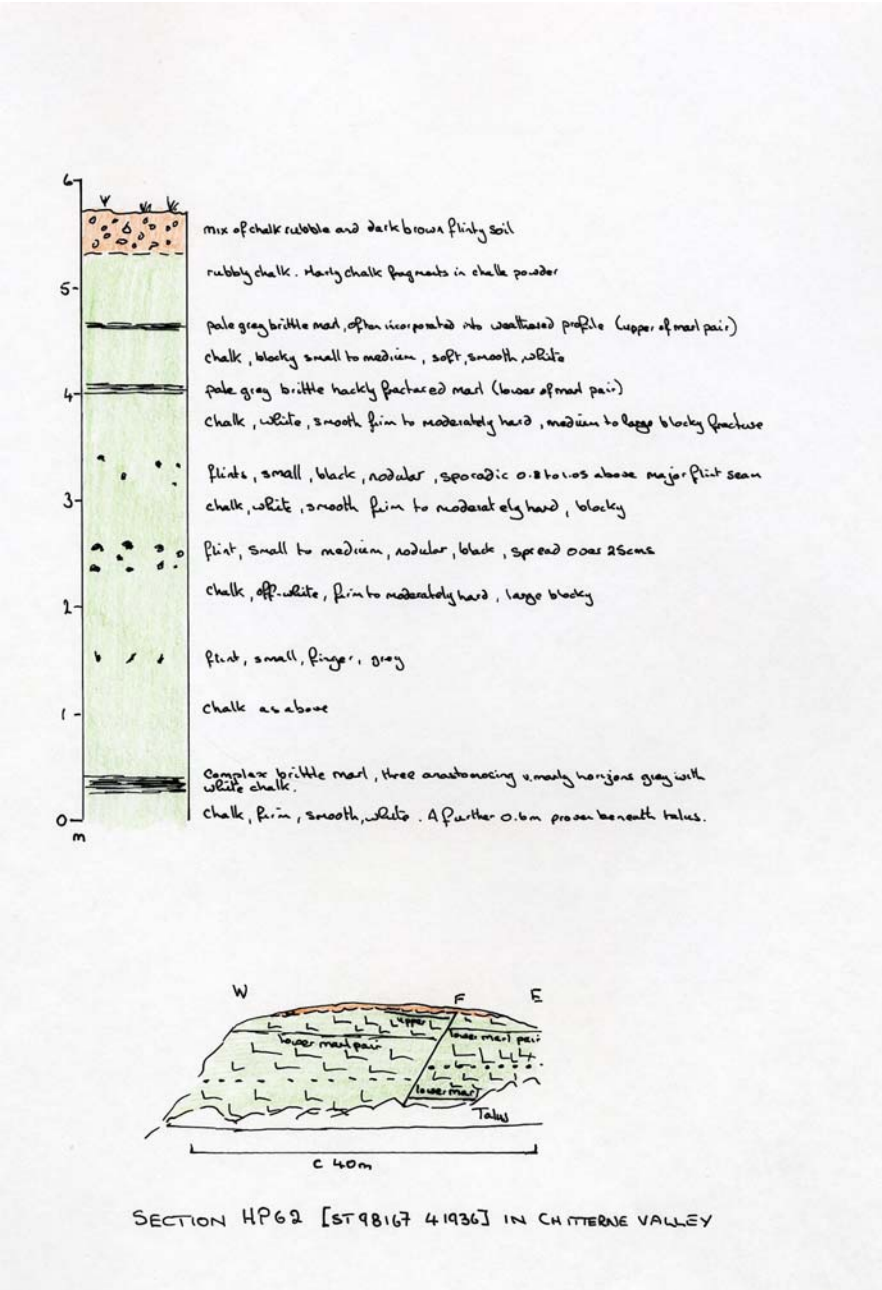


Figure 37: Section HP62 in New Pit Chalk Formation at [ST 98167 41936] Chitterne Valley

Plate 18. View of section HP 62, New Pit Chalk Formation [ST 98167 41936]. Photo P 598777

Plate 19. Close-up of HP62 [ST 98167 41936] showing fault displacing marl seam and the characteristic blocky nature of the New Pit Chalk Formation. Photo P 598778

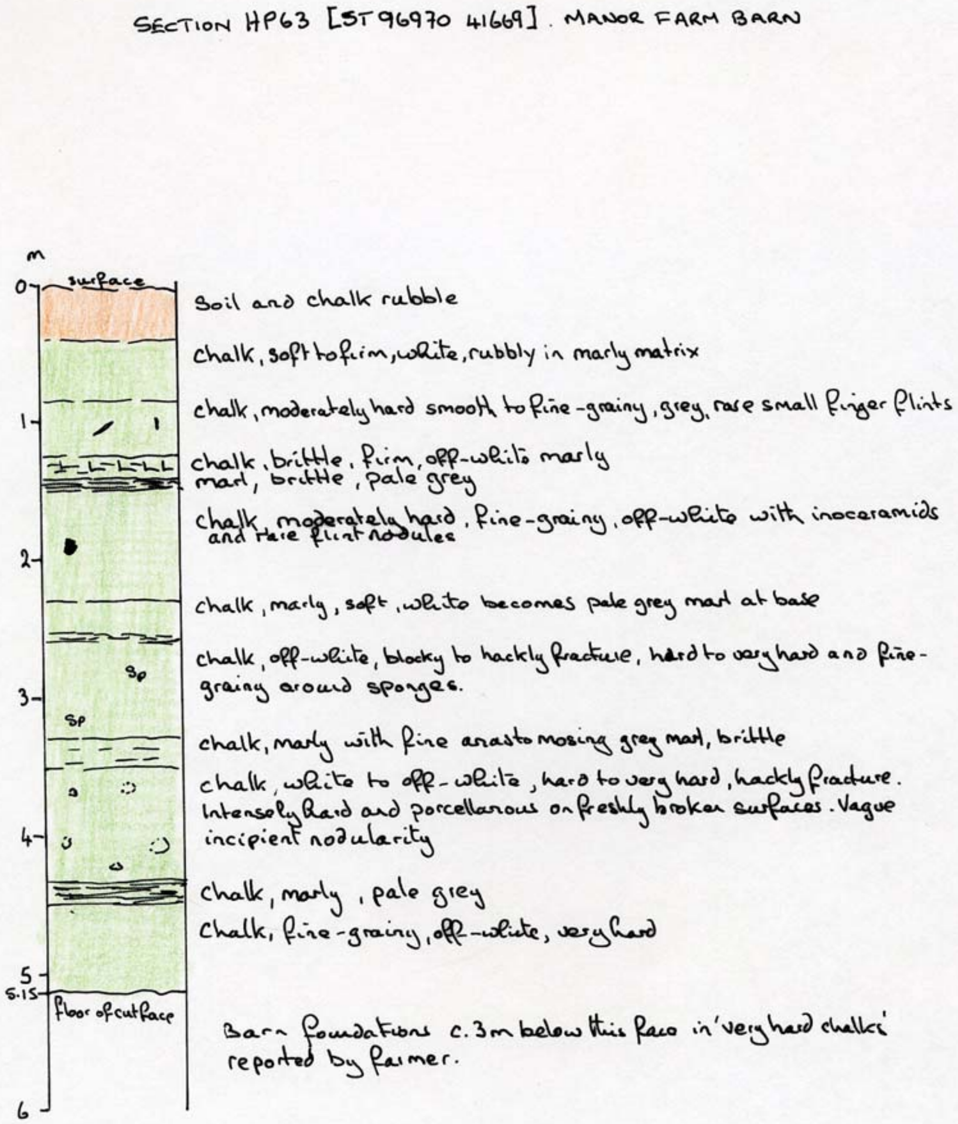


Figure 38: Section HP63 in the lower part of the New Pit Chalk Formation at Manor Farm Barn [ST 9697 4166]

Plate 20. Section HP63 in the lower part of the New Pit Chalk Formation [ST 9697 4166]. Photo P 598784

ST93NW

The New Pit Chalk Formation has an outcrop on the mid to high slopes on the flanks of Boyton Wood. Here soft to moderately hard smooth white chalks with a limited fauna have been identified in brash.

A little to the west of this district flints were noted high in the New Pit Chalk in the track [ST 9434 3975] climbing the eastern side of Corton Hill. Further south near Vineyard Wood [St 9427 3936 firm white chalk with thin-shelled flattened *Mytiloides* were noted close to the base of the formation.

Similar chalks but with common *Mytiloides* ex gr. *hercynicus-subhercynicus* and *Mytiloides mytiloides* were identified at [ST 9491 3915] again near the base of the formation.

ST93NE

This formation has a heavily indented outcrop around the River Wylye and the principal tributary dry valleys on its southern flank. Brash is typically firm to moderately hard, smooth, white, flaggy to blocky chalk with infrequent shell material. There are no significant exposures.

ST93SW

There is a very limited narrow outcrop of steeply dipping New Pit Chalk near Pitchpenny Clump. A pit [ST 9513 3244] nearby (see section on the Holywell Nodular Chalk formation) must include the basal part of the formation but is not exposed.

ST93SE

The narrow steeply-dipping outcrop of this formation is seen to the west of the sheet and from Chilmark to Teffont Magna. Elsewhere it is cut out against the Mere Fault. There are no exposures and the brash is commonly masked on steep slopes by an abundance of intensely hard debris from the Lewes Nodular Chalk upslope.

ST92NE

The New Pit Chalk has an outcrop along the face of the primary Chalk escarpment, and as three inliers in the deep valleys incised into the chalk dipslope to the south. There are no old pits or sections exposed, but small amounts of blocky soft white chalk can be seen in the trackside on top of Buxbury Hill [ST 9833 2653].

ST92SW

The outcrop is limited to a narrow strip along the primary chalk scarp and within inliers to the south. The only exposure in a small pit at [ST 9484 2474] showed over 3 m of beds in the middle part of the formation.

Formation	Lithology	Thickness m
New Pit Chalk Formation	Chalk rubble	0.60
	Rubbly chalk	0.60
	Marl, pale grey	0.15
	Chalk, rubbly, firm, off-white with scattered *Inoceramus* fragments; scattered pale grey flints vary from small (1 to 2 cm) and round to large (up to 20 cm) and knobbly; some finger flints occur. The paired valves of cf. *Inoceramus lamarcki geinitzi* Tröger were preserved in one flint nodule.	1.80+

ST92SE

The outcrop is narrow along the upper slopes of the primary scarp from White Sheet Hill to Swallowcliffe Down. Within the inliers to the south the outcrop is equally narrow. There are no significant exposures.

SU03NW

The formation has a narrow outcrop south of the River Wylye from the A303 eastward towards Little Langford Farm [SU 048 363]. Here the formation plunges beneath the superficial deposits of the River Wylye to reappear on the northern flank of the valley east of East Clyffe [SU 045 373]. The northern outcrop is sinuous and floors the minor dry valley called Clifford Bottom [SU 041 380]. Westward the formation forms the lower valley slopes in the main valley and in the dry valley that takes the A303 up the scarp to the northeast. There is little exposure and the outcrop brash is generally confused with material from the Lewes Nodular Chalk Formation above.

At Great Bathampton Farm, near Wylye an old chalk pit (Cuckoo Pit) [SU 0180 3834] shows the contact between the Holywell Nodular Chalk and New Pit Chalk formations as mentioned above. The pit shows *Mytiloides* spp. & *Orbirhynchia cuvieri* in hard, nodular chalk overlain by *Mytiloides* ex gr. *hercynicus-subhercynicus* in soft chalk.

A small chalk pit [SU 0212 3922] 500 m east of Deptford Field Barn exposes a shallow section of moderately hard to soft, white, smooth, blocky chalk containing *Mytiloides* ex gr. *hercynicus – subhercynicus* indicating the lower part of the New Pit Chalk Formation.

Towards the east a small pit [SU 04530 37406] in the farmyard at East Clyffe Farm Steeple Langford, exposes 1.5 m of firm white smooth chalk with common *Inoceramus cuvieri.*

SU03NE

The New Pit Chalk Formation has very minor outcrops to the south and north of the River Wylye floodplain on the western extremity of this sheet. There are no exposures.

SU03SW

The New Pit Chalk occurs in a narrow, steeply dipping zone in the valley to the north side of the Upper Greensand escarpment north of the River Nadder. In places it is cut out against the Mere Fault. Due to the steep dip and narrow outcrop, there are few sections or old pits currently exposed. A pit 1 km north of Dinton [SU 0167 3265] exposes c. 1 m of blocky white chalk but the face is inaccessible. Another pit, 1 km to the east of Baverstock [SU 0377 3224] exposes a few metres of soft blocky white smooth chalk beneath harder nodular Lewes Chalk. This is probably the uppermost part of the New Pit Chalk which here dips at c. 25° to the north.

SU03SE

The formation has a limited outcrop north and west of Barford St Martin and is seen again in a narrow outcrop from Barford to Folly Clump [SU 066 305] south of the River Nadder floodplain. It is steeply dipping towards the northeast.

The disused Chalk pit [SU 0579 3145] in Barford St Martin behind stables exposes about 4 m of massive soft flintless Chalk, with marl seams but much of the face is mobilized and it is not possible to get a dip reading. The limited fauna includes *Inoceramus cuvieri*, *Mytiloides* ex gr. *hercynicus-subhercynicus* and *Collignoniceras woollgari*? , that indicate the basal part of the New Pit Chalk Formation

SU02NW

The formation has a continuous outcrop within the higher slopes of the primary Chalk escarpment between Burcombe Ivers [SU 047 292] and Fovant Hut [SU 001 266]. Southwards in the Vale of Broad Chalke the formation forms a sinuous outcrop along the lower to middle slopes of the dry valleys. It floors the valley of Hut Bottom [SU 047 280] to the east and the valleys around Fifield Down and Fifield Bavant in the southwest.

Field brash consists of typically white, blocky, firm to hard chalk with a distinct lack of fossil and flint material. A small pit at [SU 0070 2559] exposes c. 4m of relatively hard nodular and blocky chalk lacking in flints and few fossils.

An old pit by the track [SU 0386 2516] reveals hard blocky white smooth chalk with occasional small flints. The rocks include several specimens of *Inoceramus cuvieri* confirming the New Pit Chalk designation. The chalk here is much harder than usual New Pit Chalk, possible due to the close proximity/transition to the Lewes Nodular Chalk Formation above.

SU02NE

The formation forms the mid to upper steep slopes of the primary Chalk scarp passing through Hoop Side [SU 059 292] in the northwest of the sheet and forms a narrow sinuous outcrop from the west towards Bishopstone. South of the Coombe Bissett Fault the unit forms the steep middle slopes around Throope Hill.

There is an overgrown exposure in the side of the track at Chalk Hollow [SU 07015 26317] that showed soft massive flintless chalk with marl seams. This appears to be upper New Pit Chalk and one of the thicker marls may be the Frognam marl at the base of the Lewes Chalk. Brash from the lower hard grounds of the Lewes Chalk are clearly visible in the brash of the adjacent arable field above the exposure. The fauna included *Terebratulina lata*, *Inoceramus cuvieri* and *Labyrinthidoma* indicating a position within the topmost New Pit Chalk and basal Lewes Nodular Chalk.

The brash in the vicinity of [SU 05070 26360] to [SU 05095 26405] included *Mytiloides* ex gr. *hercynicus - subhercynicus* and *Collignoniceras(?)* in moderately hard, smooth-textured, white chalk, indicating the basal New Pit Chalk Formation, basal *T. lata* Zone.

SU02SW & SU02SE

The New Pit Chalk Formation has a sinuous outcrop on the mid to higher steep slopes around the inliers within the Vale of Broad Chalke. There are no significant exposures with the exception of a small pit at [SU 0797 2478] where hard weakly nodular chalk containing *Terebratulina lata*, *Inoceramus cuvieri* and *Sciponoceras* sp. were noted. This would indicate the upper part of the New Pit Chalk Formation particularly as the heavy hard nodular mineralised chalk brash characteristic of the basal Lewes Nodular Chalk can be identified in the track upslope to the south.

SU12NW

The formation forms a sinuous narrow outcrop on the steep mid to higher slopes within the tributary valleys of the River Ebble south of Coombe Bissett and Homington. The formation is cut out north of the river along the Coombe Bissett Fault.

A small exposure [SU 10400 25060] west of the cricket ground south of Coombe Bissett yielded a number of specimens of *Mytiloides* ex. gr. *hercynicus – subhercynicus* indicating the basal New Pit Chalk

The chalk cliff exposed on west side of road running south from Homington between [SU 1234 2588] to [SU 1233 2576] demonstrated the lithological and biostratigraphical change from the Holywell Nodular Chalk to New Pit Chalk. Details are entered in the Holywell Nodular Chalk section above.

Spoil from a burial pit at [SU 10015 26164] included common *Inoceramus cuvieri* in firm chalk with a few small flints.

SU12SW

Only limited outcrops within the closures of northward sloping dry valleys occur within the district on this sheet. There are no significant exposures.

6.2.3 Lewes Nodular Chalk Formation

The Lewes Chalk comprises interbedded hard to very hard nodular chalks and hardgrounds with soft to medium-hard grainy chalks and marls. The nodular chalks are typically lumpy and iron-stained, this iron-staining usually marking sponges. Brash is rough and flaggy and tends to be dirty. The first regular seams of flint appear near the base. The flints are typically black or bluish black with a thick white cortex. Sheet flints are common. The formation is between 40 and 45 m thick within the district. It includes the ‘Chalk Rock’ of traditional usage (Bromley and Gale, 1982) at its base.

In this district, the Lewes Nodular Chalk Formation forms the highest steep slopes at the top of the primary Chalk scarp (and dipslopes beyond onto the major interfluves) around the Vale of Wardour in the southwest, and around the Vale of Broad Chalke in the south. It forms similar outcrops in the north and northwest where the River Wyle cuts through the generally south-eastwards dipping succession. It and appears again, as an inlier, in the Avon valley around Middle Woodford [SU 12 36] where it is brought to surface in the core of a small anticline.

In the standard Sussex succession the Lewes Nodular Chalk includes the strata from the Glynde Marl 1 to the base of the Shoreham Marl 2 (Mortimore, 1986) but this was subsequently modified in Mortimore & Pomerol (1996, Fig. 2) where the Lewes Nodular Chalk commences above the marl at the inception of nodularity. In exposed sections the Lewes Nodular Chalk can be divided informally into two units. The lower is mainly medium to high-density chalks and conspicuously iron-stained hard nodular chalks whilst the upper is mainly low to medium-density chalks with regular thin nodular beds. Between the two informal units the boundary is marked by the Lewes Marl and an extensive system of black cylindrical burrow-form flints called the Lewes Flints. The upper Lewes Nodular Chalk is further distinguished by the occurrence of the bivalve *Cremnoceramus* (Mortimore, 1986). There are several levels of sheet flint within an interval of 4 or 5m in the lower part of the Upper Lewes Chalk. The Lewes Chalk includes the top of the *Terebratulina lata* Zone, and all of the *Plesiocorys* (*Sternotaxis*) *plana* and *Micraster cortestudinarium* zones. The higher beds of the *Micraster cortestudinarium* Zone contain carious, 'rinded' flints.

In this district the basal part of the succession seen in Sussex is more condensed and the Chalk Rock becomes well developed particularly in the northwest. Thus the base of the Lewes Nodular Chalk is placed at the lowest nodular chalk recognisable in field brash and this is only a short distance below the heavily mineralised nodular chalks of the Chalk Rock in this district. The top of the formation is placed at the highest recognisable bed of nodular chalk below the incoming of smooth white chalks with *Platyceramus*. This part of the succession is also marked in this district by a belt of large nodular and carious black and grey flints that span the boundary between the Lewes Nodular Chalk and Seaford Chalk formations.

Details

ST94SW

Within the district the formation forms the top of Knook Horse Hill . Here two exposures have been logged. At [ST 9496 4162] an exposure of over 6 m of beds low in the formation was reported in Bristow et al. (1995) from manuscript notes by F J Bennett made at the end of the 19th century.

Formation	Lithology	Thickness m
Lower Lewes Nodular Chalk Formation (Chalk Rock)	Nodular, hard chalk with flints	2.70
	Massive, firm white chalk with flints	1.20
	Cream-coloured Chalk Rock with 0.3 m bed of nodules at top	0.90
	Cream-coloured Chalk Rock with several lines of nodules	1.50

Just to the south [ST 9495 4153] excavations exposed 0.40 m of rubbly hard, nodular chalk on chalkstone with four glauconitised hardgrounds, at the top and 0.30, 0.45 and 0.8 m down within a unit 0.95 m thick. Below this 0.20 m of hard blocky chalk contained *Inoceramus lamarcki*. A specimen of the large form of *Micraster leskei* was found just above the third glauconitised hardground from the surface.

Elsewhere on the hill the formation was exposed in old pits at [ST 9478 4205, 9472 4198 and 9457 4191] but these are now completely degraded. Glauconitised chalkstone was noted to the south of these pits at [ST 9452 4187 and 9448 4186].

ST94SE

The Lewes Nodular Chalk Formation forms the upper valley slopes and lower spur tops throughout the sheet. The outcrop extends for a considerable distance northward in the Chitterne Brook Valley. There is a copious hard nodular chalk brash with associated flints across the whole outcrop, with an intensely hard, porcellanous chalkstone and nodular cream-coloured chalk brash at the base that is mineralised in places.

There are numerous old pits throughout the outcrop but all are degraded and overgrown and show no exposure. The most notable of these are at [ST 9536 4288 and 9731 4215]. North of the district around Chitterne the formation can be seen at two exposures. At [ST 9904 4434] about 1.5 m of intensely hard nodular chalk and flaky grainy chalk with nodular flints can be seen in a cut behind a barn at Manor Farm.

The best exposure HP67 [ST 98208 43819] in the higher part of the formation is at Valley Farm to the west of Chitterne and just to the north of the Salisbury sheet boundary. Here a bench has been cut into the valley side to accommodate a new barn and an exposure of 3.5 m can be seen (Figure 39).

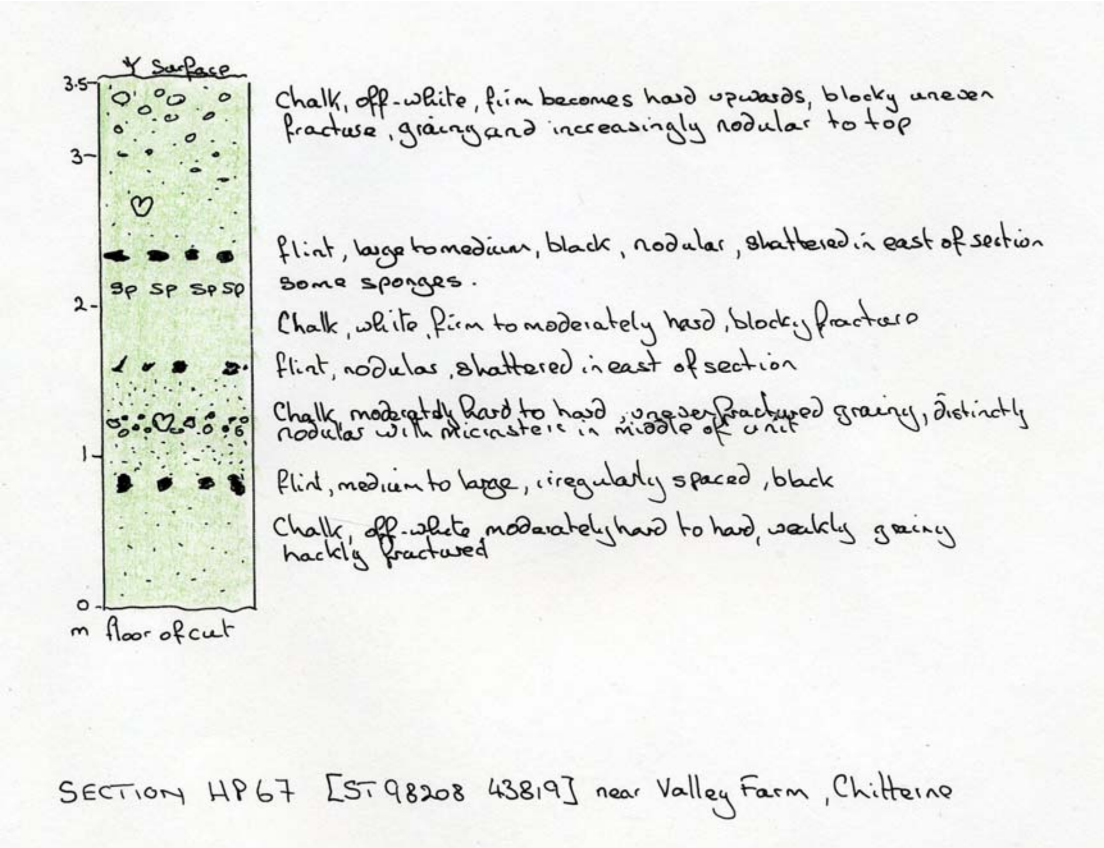


Figure 39: Section HP67 in the Lewes Nodular Chalk Formation at [ST 98208 43819] near Valley Farm, Chitterne.

ST93NW

The outcrop of the formation can be picked out easily with the copious hard nodular brash and incidence of flints within the minor valleys on the east side of Corton Down and within Sherrington Down [ST 948 371]. Mineralised porcellanous chalkstone can be seen in the brash close to the base of the outcrop.

ST93NE

The formation, marked by a copious hard nodular brash, forms a broad outcrop over upper valley slopes and broad interfluves both north and south of the River Wylye. The Chalk Rock and mineralised beds above can be seen in brash in many places. The whole succession can be seen intermittently in the worn track from Mount Pleasant [ST 9622 3878] to the Long Barrow on Boyton Down [ST 9536 3847]

Hard nodular off-white chalk and occasionally glauconite-stained chalkstone can be seen around the completely degraded pit at [ST 9562 3744] and on the opposite side of the valley to the east at [ST 9603 3750].

One of the best exposures, HP64, in the Wylye valley is to be found in a minor valley adjacent to a track at [ST 98088 36894] where about 4.5 m of bedded nodular and porcellanous chalk with three mineralised surfaces and at its base a bed of plastic grey marl can be seen (Figure 40) (see also Plates 21,22 and 23).

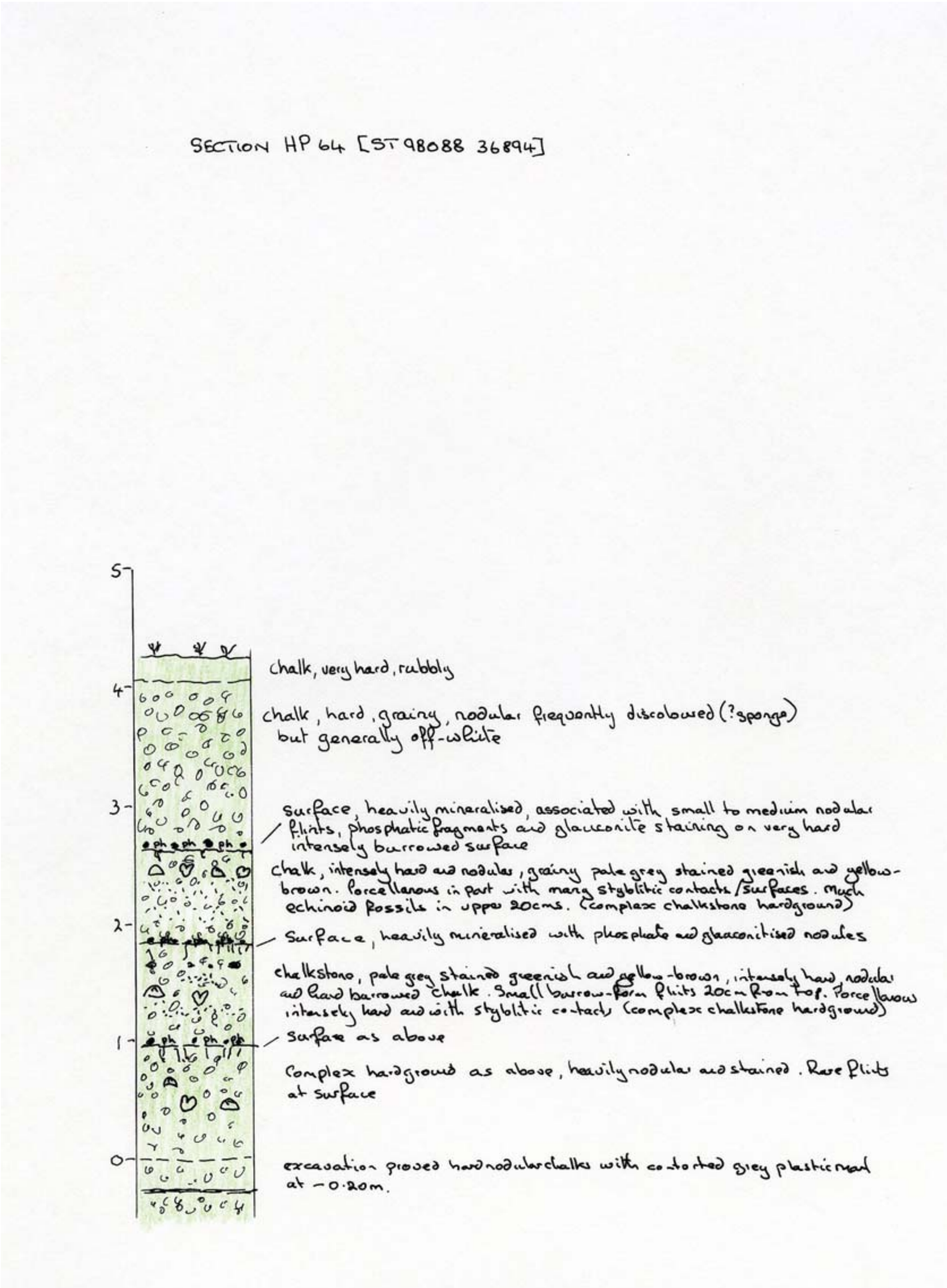


Figure 40: Section HP64 in the ‘Chalk Rock’ at the base of the Lewes Nodular Chalk Formation [ST 98088 36894]

Plate 21. Section HP64 at ST 98088 36894 in lower Lewes Nodular Chalk Formation. Photo P 598787

Plate 22. Section HP64. Close-up of nodular glauconitised chalk hardgrounds [ST 98088 36894]. Photo P 598790

Plate 23. Section HP64. Head of hammer on marl, which marks change from strongly nodular chalk to less nodular chalk in the upper part of the section. Lewes Nodular Chalk Formation. [ST98088, 36894]. Photo P584751

To the north along the same track a poor shallow and heavily overgrown pit shows the base of the formation at [ST 9323 3713] in a section only 1.5m high. Here pale grey intensely hard large blocky porcellanous chalk rests on a 5 cm grey plastic marl and firm white smooth blocky chalk.

On the east side of the minor valley noted above there was formerly an extensive exposure at Malm Pit [ST 9863 3736]. This must have exposed almost the whole of the basal 5 to 8 m of the formation but is now heavily overgrown and degraded. A badger set in the field above at [ST 9868 3748] has a brash of large blocky, intensely hard glauconitised chalkstone.

Farther east in a pit , HP65, [ST 99234 37522] adjacent to a track that divides the Short Shrub from the Long Shrub beds somewhat higher than previously seen are found (Figure 41). This pit is likely to show the highest mineralised surface in the district and possibly is the Hitch Wood Hardground of Bromley and Gale (1982).

There are no exposures on the north side of the Wylye Valley although the basal beds are easily picked out from the brash. These must have been visible in the degraded pit [ST 9793 3971] at Malm Pit Hill near Codford St Mary.

ST93SW

A very narrow outcrop near Pitchpenny Clump has the characteristic hard nodular brash but the glauconitised basal beds are not evident on this steep slope.

ST93SE

The narrow Lewes Nodular Chalk Formation outcrop straddles the Mere Fault across this sheet. It is generally steeply-dipping to the north and is frequently cut out along the fault. There are no significant exposures and the outcrop is identified on its characteristic surface brash.

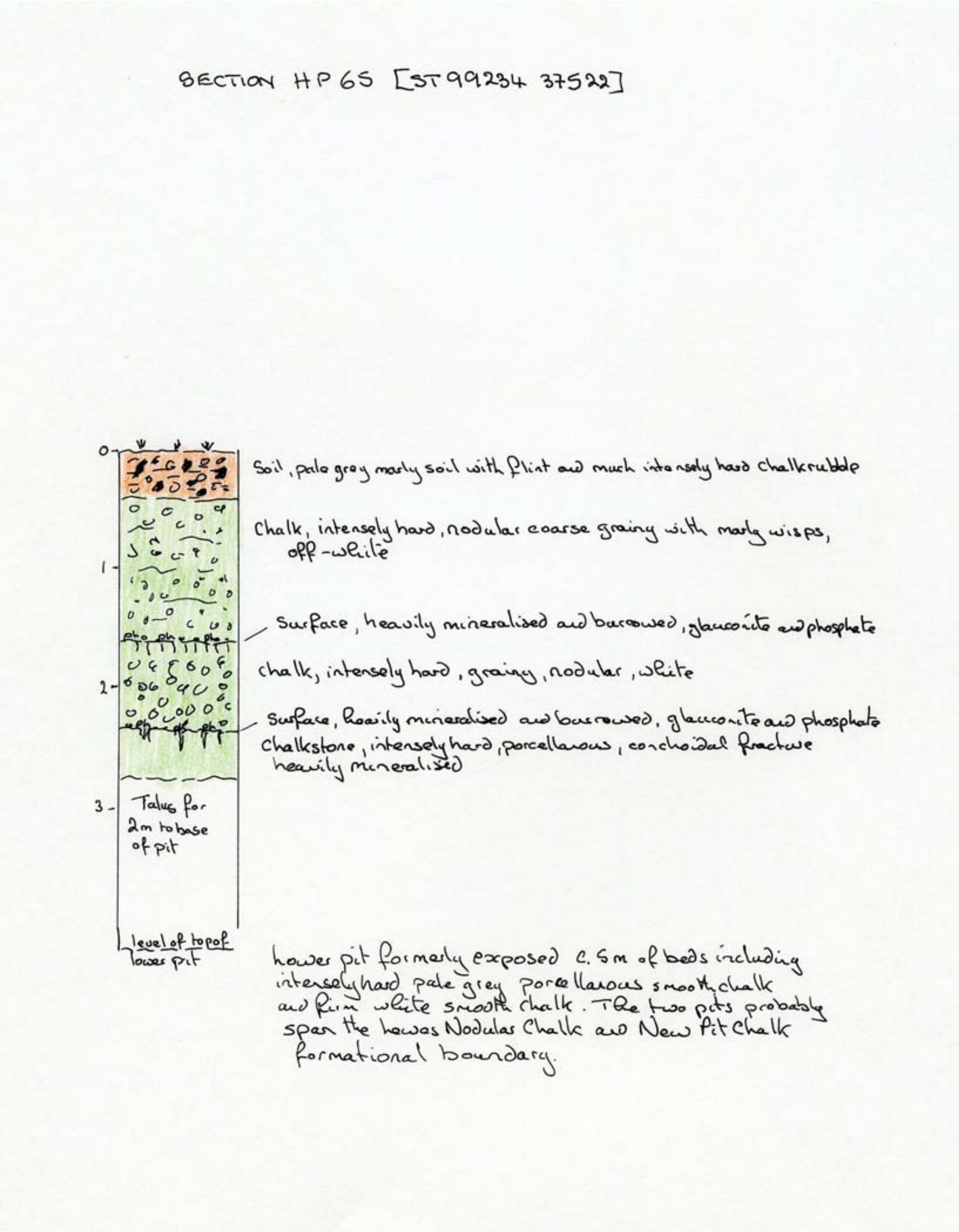


Figure 41: Section HP65 in the 'Chalk Rock' of the lower Lewes Nodular Chalk Formation at [ST 99234 37522]

Plate 24. Chalk Rock hardground of the lower Lewes Nodular Chalk Formation HP65. Head of hammer is on surface of lower of two hardgrounds exposed at this locality [ST 99234 37522]. Photo P 584753

ST92NE

The Lewes Chalk caps the top of the primary Chalk escarpment and forms much of the dipslope to the south except in the southeast corner of the sheet where it is overlain by a thin cover of Seaford Chalk. There are no old pits or sections exposed, but very hard nodular grainy flinty chalk forms an abundant brash in ploughed fields. Carious flints are particularly abundant at the top of the succession reflecting the observations made in the Avon valley to the northeast.

ST92SW

The formation caps the interfluve of White Sheet Hill where it is identified from its characteristic brash. Very hard chalkstone is frequently noted towards the base.

ST92SE

Much of the outcrop in this sheet area is in pasture but hard nodular chalks are seen frequently in the soil.

SU04SW

The Lewes Nodular Chalk Formation forms the floor and lower valley slopes of the tributary valley between Stony Hill in the west and Deptford Down in the east. There are no exposures but the base of the formation is noted by the presence of glauconitised chalkstone brash in the extreme south at [SU 010 400].

SU03NW

South of the River Wylye the formation forms the middle steep slopes in the main and tributary valleys. To the north it also forms broad interfluves north of Deptford. The major exposure [SU 0397 3755] of this formation at Steeple Langford, much quoted in the old literature, is now degraded and houses occupy the floor of the pit.

Jukes-Browne and Hill (1900) publish the following section and figure for the quarry (Figure 42 herein).

Formation	Lithology	Thickness m
Lewes Nodular Chalk Formation (with New Pit Chalk at the base-bed 9)	1 & 2 Soft white rubbly chalk with a few scattered black flints and a layer of such flints at the base	1.52
	3 Very hard nodular yellowish limestone, with many green-coated nodules, passing down into less hard nodular chalk	1.22
	4 Similar hard limestone with nodular chalk below	1.37
	5 Course of hard rocky chalk	0.30
	6 Rock and nodular chalk, like No. 3	1.22
	7 Rock as before, passing down into less hard nodular chalk	1.37
	8 Thin layer of grey marl	0.08
	9 Massive white chalk	1.83

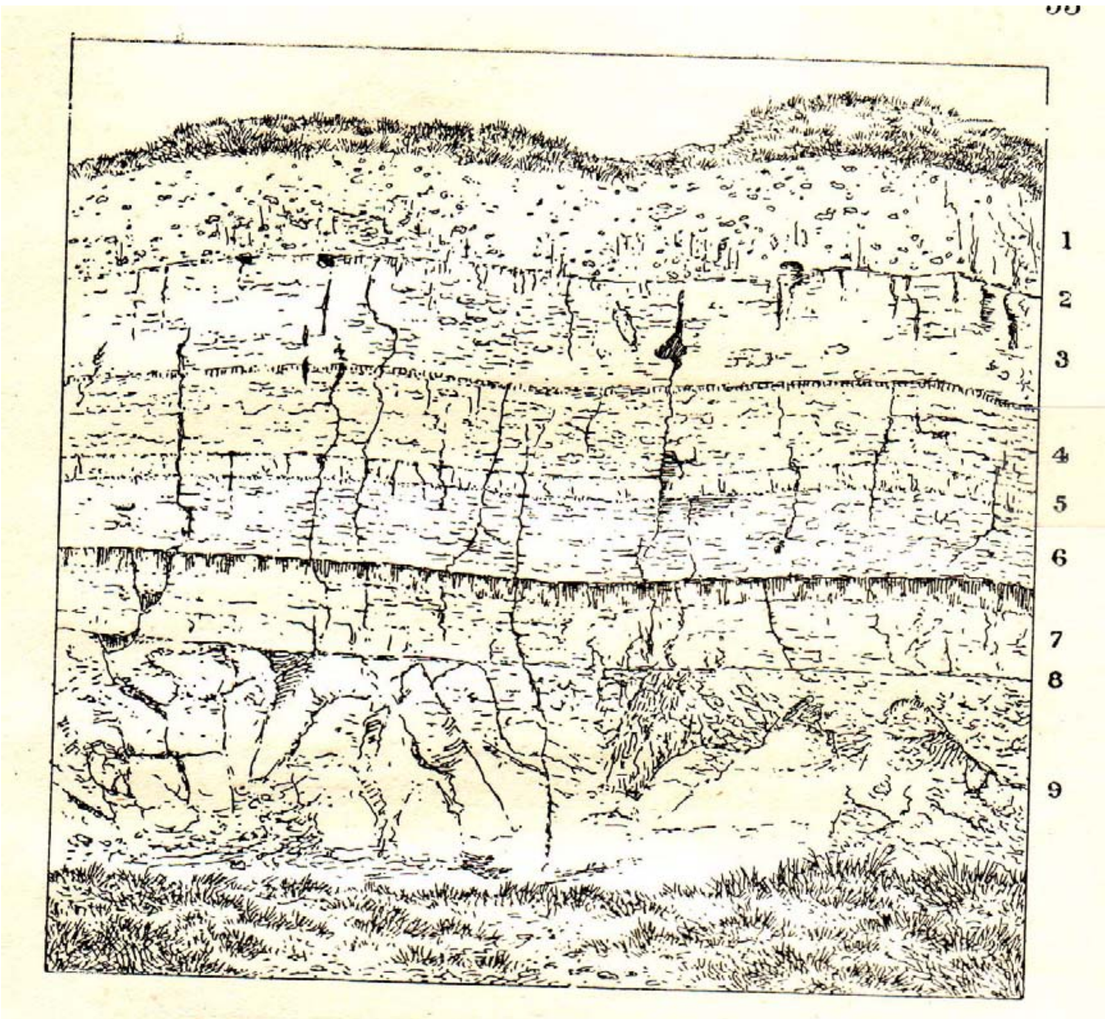


Figure 42.View of the Lewes Nodular Chalk Formation at the Steeple Langford Quarry [SU 0397 3755] (Reid, 1903).

Jukes-Browne and Hill (1900) indicate that Beds 8 and 9 belong to their “zone of *Terebratulina*”.

Bromley and Gale (1982) published the following Chalk Rock section for Steeple Langford that they correlated with the section at Berwick St James (Figure 43).

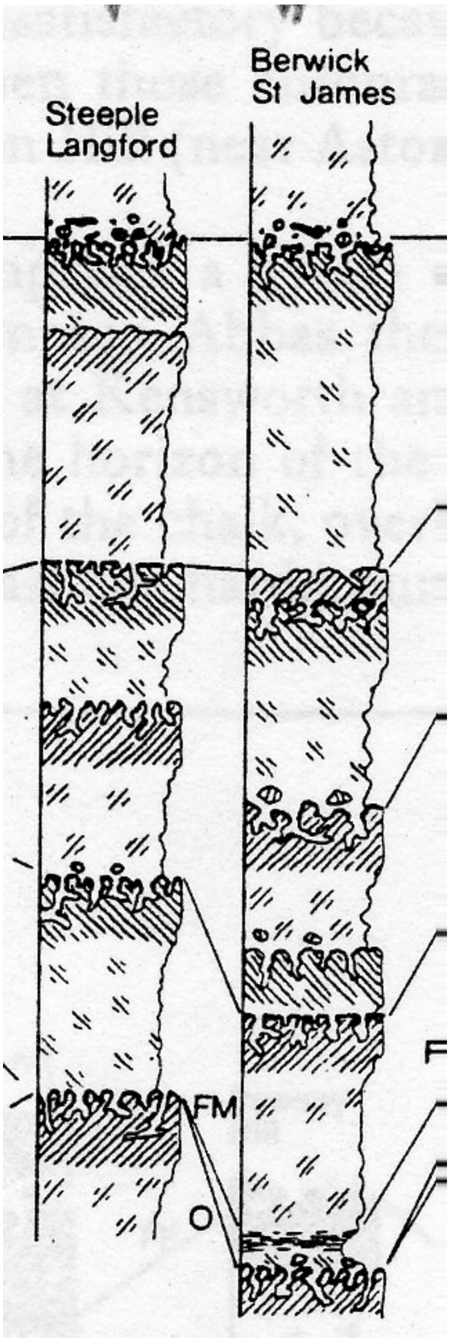


Figure 43. The Chalk Rock successions at Steeple Langford [SU 041 376] and Berwick St James [SU 075 387] after Bromley and Gale (1982). FM = Fognam Marl, O = Ogbourne Hardground, FF = Fognam Farm Hardground, LH = Leigh Hill Hardground

Field Brash at [SU 01855 38445] yielded *Echinocorys* spp. (common, including *E. gravesi*) and *Micraster normanniae?* in hard, conspicuously nodular chalk interpreted as middle Lewes Nodular Chalk (above 'Chalk Rock').

In a section [SU 0490 3634] behind the milking yard at Little Langford Farm a probable Fognam Marl is underlain by bands of hard, mineralised chalk (including a probable Ogbourne Hardground). This indicates a basal Lewes Nodular Chalk.

A small, degraded, pit at [SU 0014 3656] exposed about 5 m of nodular and rubbly hard to very hard cream-coloured chalk with four distinct hardgrounds between 0.6 and 1.1 m apart. This must be within the higher part of the Chalk Rock succession.

A degraded and overgrown roadside pit at [SU 0092 3717] contained much hard to very hard nodular chalks but without visible glauconite suggesting a position in the succession above the Chalk Rock.

A section behind a barn at [SU 0240 3662] exposed 1.5m of highly fractured blocky, hard chalk. This exposure is interpreted as marking the base of the Lewes Nodular Chalk Formation.

SU03NE

The outcrop of the formation covers the lower valley slopes of the Wylye between Little Langford and Great Wishford and also northward into the River Till valley northward to the White Lodge [SU 078 397]. On the south side of the valley there are no significant exposures but the formation outcrops on the valley flank. The Berwick St. James exposure noted by Bromley and Gale (1982) [SU 075 387] was overgrown and degraded (see Figure 43).

Jukes-Browne and Hill (1900) noted three localities (in quotes below with other details appended) where the formation was seen in section.

"The upper part of the Chalk Rock can also be seen in the river cliff [SU 073 357] about a quarter of a mile north-west of Wishford church, 10 feet (3.05 m) of the rocky beds with green-coated nodules being overlain by 12 feet (3.66 m) of nodular white chalk containing five layers of nodular flints, and three continuous layers or flint floors. These 12 feet (3.66 m) may be referred to the zone of *M. cortestudinarium*." Observations during the 2003 survey show that this former exposure is now degraded and the Lotmoor Chalk river cliff [SU 0752 3563] is now mostly formed of scree, but includes some very small exposures. Scree includes mostly hard Chalk but a small exposure proves softer Chalks. This is in the vicinity of the Lewes and Seaford Chalks' boundary.

"A quarry [SU 0729 3701] just east of the cross roads at Stapleford is probably opened in the latter zone. Mr Bennett states that it is about 20 feet (6.10 m) deep, and combining his account with that given of it by Dr Barrois, the section, now much talused, appears to have been:"

Formation	Lithology	Thickness m
Lewes Nodular Chalk formation	Hard white chalk with a few black flints and several flint seams, *Cidaris subvesiculosa* and *Micraster cortestudinarium*	3.05
	Hard nodular chalk with yellowish stains	0.91
	White chalk with flints, both nodules and continuous floors, talused, but dug for	2.13

During the 2003 survey M A Woods visited this section and produced the graphic log below. A limited fauna included *Cremoceramus* sp. (probably *C. crassus* or *C. deformis*) in c. 6 m of hard, nodular chalk with a conspicuous hardground at the base of the section (possibly the Hope Gap Hardground). He attributes the section to the upper Lewes Nodular Chalk. The Stapleford disused Chalk pit [SU 0729 3700] exposes a weathered 6 m high sequence of nodular chalks with 5 tabular flint bands and 3 nodular flint bands. There are also hardgrounds in the sequence, which are likely to be those higher up in the Lewes Chalk sequence. *Platyceramus* brash is present in the arable field above the pit indicating the presence of Seaford Chalk.

Jukes-Browne and Hill (1900) noted "what appears to be the summit of this zone, and its junction with that of *M. coranguinum*, is exposed in a quarry at the north end of Wishford: the following is Dr Barrois' account, with the thicknesses corrected by Mr Bennett:"

Formation	Lithology	Thickness m
Seaford Chalk Formation	Soft white chalk with many layers of flints and several flint seams, also joints filled with flint. *Echinocorys gibbus* and *Micraster coranguinum*	4.57
Lewes Nodular	Hard yellowish nodular chalk	0.15

Chalk formation	Rather hard chalk with scattered flints	1.83

This section appears to be the disused Chalk pit [SU 0832 3585] near Mount Pleasant and called the Stoford Pit by M A Woods. This pit is largely overgrown and degraded and exposure is limited to two small faces at the top of the pit 1 m to 2 m high and 4 m long (Figure 44). This is a soft chalk with both sheet and nodular flint bands. The dip is 4° to the south and there is a major sub-vertical jointing dipping 80° to the east-northeast. There are some harder chalks near the base, with sponges, that contain *Cremnoceramus*. There are two well developed marl seams about 3 m apart that may be the Shoreham Marls (MAW), which represent the Lewes/Seaford Chalk boundary. *Platyceramus* is present as brash in the adjacent arable fields above the pit.

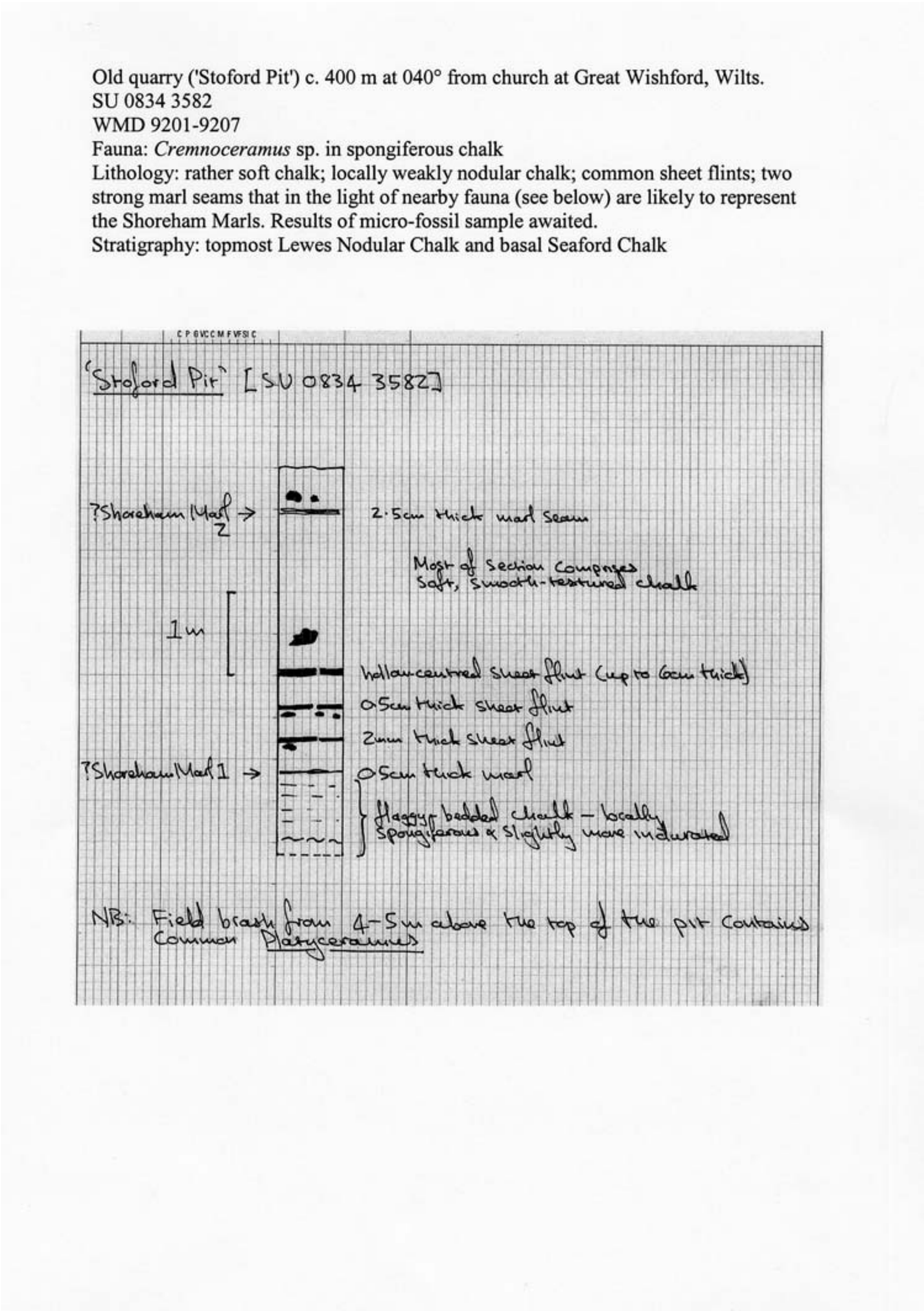


Figure 44. The Lewes Nodular Chalk Formation exposed at the Stoford Pit [SU 0834 3582]

On the north side of the Wylye valley a trackside exposure [SU 05562 37148] west of Hunter’s Lodge, includes *Plesiocorys* (*Sternotaxis*) *plana* in soft chalk a few metres below the 'Chalk Rock'. Nearby outcrops show the occurrence of a weakly developed Ogbourne Hardground below the thick (10-15cm) Fognam Marl; the marl is overlain by four further hardgrounds. The exposure is in the basal Lewes Nodular Chalk.

Plate 25. Small pit in Lewes Nodular Chalk Formation, Wylye valley near Stapleford, close up of thick marl seam (Fognam Marl). [SU05517, 37260]. Photo P584673

SU03SW

The Lewes Nodular Chalk outcrops in a narrow, steeply dipping band, running parallel with the Mere Fault, and extends from Barford St Martin, through Baverstock Manor Farm towards Marshwood. The maximum width of the outcrop is 150m. Across most of the outcrop exposure is poor, and west of Baverstock, the Mere Fault cuts out the formation in several places.

The best exposure is in an old pit, 1km east of Baverstock at [SU 0376 3223]. Here good nodular chalk with several hardgrounds and marl seams is exposed and dips at 22° at 050°. Unfortunately, access was restricted and it was not possible to study this section further.

SU03SE

The formation outcrops in two distinct localities. In the west at the closure of the Vale of Wardour the formation is seen as a narrow band on either side of the Mere Fault and has a wide spur-top outcrop southwest of Burcombe. In the east the formation is again seen on either side of the Wylye valley. Here the outcrop forms the steep lower valley flank from Wishford in the north until its south-easterly dip carries it beneath the floodplain north of Wilton.

There are few exposures within the Wylye valley on this sheet. The outcrop is however covered with a characteristic nodular flinty brash. It was not possible to visit the sections within the railway cuttings from [SU 0889 3302 to 0850 3369] as the line is very busy, the cutting narrow and access points very limited. Observation from outside the boundary indicates that there are a number of small exposures, some heavily overgrown, that have a very nodular appearance and contain flint courses. This would indicate the middle to upper part of the formation is visible. It appears that this railway line was not visited by either Jukes-Browne and Hill (1900) nor Reid (1903) or at least showed no sections worth noting.

Plate 26. Baverstock Pit. Inferred Fognam Marl in lower Lewes Nodular Chalk Formation. [SU03770, 32250]. Photo P 584760

In the west around Barford St Martin and Burcombe a number of exposures have been noted. The most complete section is that noted by Jukes-Browne and Hill (1900) in the cutting for the railways north of Barford. From their locality details this is probably the cutting between [SU 0550 3171 and 0571 3167].

Formation	Lithology	Thickness m
Lewes Nodular Chalk formation	Hard lumpy chalk with scattered nodules of black flint, very gritty and yellowish in some places (? zone of *M. cortestudinarium*)	3.66
	Hard and heavy nodular limestone with yellow stains, in two layers, the upper full of green-coated nodules	0.38
	Hard yellowish limestone passing down into hard rough nodular chalk	1.02
	Parting of white shaly chalk	-
	Hard nodular chalk	0.38
	Hard yellowish limestone with a layer of green-coated nodules at top, passing down rough lumpy chalk. *Ter. carnea* (?) and *Micraster*	2.13
	Soft yellowish-grey marl	0.08
	Rough nodular chalk with yellow stains, very hard in places, same fossils	1.37
	Parting of buff shaly marl	-
	Nodular white chalk with two layers of grey sandy and shaly chalk	1.37

	Hard nodular limestone with a layer of green-coated nodules, probably the bottom bed of Chalk-rock	0.91+

They continued to write "it will be seen that the zone of *Holaster planus* (*Plesiocorys plana*) or Chalk Rock has here a thickness of 25 feet (7.62 m). The thickness of the overlying lumpy chalk is uncertain, but in the cutting east of the bridge ([SU 0585 3165 to 0616 3161]) 5 feet (1.52 m) of it are seen overlain by soft white chalk with four continuous layers of flint, and as the upper rock bed occurs at the base of this cutting there is probably from 15 to 16 feet (4.57 to 4.88 m) of the lumpy chalk between, containing Micrasters of the *cortestudinarium* type."

Jukes-Browne and Hill (1900) also identified another pit "in the road cutting at the head of the Punch Bowl near Burcombe" This site could not be found with any degree of certainty but is likely to be at the Cross Dykes [SU 067 296] where the lowest beds of the formation are again found. Their section is given in the relevant sheet details below.

During the 2003 survey the formation was identified at a number of small pits around Manor Farm [SU 0709 3059], Burcombe. There are three small exposures in the lower valley slopes and base of the valley in this area demonstrating a total thickness of about 10 m. They are all degraded with scree faces consisting of solid blocks of Chalk. It is not possible to measure the dip, but the regional dip is to the north. The Top Rock and Hitchwood Hardgrounds may be present in the current exposures (MAW). Where visible the chalk here is both strongly and weakly nodular chalk and includes a fauna of *Cremnoceramus crassus*, *Cremnoceramus* sp., and *Micraster cortestudinarium?* Which suggest a level within the upper Lewes Nodular Chalk.

The disused pit to the west of North Burcombe Church [SU 0726 3118] is degraded, but chalk debris is largely of a hard nodular chalk.

SU02NW

The formation outcrops on the higher steep slopes of the primary scarp between Burcombe Ivers [SU 046 292] and Fovant Hut [SU 001 266] and within the tributary valleys of the Vale of Broad Chalke. Typical field brash consists of very hard nodular white chalk with rubbly, uneven flints.

A good exposure can be seen in an old pit at Chalk Pyt Farm [SU 0360 2600], Broad Chalke where c. 1.5 m of hard, blocky chalk is overlain by c. 3.5m of hard, nodular chalk with abundant hardgrounds and marl seams (Figure 45). The lowermost part of the section is thought to be uppermost New Pit Chalk with the higher part in Lewes Nodular Chalk with the 'Chalk Rock' exposed. *Labyrinthidoma* in inferred Fognam Marl was identified. The beds had an apparent 3-4^{o} dip to the SE. This pit lies close to the inferred line of a fault, which crosses the area in a general NW – SE direction.

Exposure adjacent to barns at Chalk Pyt Farm, Broad Chalke, Wilts.
SU 0360 2600
WMD 9322-9335
Fauna: *Labyrinthidoma* in inferred Fognam Marl
Lithology: c. 1.5 m of hard, blocky chalk overlain by 3.48 m of hard, nodular chalk with hardgrounds and marl seams.
Stratigraphy: topmost New Pit Chalk & basal Lewes Nodular Chalk.

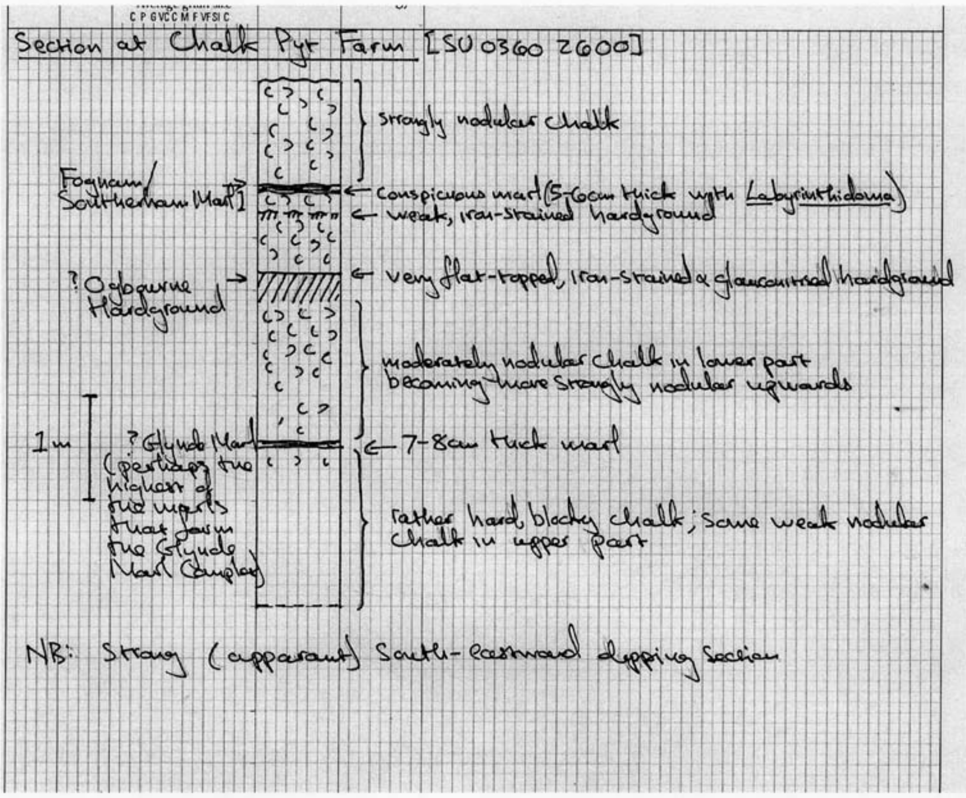


Figure 45: Chalk Pyt Farm section [SU 0360 2600] in lower Lewes Nodular Chalk Formation

An old chalk pit [SU 0070 2560] on Fifield Down exposed a poor section in hard, nodular chalk with marls and hardgrounds, underlain by firm, non-nodular, blocky chalk (Figure 46). The whole fauna includes *Labyrinthidoma*, and *Terebratulina lata* indicating the upper New Pit Chalk & basal Lewes Nodular Chalk (including Fognam Marl).

Old chalk pit on Fifield Down, c. 1.2 km at 294° from Manor Farm, Fifield Bravant, Wilts.
SU 0070 2560
WMD 9279-9286
Fauna: *Labyrinthidoma*, *Terebratulina lata*
Lithology: hard, nodular chalk with marls and hardgrounds, underlain by firm, non-nodular, blocky chalk.
Stratigraphy: upper New Pit Chalk & basal Lewes Nodular Chalk (including Fognam Marl).

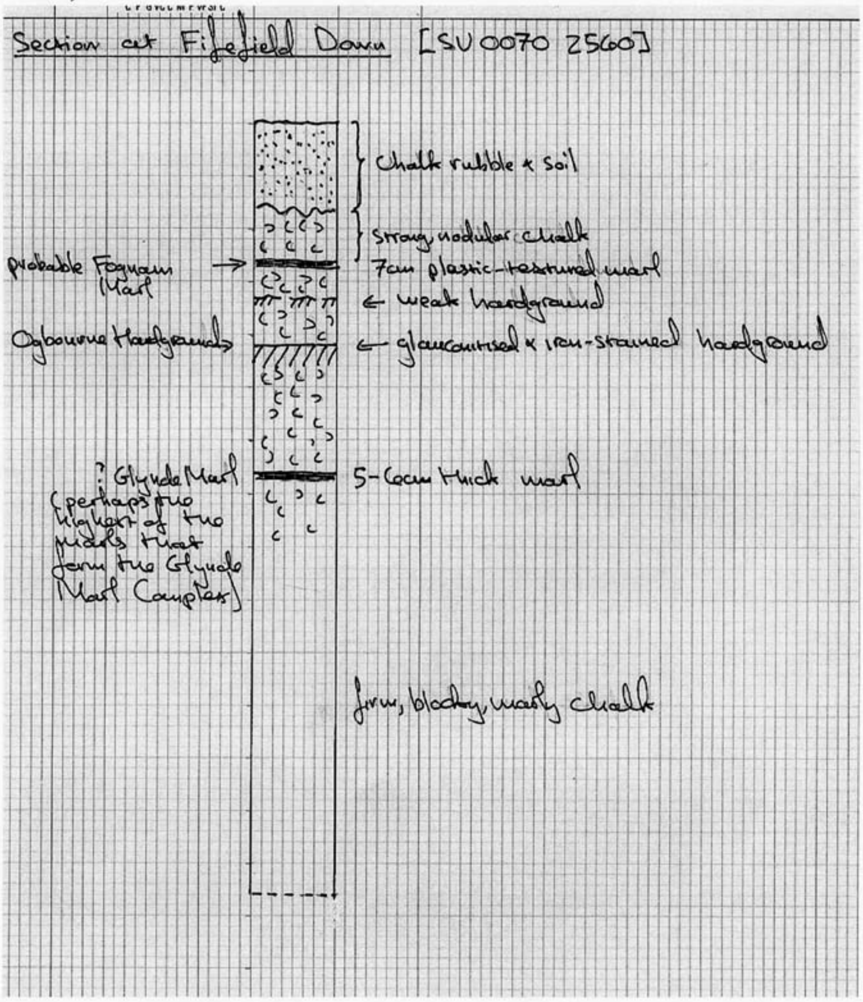


Figure 46: Section in Lower Lewes Nodular Chalk Formation at Fyfield Down [SU 0070 2560]

SU02NE

The formation outcrops on the higher slopes of the primary chalk escarpment around Hoop Side [SU 059 292] and in the valley of the River Ebble around Bishopstone and Stratford Tony.

The exposure [SU 0533 2673] near Stoke Farm has two faces each up to 7 m high and 25 m long of nodular chalks. The lower part of the exposure contains two hard grounds both about 1 m thick and considered to be within the lower Lewes Chalk succession and part of the Chalk Rock. The Fognam Marl is not seen and presumed to be below the base of the pit. The upper part of the exposure shows a channel feature, which includes 'soil debris' (photo). The dip is 3° to the southeast.

Exposure in a road cutting [SU 0518 2660] shows hard nodular Lewes Chalk with a dip of 3° to the southeast.

The disused Chalk pit [SU 0822 2836] on Portfield Road has a degraded face up to 4 m high. The macrofossil evidence was weak but *Cremnoceramus* sp. and *Micraster* sp. are present in hard, nodular chalk and the upper Lewes Nodular Chalk is inferred. Field brash collected nearby included flint casts of *Echinocorys* spp. and *Micraster* sp. The morphology of the *Micraster* is consistent with assignment to upper Lewes Nodular Chalk.

The brash in the arable field behind Bishopstone council houses [SU 0764 2644] includes much porcellanous Chalk, indicative of the hard grounds of the Lewes Nodular Chalk succession.

The overgrown exposure in the side of the track at Chalk Hollow [SU 07015 26317] showed soft massive flint less chalk with marl seams including *Terebratulina lata*, *Inoceramus cuvieri*, *Labyrinthidoma*. This section appears to be within the highest New Pit Chalk and one of the thicker marls may be the Frognam Marl at the base of the Lewes Nodular Chalk. Brash from the lower hard grounds of the Lewes Nodular Chalk are clearly visible in the adjacent arable field above the exposure

In a trackside exposure between [SU 05095 26405 to 05132 26457], hard, nodular chalk with locally conspicuous grains of glauconite including *Inoceramus cuvieri* and *Micraster* sp. (smooth ambulacra possibly representing *M. leskei* (large form)) indicates a level low in the Lewes Nodular Chalk.

Jukes-Browne and Hill (1900) identified a site "in the road cutting at the head of the "Punch Bowl"". This may be near to the Cross Dykes [SU 067 296] although the site has not been identified during the 2003 survey.

Formation	Lithology	Thickness m
Lewes Nodular Chalk Formation (Zone of *Holaster planus*)	Hard compact yellow limestone	0.46
	Hard rough nodular chalk	3.05
	Layer of soft marl	-
	Hard rough nodular chalk with yellow stains	1.83
	Tough gritty whitish chalk, splitting into flattish lumps with lenticular seams of greyish marl	1.52
	Hard nodular rock with two layers of greencoated nodules; passes into next	1.07
Lewes Nodular and New Pit Chalk formations (Zone of *Terebratulina lata*)	Tough and lumpy white chalk	1.52
	Seam of light grey marl	0.10
	Bedded white chalk	0.91+

SU02SW & SU02SE

The Lewes Nodular Chalk Formation forms the higher valley slopes and part of the broad interfluves within the tributary valleys to the south of the Vale of Broad Chalke. There are no significant exposures but the characteristic nodular chalk brash with flints is noted in many places.

SU13NW

Within the River Avon valley there is an inlier of the upper part of the Lewes Nodular Chalk Formation that stretches for some 2.5 km from Upper Woodford southwards to Lower Woodford. The formation, brought up in the core of the gentle High Post Anticline, is exposed at a number of localities, one of which was identified by Jukes-Browne and Hill (1900).

A roadside pit at upper Woodford [SU 1235 3700] exposes 7.5m of weakly nodular, blocky white chalk with several major sheet flints and nodular flint seams (Figure 47). *Platyceramus* fragments were collected from near the top of the pit indicating that the basal Seaford Chalk Formation forms the uppermost 2 m or so of the visible face (above the marl 5.8 m from the base that is equated to the Shoreham Marl 2.

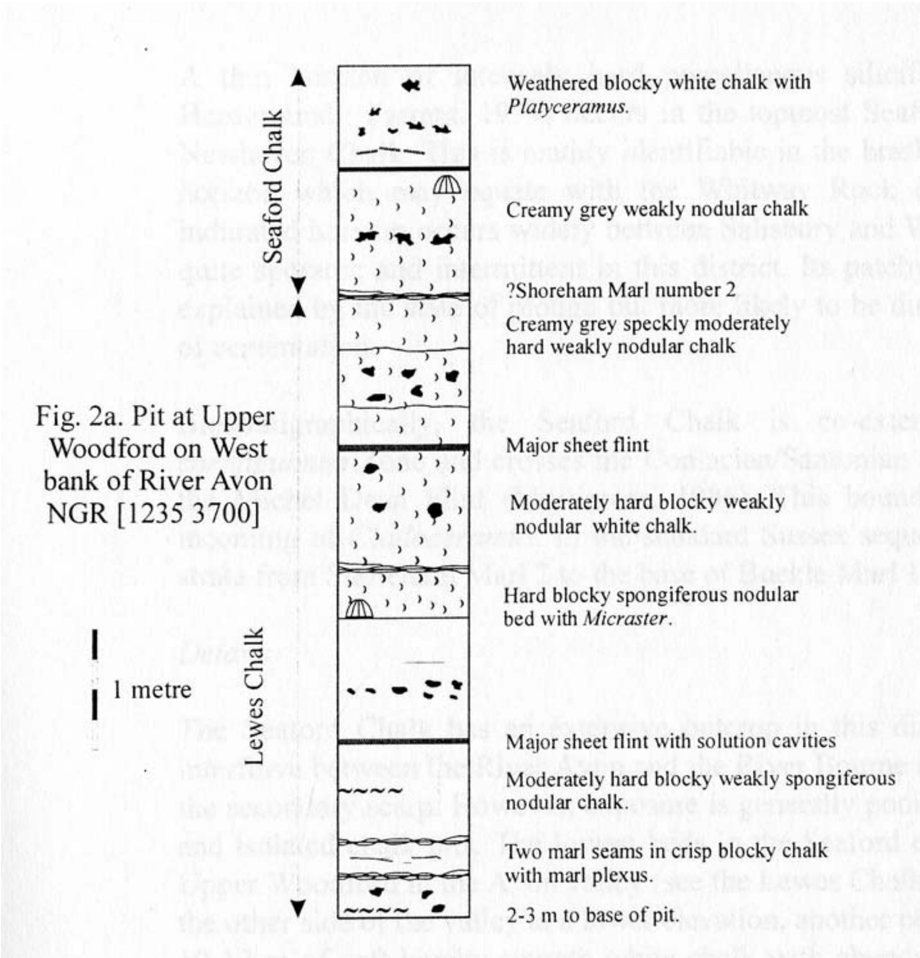


Figure 47: The uppermost Lewes Nodular Chalk Formation and basal Seaford Chalk Formation in the pit at Upper Woodford [SU 1235 3700]. (Woods, 1999c, fig. 2a)

To the south at Middle Woodford [SU 1204 3572] an exposure of about 4 m of spongiferous nodular yellowish chalk is separated by marl from about 3 m of white chalk with flints. The marl is equated with the Shoreham Marl 2 and therefore separates the Lewes Nodular Chalk below, from the Seaford Chalk above. This locality is thought to be that mentioned by Jukes-Browne and Hill (1900) for which he produced the following notes.

Formation	Lithology	Thickness m
Seaford Chalk Formation	Soft white chalk with many layers of flint nodules, and some large masses of flint	7.32
Lewes Nodular Chalk formation	Hard yellowish nodular chalk with marked plane of division at top	0.61
	Hard yellowish nodular chalk, with nodular upper surface, enclosing many flints of irregular shapes and often hollow, with *Doryderma ramose* (*Doryderma roemeri*)	0.61
	Softer white chalk with numerous flints and a seam of continuous flint	3.05

In addition the fauna quoted for the locality from the lower three beds included *Micraster*, *Cidaris clavigera* (*Tylocidaris clavigera*) spines, *Terebratula semiglobosa* (*Gibbithyris semiglobosa*) and

Rhynchonella reedensis (*Orbirhynchia reedensis*) and *Coscinopora infundibuliformis* (probably a bryozoan).

SU12NW

The formation forms the narrow outcrop on the flanks of Hommington Down, north of the Coombe Bissett Fault and the broad interfluves south of the River Ebble.

Jukes-Browne and Hill (1900) record a road cutting north of Hommington where “the hard, yellowish basement rock is seen to dip northward at about 8 deg., and to be overlain by about 20 feet (6.10 m) of nodular rock with some scattered flints and another hard bed at the top.” The exact location is not known but it must be in the road climbing the valley at about [SU 1255 2650] and would indicate that the underlying New Pit Chalk Formation must be close to the surface hereabouts adjacent to the fault

A small outcrop [SU 10317 25065] in field above Lower Coombe Farm, near Coombe Bissett exposed hard, nodular, glauconitic chalk inferred to represent part of the 'Chalk Rock' and included (*?*) *Inoceramus* ex gr. *lamarcki.*

Field brash [SU 10001 26388] comprising very hard, nodular chalk included *Micraster corbovis* (*lata* Zone type) indicating a position in the lower Lewes Nodular Chalk.

An old chalk pit [SU 1322 2604] south of the Homington to Odstock road comprises a couple of metres of very hard, nodular chalk with a thick plastic-textured marl and two moderately well developed hardgrounds (Figure 48). There is a marked eastward apparent dip.

The fauna from the marl includes the brachiopod *Terebratulina lata*, and this also occurs in the highest metre of exposure, together with common *Inoceramus cuvieri*.

The marl is assumed to be the correlative of the Fognam Marl / Southerham Marl 1, but the large agglutinating foraminifer (*Labyrinthidoma*) which characterises this horizon, was not found. The hardground below the marl is presumed to be the Ogbourne Hardground and/or Pewsey Hardground, and that above the marl the Fognam Farm Hardground. These hardgrounds form the basal part of the Chalk Rock, and are likely to occur almost at the base of the Lewes Nodular Chalk Formation in the Salisbury district.

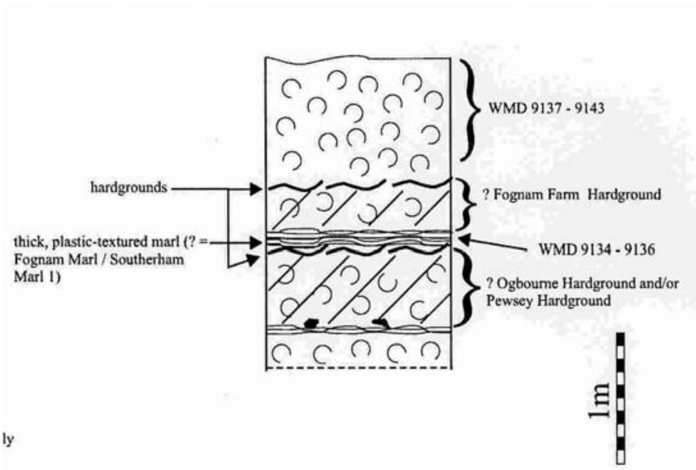


Figure 48. The Lewes Nodular Chalk Formation in the old chalk pit south of the Odstock – Homington Road [SU 1322 2604]. WMD = fossil collecting numbers.

SU12SW

Field brash north of Parsonage Farm [SU 10798 24933] comprised very hard, nodular, spongiferous chalk with *Mytiloides costellatus* and *? M. striatoconcentricus* indicating the lower to middle part of the Lewes Nodular Chalk.

6.2.4 Seaford Chalk Formation

The Seaford Chalk is between 60 and 70m thick and outcrops over a wide area of the Salisbury Sheet. It underlies much of the Chalk dip slope and broad interfluves between the primary escarpment and the negative break of slope below the secondary Chalk escarpment. Topographically, the Seaford Chalk forms characteristic smooth convex slopes of the major ridges between the river Ebble, Nadder, Wylye, Avon and Bourne, and the rounded quite steep sided valley sides. Examples can be seen in the Bourne valley around Idmiston.

The Seaford Chalk is composed primarily of soft smooth blocky white chalk with abundant seams of large nodular and semi-tabular flint, with thin harder nodular chalk near the base. The flints in the lower part of the unit are often highly carious whereas higher in the sequence the flints are black and bluish black mottled grey with a thin white cortex. These flints commonly enclose shell fragments. Some of the large flint bands, notably the Seven Sisters Flint (Mortimore, 1986), form almost continuous seams and in places create local topographic features. Examples can be seen around Boscombe Down and Idmiston. Thin planar sheet flints are common in parts of the sequence.

Typically in brash the lower part of the Seaford is very similar to the upper part of the Lewes Chalk, and even in exposures they can be hard to distinguish. The lower Seaford Chalk contains an abundance of fragments of the bivalves *Volviceramus* and *Platyceramus*, whilst the upper part contains *Cladoceramus* and *Platyceramus* (Mortimore, 1986). In the absence of these bivalves the flaggy nature and pure whiteness of the soft chalk serves to distinguish it from the Lewes Chalk below. About 15 to 20 m up in the Seaford Chalk succession a very large semi-tabular flint (often up to 30 cms thick) with characteristic brown staining is frequently found as field brash or more commonly as 'field-picked' cairns on the margins of ploughed fields. This is equated with the Seven Sister's Flint and can be distinguished from other large flints by its usual content of *Platyceramus* and *Volviceramus* bivalves.

Another particularly characteristic semi-tabular flint occurs near the top of the Seaford Chalk in the present area, about 11 m below the base of the Newhaven Chalk. This flint is generally about 10 cm in thickness, of uniform appearance, and tends to fracture vertically. The blocks thus formed are up to 50 cm across and are fairly conspicuous in ploughed fields. This flint bed is tentatively correlated with Whittaker's Three Inch Band of the North Downs (described by Robinson, 1986), which is probably equivalent to the Rough Brow Flint of the Sussex coast (Mortimore, 1986). However, no biostratigraphic information has so far been found to support this correlation.

Above this flint band is a thin (1-2m) horizon of intensely hard porcellanous indurated chalk (the 'Winchester Hardground'), Farrant (1999), now formally called the Stockbridge Rock Member), about 5m below the Newhaven Chalk and is shown on the 1:10 000 maps as a Limestone bed. It contains abundant sponge spicules, most commonly as moulds, together with some complete sponges. This is readily identifiable in the brash and forms a useful marker horizon. It occurs at about the level of Barrois' Sponge Bed and the Clandon Hardground of the North Downs (Robinson, 1986) and may equate with the Whitway Rock of the Newbury area (Sumbler, 1996). In Kent, Rowe's Echinoid Band, a bed of about 30 cm containing an acme occurrence of *Conulus* sp. with other echinoids, occurs just above Barrois's Sponge Bed (Robinson, 1986) and is known to occur just above the Stockbridge Rock Member. The Stockbridge Rock Member occurs widely between Salisbury and Winchester, but appears to be quite sporadic and intermittent in the west of the district, and has not been recorded north of Tidworth nor within the outcrops to the west. Its patchy distribution may be partly explained by the state of plough but more likely to be due to variations in the degree of cementation. As yet it has not been seen in section so its true origin is open to debate. Field evidence from the Winchester area (Farrant, 2000), suggests that there might be several thin hard bands between 5 m and 10 m below the base of the Newhaven Chalk in those areas, each separated by short intervals of white chalk. Flint nodules enclosing the echinoid *Echinocorys* have been found as brash a few metres below the base of the Newhaven Chalk in several places throughout the area north of Salisbury.

Biostratigraphically, the Seaford Chalk is co-extensive with the *Micraster coranguinum* Zone and crosses the Coniacian/Santonian boundary that is placed at the Michel Dean Flint (Mortimore, 1986). This boundary is also marked by the incoming of *Cladoceramus*. In the standard Sussex sequence the member covers the strata from Shoreham Marl 2 to the base of Buckle Marl 1.

Jukes-Browne and Hill (1900) estimated the thickness of the *M. coranguinum* zone based on…. "the quarry on Camp Down [SU13SW], between the valleys of the Wylye and the Avon, is 200 feet (60.96 m) above the rivers ; this quarry is in the *M. coranguinum* zone, and the beds are horizontal, while its base is probably at about the level of the Avon stream. Hence there is over 200 feet (60.96 m) of this zone."

Details

ST94SE

The Seaford Chalk Formation forms the broad interfluves of the highest part of Codford Down and more extensively on East Codford Down from Codford Circle (Wilsbury Ring) [ST 982 405] to Clay Pit Hill [ST 994 424] to the east of the Chitterne Brook valley. Over the highest part of the interfluve north of Clay Pit Hill a thin veneer of the Clay-with- flints is mapped overlying the formation.

There a no significant exposures within the Salisbury district but to the north an excavation [ST 9941 4309] for a factory shows 3.2 m of white blocky, moderately hard, smooth chalk with widely spaced large nodular flints. Within the middle of this succession the chalk becomes marly and pale grey but there are no discernable bounding surfaces. All of the chalks contain *Platyceramus*.

Elsewhere its copious white, firm, flaky to blocky chalk brash and nodular flints within which *Platyceramus* fragments can commonly be found, identifies the formation.

ST93NW

The formation forms the broad interfluve of Great Ridge (capped by clay-with-flints) and the long slopes northward into the Wylye valley. There are no significant exposures of the formation within the district and much of the ground on and north of the Great Ridge is in pasture. The fact that Great Ridge itself represents a significant east-west trending anticline is born-out by the common co-occurrence, adjacent to the crest, of *Platyceramus* and *Volviceramus* bivalve fragments in field brash. Both species are common in the lower half of the formation.

ST93NE

The principal outcrop is in the south of the sheet forming Great Ridge. Here the highest part of the formation is masked by a cover of clay-with-flints and it may well be that a thin veneer of the overlying Newhaven Chalk Formation intervenes beneath Stockton Wood [ST 967 357]. To the northeast the Seaford Chalk is again seen on the interfluve northeast of Starveall [ST 9944 3932]

The only notable exposure [ST 98187 36088] is on the flanks of the coombe known as Roakham Bottom. The quarry exposes about 6.5 m of sift to firm, white, smooth chalk with regular seams of flint and three distinct acmes of *Platyceramus* (Figure 49). This would indicate that the lower part of the formation is visible here.

There are two small pits at Wylye Down Buildings [ST 997 353] but they are both degraded and only a poor section of soft white blocky chalk was visible behind a barn in the most westerly of these.

A small pit near Coronation Plantation [ST 9608 3597] is degraded but a face about 3.5 m high in soft to firm white smooth chalk with two nodular flint seams at 0.8 m and 1.2m from the base was noted. Access into the pit is difficult and it has been used for the burning of farm waste which elsewhere renders the chalk hard and brittle with a pinkish grey tinge.

Further west a small round pit [ST 9552 3583] about two metres deep and totally degraded has two drainage sumps (dolines) in its base that take field drainage from the clay-with-flints cover immediately to the south.

Boreholes along the line of the proposed A303 dual carriageway on the south side of Great Ridge all have spoil comprising white firm smooth chalk with large nodular flints. At a number of these borehole sites the spoil also contains chalks with *Platyceramus* and *Volviceramus* fragments.

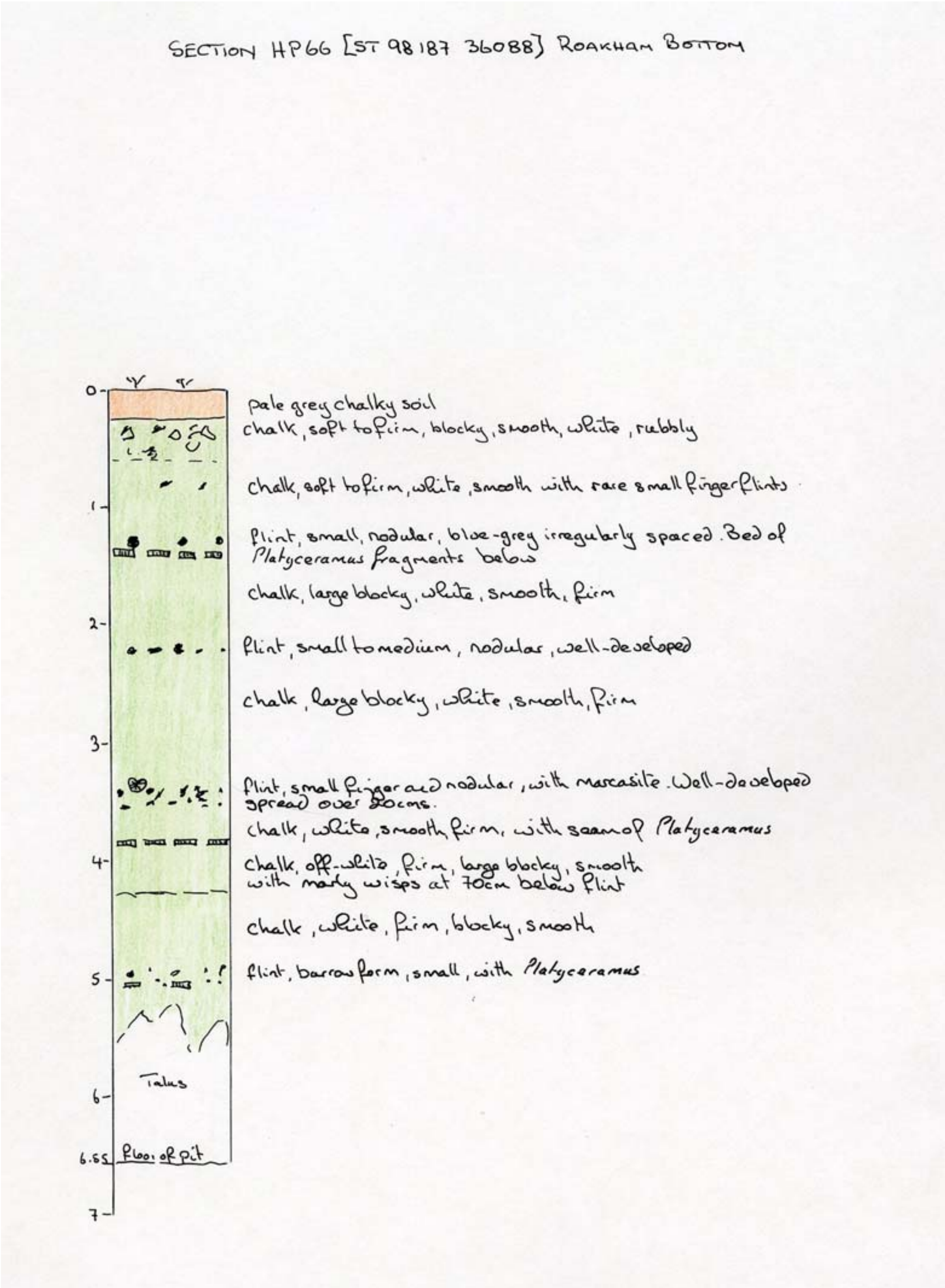


Figure 49: Section HP66 in Seaford Chalk Formation [ST 89187 36088], Roakham Bottom

Elsewhere the outcrop is distinguished from its copious firm white chalk and flint brash. The brash from the lower 20 m or so of the formation commonly contains significant amounts of *Platyceramus*.

ST93SW

There is a broad outcrop of the formation on the southern slopes of Great Ridge and down into the valley running north from Fonthill Bishop. The brash in this area has common *Platyceramus* and *Volviceramus*. There are no exposures.

ST93SE

The Seaford Chalk Formation forms the long rounded slopes for some 2 km southward from Great Ridge. This broad expanse has few exposures but a brash of nodular flints and soft, smooth white chalk with common *Platyceramus* and *Volviceramus* together with micropalaeontological determinations of the brash are sufficient to determine that the Newhaven Chalk Formation is not encountered. The southern margin of the formation is the Mere Fault and it is not seen south of this fault in this sheet.

Two small pits at [ST 9778 3331 and 9954 3355] both show 3 m of soft to firm, blocky, smooth, white chalk with flints and infrequent *Platyceramus* but both are degraded and the exposures are poor. Spoil thrown out from excavations for a building platform [ST 9633 3409] near The Dairy, Manor Farm, Chilmark was unusually hard and blocky with large nodular brown stained flint fragment. The presence of much *Platyceramus* and *Volviceramus* together with the flints suggests that the excavation encountered the Seven Sisters Flint at which there is an acme of these fossils.

ST92NE

The Seaford Chalk has a very limited outcrop in the southeast corner of this sheet on the top of the primary chalk scarp marking the southern flank of the Vale of Wardour. The basal part of the Formation just caps the top of the primary Chalk scarp and the dip slope to the south. The total thickness of Seaford Chalk is estimated to be less than 5m. There are no sections, but much very flinty soft white chalk was observed with abundant carious nodular, tabular and sheet flints and occasional *Platyceramus.*

ST92SE

The formation is limited to the highest part of interfluves in the northeast of this sheet. The presence of *Platyceramus* in some abundance serves to distinguish the formation from the underlying Lewes Nodular Chalk. There are no significant exposures.

SU04SW

This 1:10K sheet is developed almost entirely within the Seaford Chalk Formation. Approximately 60 m of Seaford Chalk is exposed in this area.

All of the dry valleys draining northeast from the Yarnbury Castle – Chitterne ridge are approximately coincident with the dip and follow the same stratigraphical horizon. The floor of these valleys is at or close to an acme of *Volviceramus involutus*, probably at or close to the level of the Seven Sisters Flint at the top of the Belle Tout Beds. A small, but pronounced positive feature, marks this about 2-5 m above the valley floor. Good specimens of *Volviceramus* were collected at several localities on this feature (Table 1.) This acme gradually dips below the valley floor to the north on the Devizes sheet, just south of the Chitterne – Shrewton road. *Platyceramu*s and *Volviceramus* have been identified at [SU 0471 4139, 0257 4257, 0352 4238, 0246 4245 and 0373 4259].

The upper beds of the Lewes Nodular Chalk Formation floor the deeply incised valleys in the southwest that drain to the south. Upslope onto the interfluves a soft to firm, smooth, white chalk brash with flints and much *Platyceramus* indicate the Seaford Chalk.

There are no significant exposures but to the north on the MOD Salisbury Plain Training Area there are frequent small exposures in tank tracks where these climb steep valley sides.

SU04SE

This 1:10K sheet is developed entirely within the Seaford Chalk Formation. Approximately 55 m of Seaford Chalk is exposed in the Till valley. The floor of the valley is very close to the base of the Seaford Chalk and it is possible that the uppermost part of the Lewes Nodular Chalk Formation occurs at rock-head beneath the alluvium in the Winterbourne Stoke area. However, no evidence of Lewes Chalk was seen at outcrop. The hill tops either side of the Till valley are developed in the upper part of the Seaford Chalk (Haven Brow Beds), where pink rinded flints (and occasionally *Zoophycos* flints) are locally conspicuous.

Plate 27. View north over Seaford Chalk dipslope looking towards Deptford Down Dropping Zone Salisbury Plain Training Area. Typical head in dry valley. [SU 0100 4050]. Photo P 598782.

Platyceramus and *Volviceramus* are locally abundant. Good specimens were collected from exposures and brash from a number of localities at [SU 0639 4123, 0701 4128, 0511 4157, 0563 4103, 0664 4149, 0831 4152, 0715 4145, 0662 4188, 0852 4137, 0777 4022, 0833 4272 and 0833 4213].

SU03NW

There is a wide outcrop on the interfluves both north and south of the River Wylye. To the south the formation underlies the slopes up to the crest of Great ridge where it is covered by a thin veneer of clay-with-flints. It may well be that the basal beds of the succeeding Newhaven Chalk Formation intervene between the Seaford Chalk and the Clay-with-flints but there is no evidence to substantiate this from the 2003 survey. The base of the formation dips gently toward the southeast.

There are no significant exposures and the outcrop is determined from the copious characteristics brash. An acme of *Platyceramus* was noted at a number of localities within the lower part of the formation.

SU03NE

The formation outcrops widely on the lower valley slopes and interfluves of the River Wylye and River Till. For the most part the formation is recognised by its characteristic firm white smooth chalk brash with nodular flints but Platyceramus is commonly found within the lower part of the succession.

A poor exposure at Stoford in a disused chalk pit [SU 0860 3561] comprises only 0.5 m of massive soft chalk at the top of a degraded 5 m face.

Elsewhere field brash [SU 07467 36982] at about 8-10 m above 'Stapleford Pit' (see above) yielded *Platyceramus* (shell fragments, including moderately thick-shelled examples). Similarly, at [SU 0836 3590] about. 4-5 m above the top of 'Stoford Pit' *Platyceramus* shell fragments were common in a soft chalk brash.

SU03SW

The Seaford Chalk outcrops over much of the northern half of this sheet. Over 50 m of Seaford Chalk is exposed, which must be close to the maximum thickness known in this area. The uppermost part of the Seaford Chalk underlies the forested Greta Ridge running along the northern part of the sheet around Grovely Lodge. This must be close to the top of the Formation, but no evidence for any Newhaven Chalk was found beneath the clay-with-flints. Conversely, the lower part of the Seaford Chalk is exposed in the deep valleys either side of the ridge, but no evidence for the Lewes Nodular Chalk was seen.

Abundant *Platyceramus* was found in many locations, especially in a zone just north of the Mere Fault and in the major dry valley systems that drain to Baverstock. Good acmes of *Volviceramus* and *Platyceramus* were found at Upper Marshwood [SU 0065 3295, SU 0327 3282, SU 0181 3381] and around Field Barn [SU 0155 3295], but none could be traced significant distances laterally.

The best exposure in an old chalk pit 760 m at 024° from Baverstock Manor, Baverstock, Wilts [SU 0313 3288]. Here 8-10 m of soft white smooth chalk is exposed. The section contains several marl seams at the base, with some large nodular flint seams and sheet flints (Figure 50). Several small conjugate faults cut the section with small throws of around 0.2 m. possibly reflecting the proximity of the Mere Fault. However, the overall dip is gentle to the south. *Platyceramus* was recorded here, which coupled with common marl seams and flinty chalk, suggests a horizon within the lower Seaford Chalk (Belle Tout Beds). No other exposures were seen.

Fragments of very hard, yellow, spongiferous, porcellanous chalk were noted in field brash 900 m southwest of Grovely Lodge. This may represent either a localised sponge bed or possibly a localised westward continuation of the Stockbridge Rock Member. However, it cannot be traced very far, and is probably too low in the sequence to be the Stockbridge Rock Member.

SU03SE

The Seaford Chalk Formation forms the eastern part of Great Ridge and slopes from it between the Wylye and Nadder rivers and the interfluve east of South Newton and south of Wilton.

The formation is seen at Ugford Clump in a disused chalk pit [SU 0803 3189] The Chalk dips at 6° to the north. It consists of soft white chalk with nodular flints and three marly chalk seams which yielded *Platyceramus*, *Volviceramus involutus* indicating the lower part of the Seaford Chalk Formation.

Jukes-Browne and Hill (1900) describe a section from ‘Ufford’ that must be this same locality. They state that the chalk dips at about 2° to the southeast and the beds are broken by a small fault with a throw of 1.37 m but fail to give a direction of throw. The beds include *Micraster coranguinum*, *Galerites albogalerus* (*Conulus albogalerus*) and *Inoceramus involutus* (*Volviceramus involutus*) that would indicate a level within the lower middle part of the formation.

Formation	Lithology	Thickness m
Seaford Chalk Formation	Chalk, inaccessible	2.44
	Continuous seam or floor of flint	0.03
	Firm solid chalk without flints	0.61
	Soft, loose marly chalk crowded with flints	0.30
	Solid bedded chalk, with few flints	1.22
	Soft marly chalk	0.15
	Chalk with many shattered flints	2.44

South of the River Nadder a large overgrown pit, overshadowed and dark, on the Wilton Estate was not visited. This is the site of the mausoleum for the Pembroke family and does not appear to have been visited during the original survey either.

Quarter Sheet: SU03SW

Old chalk pit 760 m at 024° from Baverstock Manor, Baverstock, Wilts.
SU 0313 3288
WMD 9359
Fauna: *Platyceramus* in soft chalk with common flints and marl seams
Stratigraphy: lower Seaford Chalk

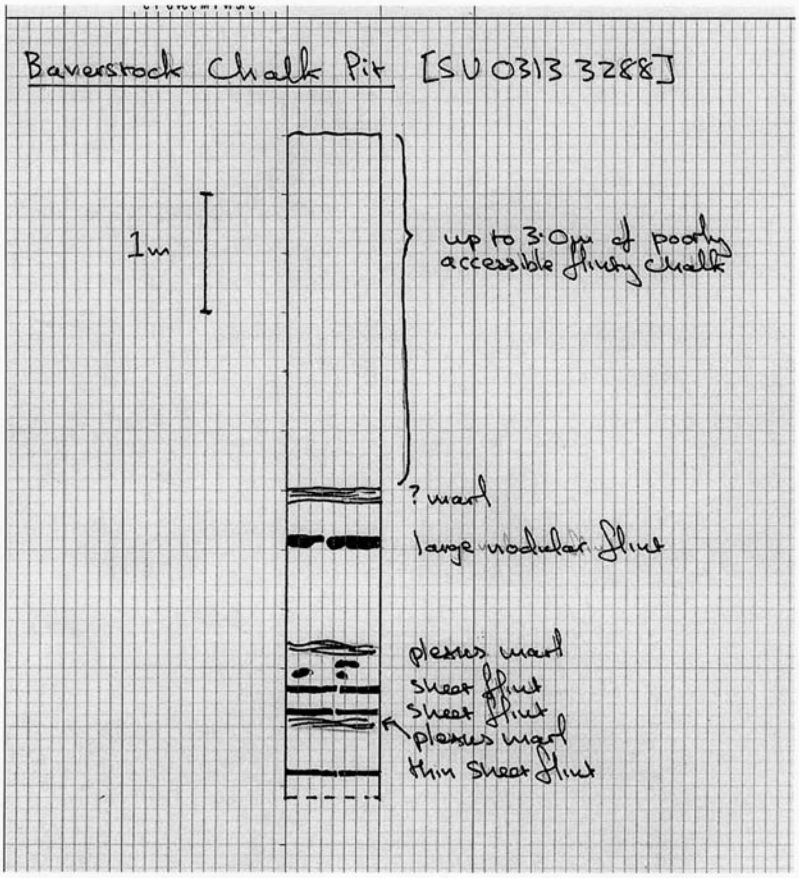


Figure 50: The Seaford Chalk Formation exposure at Baverstock Chalk Pit [SU 0313 3288]

To the north east of the River Wylye the formation was seen at shallow overgrown and degraded pits at [SU 0968 3290, 0985 3353, 0910 3461 and 0917 3465]. There was little exposure but brash and spoil show firm, white, blocky, smooth chalk with flint and much *Platyceramus* indicative of the lower part of the formation.

SU02NW

The formation underlies the broad rounded interfluves on the crest of the primary chalk scarp between the Vale of Wardour and the vale of Broad Chalke. Much of the outcrop carries a reddish brown flinty soil that when seen in section is of limited (< 0.5 m) thickness. This cover disguises much of the outcrop with the exception of the lower boundary where the cover is absent at a marked positive break of slope.

SU02NE

The Seaford Chalk Formation forms the broad outcrop over the major catchment divide between the Nadder and Ebble valleys. In the west this interfluve carries a veneer of clay-with-flints that masks much of the highest crests.

There are three significant exposures but each is degraded and gives limited exposure.

The Windwhistle Farm pit [SU 0729 2815] exposes about 3 m of soft, smooth-textured chalk with flints and thin marly chalk horizons in the Seaford Chalk. They have a dip of 4°to 220°. The rocks contain *Volviceramus* and *Platyceramus* indicative of lower Seaford Chalk.

The Ragland disused Chalk pit [SU 0835 2631] is degraded but has a large exposure (8 m high and 40 m long) in the upper part of the pit. It is formed of a massive, soft chalk with nodular flint bands occurring every 0.5 m to 1 m. Several beds of abundant *Platyceramus* are present suggesting lower Seaford Chalk, but little other fossil debris is present. There are also numerous marl seams present. The general dip is 3° to 070°.

The Upper Folly disused Chalk pit [SU 0976 2893] is degraded and partially backfilled with a 3 m high by 40 m long face at the top of the pit. The exposure is of a soft, homogeneous and massive Chalk with nodular flint bands and a dip of 6° to 33° east of north.

A hard bed of chalk in the Seaford at [SU 0785 2700] forms a feature in the main and tributary valleys at right angles to one another and indicates a dip of 2° to the southeast.

SU02SW & SU02SE

South of the River Ebble and within the district the formation has a limited outcrop on the highest crests. There are no significant exposures.

SU14SW

This 1:10K sheet is developed almost entirely within the Seaford Chalk Formation. Approximately 45 m of Seaford Chalk is exposed in the Avon valley. The hilltops are predominantly in the Upper Seaford Chalk (Haven Brow Beds). The Avon valley has incised to a level approximately that of the Seven Sisters flint.

An old chalk pit a few metres above the flood plain on the west bank of the River Avon, 1.5 km northeast of Springbottom Farm at [SU 1368 4058] displays a small, somewhat weathered section of low-middle Seaford Chalk (Figure 51). The exposed section, comprising c. 4.5 m of firm to soft, sparsely fossiliferous, flinty chalk, occurs in the upper part of the quarry. A well-developed semitabular flint band occurs in the higher part of the section. The in situ fauna includes presumed thin-shelled *Platyceramus* and crushed and incomplete *Micraster*. Loose, and possibly dumped material in the bottom of the pit includes *Platyceramus* and *Volviceramus involutus*.

The section is questionably assigned to an interval in the Seaford Chalk Formation between the Seven Sisters Flint and the base of the Santonian, which is typically poorly fossiliferous. If the loose fauna is from chalk formerly exposed in the bottom of the pit, then the logged succession cannot be far above the horizon of the Seven Sisters Flint, since it is at this level that *V. involutus* has its main occurrence.

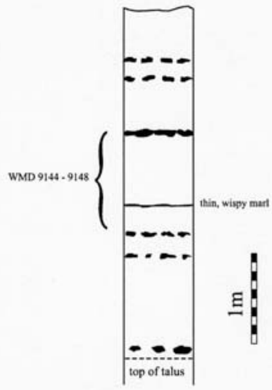


Figure 6. The Chalk succession near Normanton [SU 1368 4058]

Figure 51: The Seaford Chalk Formation succession near Normanton [SU 1368 4058]

Spongiferous hard Chalk occurs in a small area around [SU 1242 4125]. This may be co-extensive with the Cuckmere Sponge Bed (Mortimore, 1986). To the west of Stonehenge, the Seaford Chalk appears to be less flinty above c. 105-110 m OD. This may be associated with the upper part of the formation. Here characteristic pink rinded flints are locally common.

A small pit at [SU 1428 4025] exposes 4-6 m of soft blocky white chalk with three large flint seams. The pit was virtually unfossiliferous.

Just south of Stonehenge, much of the Seaford Chalk is cut out by a synsedimentary channel infilled with phosphatic and Newhaven Chalk. This is described more fully in the Newhaven Chalk section.

SU14SE

Much of the Amesbury area is underlain by the mid-upper part of the Seaford Chalk. At least 40 m of Seaford Chalk outcrops in this area, but very few exposures occur. Newhaven Chalk underlies much of the eastern part of the sheet. A cutting and pit on the A345 just south of Amesbury [SU 1585 4068] exposes c. 7 m of soft smooth blocky white chalk with a major semi continuous tabular flint band 8 cm thick 6 m above the base of the section. Fossil evidence including *Conulus* favours assignment to the upper *M. coranguinum* Zone and hence the upper Seaford Chalk (Woods, 1999b, locality 16). Several small faults occur, the largest with a throw of c. 2.5m down throwing to the north.

Fossils obtained from excavations for a new housing estate in Amesbury [SU 1650 4135], although not in situ indicate a level close to the top of the Seaford Chalk. The Stockbridge Rock member outcrops in the fields due east of Boscombe Down airfield, although its outcrop in this area is discontinuous.

SU13NW

Seaford Chalk outcrops over much of this sheet except for a small inlier of Lewes Nodular Chalk in the Avon valley between Upper Woodford and Lower Woodford along the axis of the Woodford-High Post anticline. Approximately 60 m of Seaford Chalk outcrops in this sheet. However, exposure is generally poor and restricted to field brash and isolated chalk pits.

The contact between the Lewes Nodular Chalk and the Seaford Chalk is seen in a roadside pit at Upper Woodford [SU 1235 3700] (see above in Lewes Nodular Chalk section). The section exposes 7.5m of weakly nodular blocky white chalk with several major sheet flints and nodular flint seams. *Platyceramus* fragments were collected from near the top of the pit, thus indicating that the Seaford Chalk also occurs here. A conspicuous marl seam about 5m above the base of the exposure may equate with a similar marl seam seen in a pit 1.2 km further south [SU 1204 3572], which has been correlated with Shoreham Marl 2 (Mortimore, 1986), This marl marks the junction of the *M. cortestudinarium* Zone and the *M. coranguinum* Zone, and hence the junction between the Lewes and Seaford Chalk formations.

On the other side of the valley at a lower elevation, another pit [SU 1333 3746] exposes about 10-12 m of soft blocky smooth white chalk with abundant large carious flint seams and numerous sheet flints, the upper 6m of which is inaccessible. The lower part of the section is rich in flaser or plexus marl seams and is very similar to the upper part of the pit at Upper Woodford described above [SU 1235 3700]. About 2.5m above the base of the section is a prominent acme of *Echinocorys*, which is unusual for this stratigraphical level in the lower *M. coranguinum* Zone

The basal beds of the Seaford Chalk outcrop along the floor of the Chine Farm valley [SU 1120 3740], where occasionally hard nodular chalk occurs with *Volviceramus involutus* and *Platyceramus* fragments. The valley floor here is approximately coincident with the dip which here is approximately east-northeast at about 0.5-1°.

An old chalk pit near Westfield Farm [SU 1174 3866] exposes a few metres of soft, white flinty chalk with a large tabular flint seam near the top of the section (Figure 52). The chalk is very fractured and the flint bands appear to show a considerable eastward dip across the face of the pit. The fauna includes the bivalves *Cordiceramus cordiformis?*, *Mimachlamys cretosa* and *Spondylus dutempleanus*, a crushed and incomplete *Micraster* sp. and common asteroid skeletal plates indicative of the upper Seaford Chalk. It is possible that this pit is close to or within a fault zone.

The summits of the hills either side of the Avon valley (Rox Hill clump, Boreland Hill and High Post) are at or close to the top of the Seaford Chalk. No evidence for the base Newhaven Chalk has been found at these sites. However, just below the summit of Rox Hill, a thin band of very hard porcellanous chalk may be the Stockbridge Rock Member. This occurs at [SU 1190 3880] about 15 m below the summit. However no trace of this can be found on the east side of the hill and no Newhaven Chalk occurs on the summit. This anomaly may be explained by a small fault. At the summit itself, fragments of a thick tabular flint seam occur which may be the same as that seen elsewhere in the Bourne River catchment at or close to the top of the Seaford Chalk. Hard porcellanous chalk also occurs on the summit around Newton Barrow [SU 1018 3551], in the southwest corner of the sheet, and the slope to the south, which is probably the Stockbridge Rock Member. It appears to be less well developed west of the River Avon.

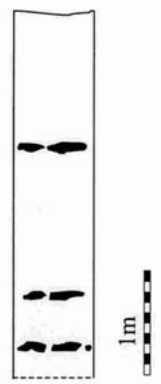


Figure 3. The Chalk succession at Westfield Farm [SU 1174 3866]. Specimens (WMD 9110 - 9124) collected throughout the section.

Figure 52: The Seaford Chalk Formation succession at Westfield Farm [SU 1174 3866]

Field brash at [SU 1020 3780] included a serpulid, *?Platyceramus* and *Spondylus* (in hard, spongiferous chalk). The possible record of *Platyceramus* might suggest the Seaford Chalk Formation, but hard, spongiferous chalk is more typical of the Lewes Nodular Chalk Formation. The hard chalk could be a local horizon within the Seaford Chalk.

Brash near Middle Woodford [SU 1171 3726] and Chine Farm [SU 1155 3731] included shell fragments of *Volviceramus involutus*, thick shell fragments of *Platyceramus* and *Micraster coranguinum* (Chine Farm) indicating the lower Seaford Chalk Formation.

An old silage pit near Lower Woodford [SU 1199 3519] comprises shell fragments of the bivalve *Platyceramus*.

SU13NE

Seaford Chalk outcrops over much of this sheet except for a small finger of Newhaven Chalk on Boscombe Down airfield. Approximately 55 m of Seaford Chalk outcrops, although exposure is generally poor and restricted to field brash and isolated chalk pits. Very hard indurated porcellanous blocky often yellowish manganese stained chalk occurs sporadically in the field brash. This is probably the Stockbridge Rock Member. It does not appear to be continuous over the area, but occurs at widely separated localities including around High Post [SU 150 360], East Gomeldon [SU 193 355] and Idmiston [SU 195 360].

A small pit just northwest of West Gomeldon Farm at [SU 1749 3614] displays 5-6m of very flinty soft white smooth blocky chalk in the *M. coranguinum* Zone (Figure XX). Four semi-tabular major flint bands cut the section and the chalk contains an abundance of nodular flint. It is probably in the mid Seaford Chalk.

A small exposure with an enormous tabular flint (approx 1 m across) was seen near Idmiston [SU 1920 3788]. Here two tabular flints about a metre apart are seen in a 2 m exposure of soft, blocky white chalk with *Platyceramus*.

SU13SW

Seaford Chalk outcrops on the northern half of this sheet, and dips south under the secondary Newhaven scarp at Old Sarum. Almost the entire thickness of Seaford Chalk outcrops on this sheet, estimated at 65-70 m. There are a few exposures

The Stockbridge Rock Member is well developed on this sheet and can be traced as a series of very hard porcellanous chalk bands separated by less indurated hard chalks around the Longhedge Farm – Stratford Bridge valley north of Old Sarum. Here it forms a small positive feature that can be easily traced.

There are a number of small exposures, mainly within the Avon valley and the major exposure of the formation in the district on the north side of the Nadder valley at Quidhampton.

The Quidhampton site was extant during the original survey and Jukes-Browne and Hill (1900) gave the following section. "At Quidhampton there is a large pit on the north side of the railway, showing between 50 and 60 feet (15.24 to 18.29 m) of chalk. Flints occur in regular courses, which are only about 2 feet (0.61 m) apart in the upper 40 feet (12.19 m), but more distant in the lower part; most of them have very thin rinds, some hardly anything but a white skin, but a few have a definite white crust; some are large with irregular knobbly surfaces. The bedding is nearly horizontal. From the lower beds Mr Jukes-Browne obtained *Micraster coranguinum*, *Epiaster gibbus* (*Micraster* (*Isomicraster*) *gibbus*), *Terebratula carnea* (?), *Inoceramus cuvieri*, *Lima hoperi* (*Plagistoma hoperi*), and *Ostrea vesicularis* (*Pycnodonte vesiculare*), and Dr Blackmore has found a few other species."

The exact location of this early description is not known and the exposure has been greatly expanded to the north since that original survey. Figure 45 gives a graphic composite log for the succession as seen in 2003. This is nominally located at [SU 1134 3161] at the base of the northern face of the present pit, where the full section is visible but mostly inaccessible, and is made up of correlated sections throughout the extant quarry.

The lower part of the exposed succession is very poorly fossiliferous. However, fossils are relatively abundant in the loose rubble in the bottom of the pit, and in spoil from drainage channels dug into the floor of the pit. This material includes relatively common fragments of *Volviceramus involutus*, which is characteristic of the lower part of the Seaford Chalk Formation. One superb specimen shows marked anteroposterior elongation of the right valve, a feature of the *V. involutus* acme that occurs above the Seven Sisters Flint (Lake et al., 1987). This marker is therefore presumed to be in the unexposed succession below the current floor of the quarry.

Most of the lower part of the succession exposed in the quarry is devoid of fauna. It lacks strong semitabular flint horizons and marl seams. On balance, these features favour assignment to the Cuckmere Beds, which represent the Late Coniacian part of the Seaford Chalk Formation.

Cladoceramus undulatoplicatus occurs in two acmes in the middle of the exposed succession at Quidhampton. This fossil indicates the basal Santonian part of the Seaford Chalk Formation (basal Haven Brow Beds), and marks a return to more fossiliferous chalk. The upper acme occurs in a flint band, and is a possible correlative of the Flat Hill Flint in Sussex and Bedwell's Columnar Flint in Kent (Mortimore, 1986)

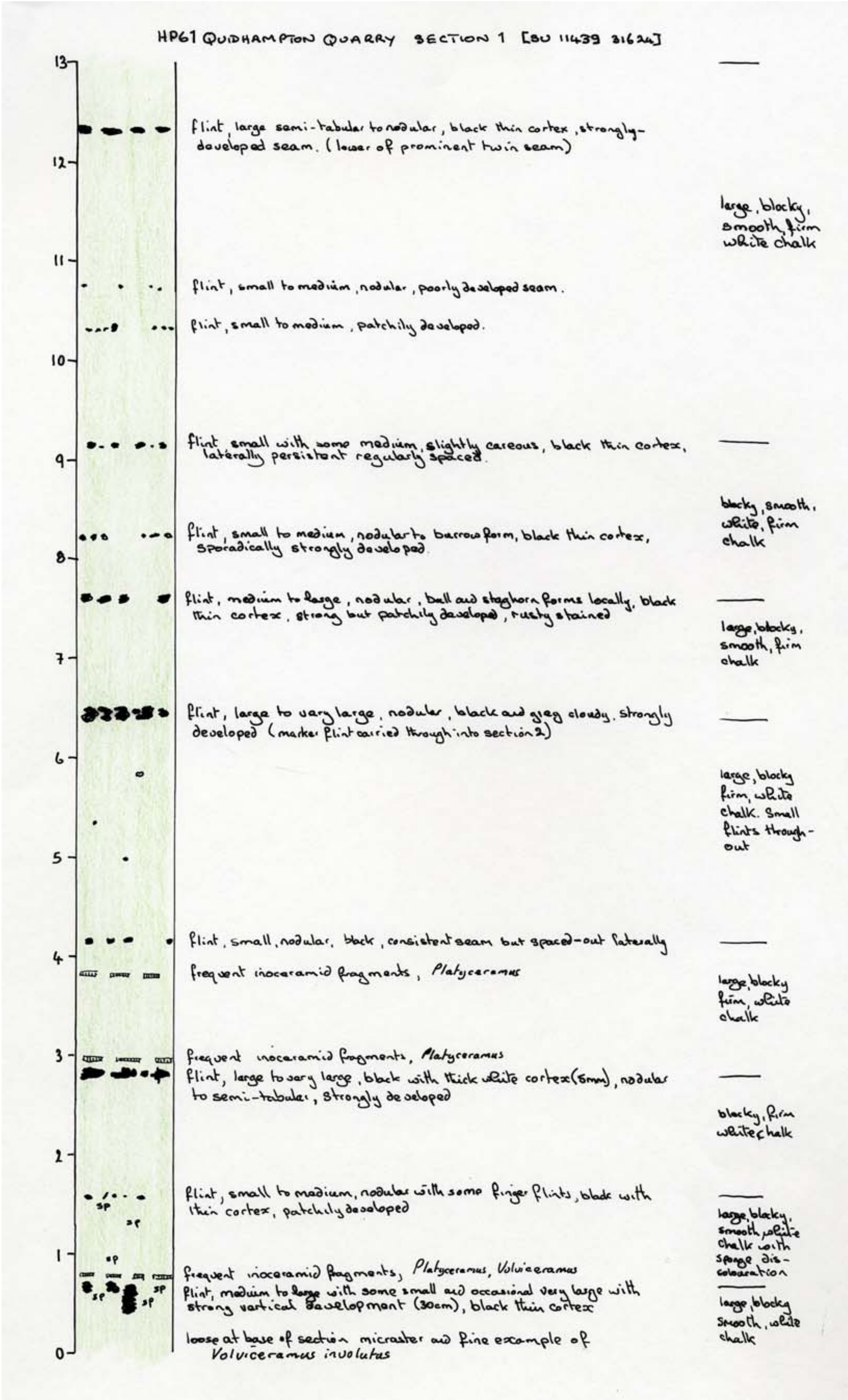
The highest exposed chalk at Quidhampton includes several iron-stained spongiferous chalk horizons. This is a feature of the upper Seaford Chalk Formation seen elsewhere, although *Conulus*, which is typically abundant near the top of the formation, was not seen.

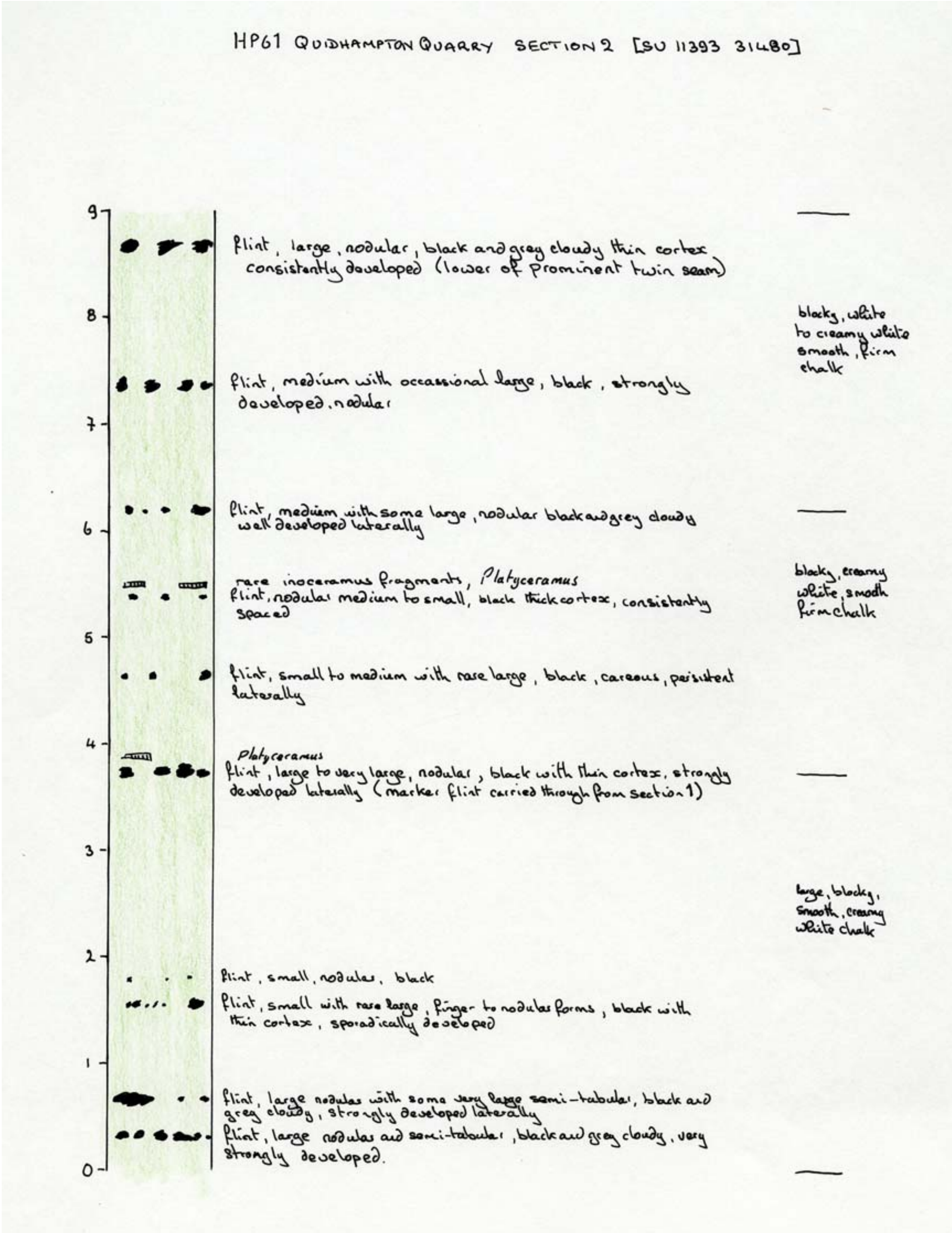
There is a small pit [SU 1271 2470] at Little Durnford, on the eastern bank of the Avon, which exposes chalk with many layers of thin-skinned flints, most of them stained read or reddish with iron oxide; this is certainly in the zone of *Micraster coranguinum*, that fossil and *Echinocorys scutata* being common here. This clear section seen by Jukes-Browne and Hill (1900) is no longer visible.

Southwards on the east side of the Avon valley a large pit [SU 1297 3332] the Manor House was not seen during the original survey and is no longer worked. A 7 m section of very soft large blocky

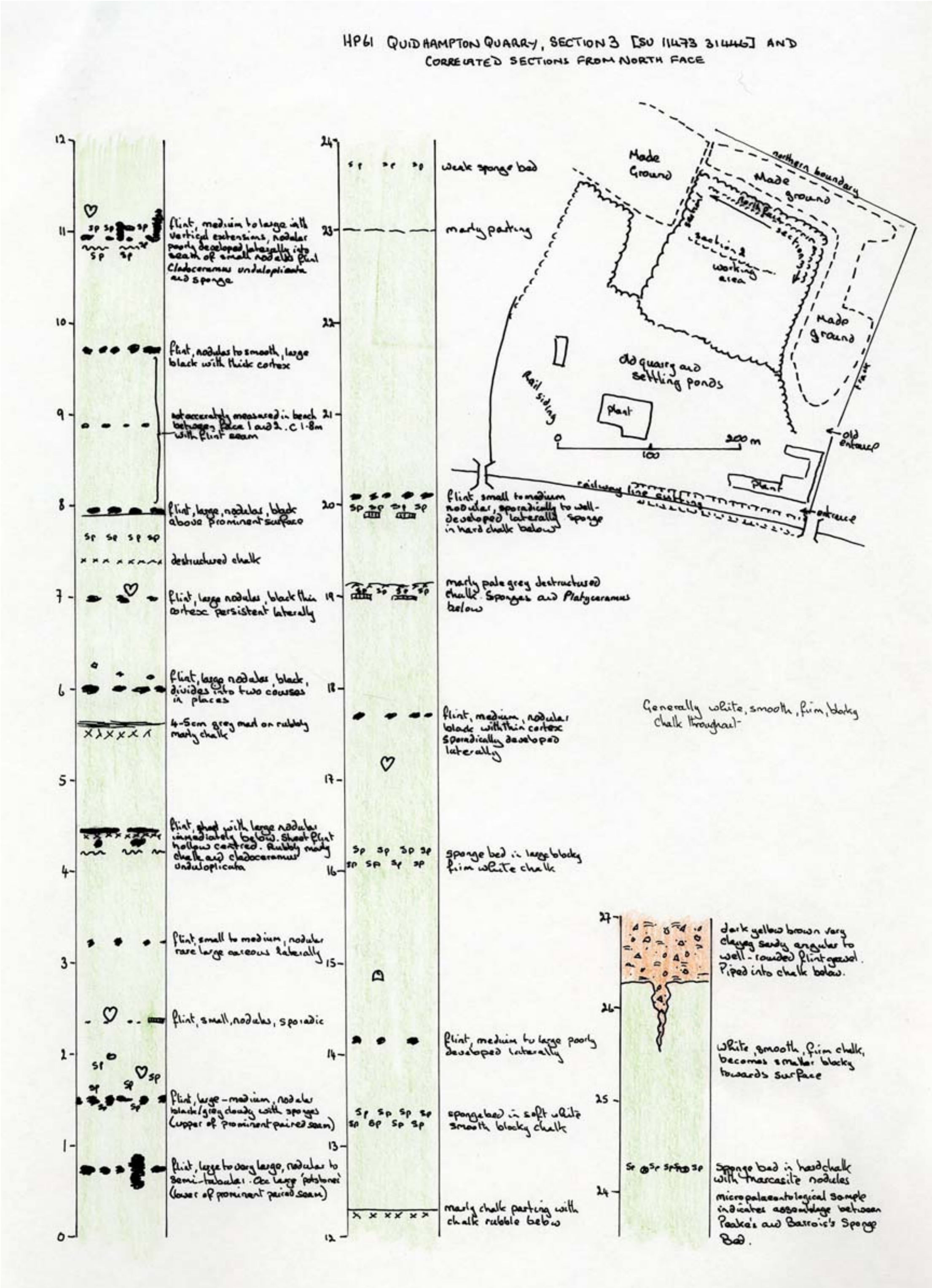
Figure 53 a, b, c. The Seaford Chalk Formation exposure at Quidhampton.

a.




HP61 QUIDHAMPTON QUARRY SECTION 2 [SU 11393 31480]
9
flint, large, nodular, black and grey cloudy thin cortex consistently developed (lower of prominent twin seam)
8
blocky, white to creamy white smooth, firm chalk
flint, medium with occasional large, black, strongly developed, nodular
7
flint, medium with some large, nodular black and grey cloudy well developed laterally
6
rare inoceramus fragments, Platyceramus
flint, nodular medium to small, black thick cortex, consistently spaced
blocky, creamy white, smooth firm chalk
5
flint, small to medium with rare large, black, carious, persistent laterally
4
Platyceramus
flint, large to very large, nodular, black with thin cortex, strongly developed laterally (marker flint carried through from section 1)
3
large, blocky, smooth, creamy white chalk
2
flint, small, nodular, black
flint, small with rare large, finger- to nodular forms, black with thin cortex, sporadically developed
1
flint, large nodules with some very large semi-tabular, black and grey cloudy, strongly developed laterally
flint, large nodules and semi-tabular, black and grey cloudy, very strongly developed.
0

b.


HP61 QUIDHAMPTON QUARRY, SECTION 3 [SU 11473 31446] AND CORRELATED SECTIONS FROM NORTH FACE
flint, medium to large with vertical extensions, nodular poorly developed laterally into seam of small nodules flint
Cladoceramus undulatoplicata and sponge
flint, nodules to smooth, large black with thick cortex
with flint seam
flint, large, nodular, black above prominent surface
destructured chalk
flint, large nodular, black thin cortex persistent laterally
flint, large nodular black, divides into two courses in places
4-5cm grey marl on rubbly marly chalk
hollow centred. Rubbly marly chalk and Cladoceramus undulatoplicata
flint, small to medium, nodular rare large carious laterally
flint, small, nodular, sporadic
flint, large-medium, nodular black/grey cloudy with sponges (upper of prominent paired seam)
flint, large to very large, nodular to semi-tabular. Occ large 'potstones' (lower of prominent paired seam)
weak sponge bed
marly parting
flint, small to medium nodular, sporadically to well-developed laterally sponge in hard chalk below
marly pale grey destructured chalk. Sponges and Platyceramus below
flint, medium, nodular black with thin cortex sporadically developed laterally
sponge bed in large blocky firm white chalk
flint, medium to large poorly developed laterally
sponge bed in soft white smooth blocky chalk
marly chalk parting with chalk rubble below
Made Ground
northern boundary
Made ground
North Face
section 2
section
working area
Made ground
old quarry and settling ponds
Rail siding
plant
0
100
200 m
old entrance
Plant
railway line cutting
entrance
Generally white, smooth, firm, blocky chalk throughout
dark yellow brown very clayey sandy angular to well-rounded flint gravel. Piped into chalk below.
White, smooth, firm chalk, becomes smaller blocky towards surface
Sponge bed in hard chalk with marcasite nodules
micropalaeontological sample indicates assemblage between Peake's and Barrois's Sponge Bed.

c.

Plate 28 View looking towards the northwest of Quidhampton Quarry, [SU 1141 3157]. Photo P598771

Plate 29. View of major flint at level of *Volviceramus* acme at the base of Quidhampton Quarry.[SU 1140 3155]. Photo P 598767

smooth white chalk with marl partings contains at least four major flint seams. The bedding is disrupted by two small faults that downthrow to the northeast. The chalks are poorly fossiliferous and contain rare *Platyceramus* and *Magadiceramus* ex gr. *subquadratus*. This may indicate the generally poorly fossiliferous middle to higher part of the Seaford Chalk formation.

There are two pits to the south of The Manor House and one of these [SU 1329 3270] is probably that noted in Jukes-Browne and Hill (1900) at … “the north end of the village of Stratford”… which is now degraded and with no exposure but formerly gave the following information. The pit “shows some 25 feet (7.62 m) of firm but brittle white chalk, with layers of flints at intervals of from 1 to 3 feet (0.30 to 0.91 m); these flints have thin skins, and many are cavernous (carious), the hollows showing traces of *Doryderma ramose* (*D. roemeri*) and some have drusy cavities filled with quartz crystals. Several layers, however, consist of solid flints stained red or brown. *Micraster coranguinum, Galerites albogalerus* (*Conulus albogalerus*), *Cidaris hirudo* (*Hirudocidaris hirudo*), *Ostrea semiplana* (? *Hyotissa semiplana*), *Inoceramus cuvieri* and other fossils have been found here."

The formation is next seen [SU 1321 3114] on the west side of the valley near Cowslip Farm. Here a very degraded and overgrown pit gave limited exposures of white blocky smooth chalk with infrequent fragments of thin *Platyceramus* high within the Seaford Chalk succession.

Soft white smooth chalks were seen in degraded pits at [SU 1238 3271 and 1221 3370] but there is no fossil evidence from these sites. Two further sites at [SU 1190 3411 and 1174 3472] both show soft white smooth chalk with nodular flints in degraded pits.

Jukes-Browne and Hill (1900) identified a large pit on Camp Down near the main road showing 25 to 30 feet (7.62 to 9.14 m) of chalk with thick-rinded flints, many of them showing pink, white, and grey bandings, and being of very irregular shapes with knobbly or cornuted projections. This site is estimated to be at [SU 1097 3426] where a degraded pit is seen.

To the east of Quidhampton a redevelopment site at the old Dairy off Pembroke Road [SU 1217 3116] exposed 2 m+ of soft white blocky chalk with common thin sponge beds, rare flint and fragments of *Micraster*. The beds are attributed to the Seaford Chalk Formation but must be high in the succession possibly at the level of the Cuckmere Beds.

SU13SE

The north-western corner of the Laverstock area surrounding the Bourne valley is underlain by the mid-upper part of the Seaford Chalk Formation. Approximately 30 m of Seaford Chalk outcrops in this area, but very few exposures occur. Newhaven and Culver Chalk underlie much of the southern and eastern part of the sheet. The Stockbridge Rock Member occurs sporadically in the northern part of the sheet.

SU12NW

The formation outcrops on the interfluve between the River Nadder and the River Ebble from Salisbury Race Course to Dogdean Farm [SU 134 271] and again south of Odstock [SU 147 260]. The eastward extension of the Mere Fault is not easy to distinguish hereabouts through this outcrop but it can be picked out from the spread of micropalaeontological samples taken during the 2003 survey.

The only exposure is an old pit [SU 1452 2590] south of Odstock where about 6 m of flinty chalk are exposed (Figure 54). Most of the succession is poorly fossiliferous, although *Platyceramus* is common and locally thick-shelled in the lowest metre. A loose fauna includes possible *Volviceramus involutus*.

It is presumed that the bulk of the section equates with an interval between the Seven Sisters Flint and the base of the Santonian, in the middle part of the Seaford Chalk Formation. The succession above the Seven Sisters Flint has the last records of common *Volviceramus* and *Platyceramus*, before the chalk becomes markedly poorly fossiliferous.

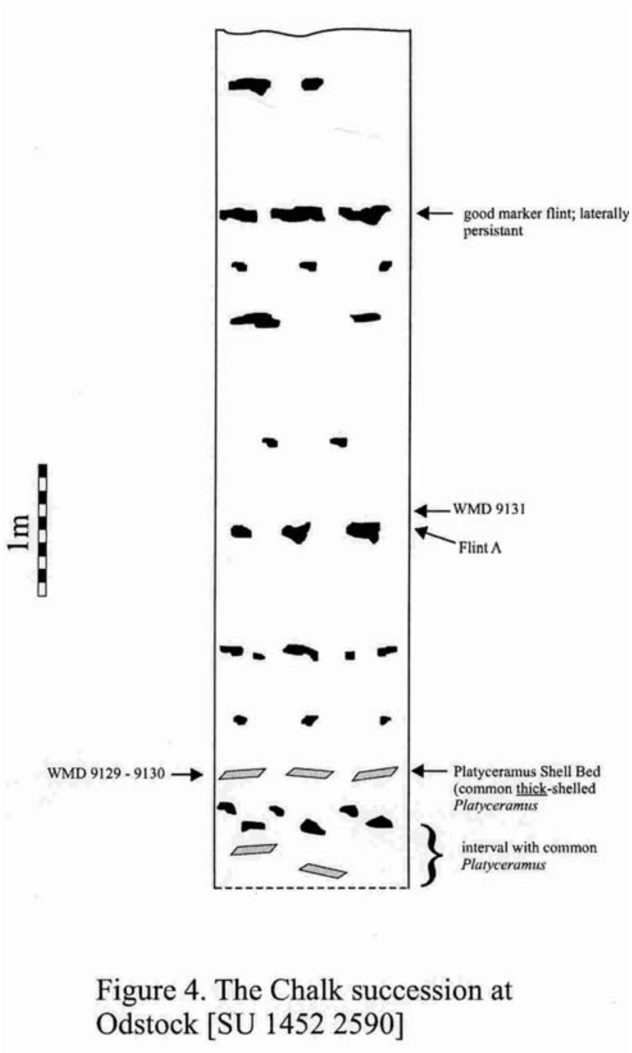


Figure 54: The Seaford Chalk Formation succession at Odstock [SU 1452 2590]

SU12NE

The formation outcrops in the southwest of the sheet south of Nunton. To the north the Seaford Chalk is cut out against the Mere Fault.

The only significant exposure is within foundations and spoil derived from construction of new barn [SU 1584 2560] near Nunton (Plate 30). The blocky, soft, smooth chalk with flints includes *?Cordiceramus cordiformis, Platyceramus* (including thick-shelled fragments), *Conulus* sp. and *Micraster* sp. indicating the upper part of the Seaford Chalk Formation; Santonian, upper *M. coranguinum* Zone.

Plate 30. Cutting in Seaford Chalk, near Nunton [SU 15911 25578]. Photo P584727.

SU12SW & SU12SE

The outcrop of the formation stretches for Nunton Down across Clearbury Down and is lost eastward beneath the superficial deposits of the River Avon. There are few exposures with only a poor record of the pit opposite Charlton Manor Farm [SU 166 240] being "about 30 feet (9.14 m) deep" (Jukes-Browne and Hill, 1900).

SU24SW

A small, disused chalk pit beside a track between Newton Tony and Wilbury Park [SU 2193 4056] exposes about 1 m of soft white chalk. A 10 centimetre-thick tabular flint occurs at the top of the section, 4 m to 5 m below the level of the Stockbridge Rock Member in the nearby fields. This flint is tentatively correlated with Whittaker's Three Inch Flint (see above) although it lacks the carious nature of that flint bed where it occurs in Kent and Sussex, and no fossils were found in association with it. A course of large flint nodules occurs 0.65 m below the tabular flint.

Very hard, locally porcellanous, blocky chalk, often yellowish or creamy in colour, occurs in the field brash at the level of the Stockbridge Rock Member in many places along the Bourne Valley and in the east of the area, for example on the low ridge extending east-north-east from Grateley. In many places in the Bourne Valley, this brash is associated with a persistent small positive topographic feature. Head has obscured similar features that might exist east of Grateley. Given the limitations of exposure, this bed could be continuous throughout the present area, although in areas to the south it is considered to be probably discontinuous (Farrant, 2000). In the area within the district this type of chalk occurs in field brash at a range of heights between about 80 m and 90 m OD. This might indicate that several hard beds occur within a short interval but alternatively could just be a consequence of the extensive superficial mass-movement in that area.

A note made about 1894 by F J Bennett on a 1:10 560 field slip (held in the BGS archives) records that the railway cutting west of Newton Tony (now mostly back-filled) [SU 210 403] once exposed about 9 m ('30 feet') of white chalk with scattered large flints and four thin marl partings, overlying a 10 centimetre-thick 'hard cream-coloured band', with 1.5 m of white chalk with numerous scattered flints below it. He found *Micraster* and fragments of sponges but states that determinable fossils were rare. As mapped, this cutting lies within the upper part of the Seaford Chalk and, except for the presence of 'marl partings', the described characters are broadly consistent with this. The top of the cutting is at about 106 m OD, so the 10 centimetre 'hard band' would lie at about 97 m OD, roughly the same level that the Stockbridge Rock Member was found in brash just north-east of Newton Tony [SU 2207 4060]. This appears to be the only recorded outcrop of the Stockbridge Rock Member to date.

However, surveying elsewhere in the area suggests that the Stockbridge Rock Member lies about 6 m (± 1 m) below the base of the Newhaven Chalk. That implies that a few metres of Newhaven Chalk occurs at the top of the Newton Tony cutting, perhaps as part of a small outlier. Although this might explain the presence of 'thin marl partings' in the section, there is no other evidence for the occurrence of the Newhaven Chalk here: the soil in the adjacent fields contains many large flints and no crinoid debris was found in the accompanying chalk brash (only fragments of *Platyceramus*), or in chalk exposed in the roots of numerous blown-down trees in the nearby Beaumont's Plantation [SU 212 404]. Indeed, a persistent positive feature thought to mark the Stockbridge Rock Member occurs on either side of this cutting at about 103 m OD, so it is conceivable that Bennett's measurement is in error.

Spoil from a roadside salt bunker opposite Beech Hanger (a side road) on the east side of Cholderton [SU 2229 4219] comprises soft to firm white chalk together with very hard creamy-coloured chalk containing sponge spicules, resembling the Stockbridge Rock Member. Fragments of the inoceramid bivalves *Platyceramus*? and *Sphenoceramus* aff. *patootensis* are also present, confirming a position in the upper Seaford Chalk or younger (Woods, 1999a).

SU23NW

The formation outcrops on either side of the Bourne River on the lower slopes in the broad valley. The Stockbridge Rock Member is found in a number of localities on the south-eastern slopes but cannot be mapped consistently.

There is a 10 m deep abandoned railway cutting [SU 2244 3942] near Newton Tony Junction but it is heavily overgrown and degraded. There are several poor exposures that show soft, white, blocky and slabby chalk with some large pipe flints but no fauna was collected.

The cutting [SU 2025 3725 to 2079 3763] to the northwest of the Porton Down establishment was not accessible during the 2003 survey. However soft to firm chalk with large flints was noted in the field adjacent.

6.2.5 Newhaven Chalk Formation

Lithologically similar to the Seaford Chalk, the Newhaven Chalk is composed of soft to medium-hard, blocky smooth white chalks with numerous marl seams and flint bands and is 55 to 70m thick. Typically, the marls vary between 20 and 70mm thick but they are generally much thinner, often little more than a few millimetres, in this area, as they die out over synsedimentary positive features (Mortimore, 1986; Mortimore and Pomerol, 1987; Mortimore and Pomerol, 1991). The flints are generally much smaller and less continuous than those in the underlying Seaford Chalk. Tabular and sheet flints are not so well developed, but finger, horn and *Zoophycos* flint forms are more common. Channels with hardgrounds and phosphatic chalks occur locally elsewhere in the succession and were noted in the boreholes drilled for the A303 dual carriageway southeast of Stonehenge.

The Newhaven Chalk outcrops extensively over the eastern part of the district occupying much of the sloping ground on and immediately below the face of the secondary Chalk escarpment. In the South Downs, the base of the Newhaven Chalk typically forms a prominent double negative feature break at the base of this scarp. But although the secondary escarpment is well developed in this district, only rarely does the base of the Newhaven Chalk correspond with the most prominent negative break of slope. Instead this break usually occurs within the *M. testudinarius* Zone, about 10 m above the base of the formation. The lowest ten metres of the Newhaven Chalk generally caps the spurs extending out from the scarp foot. The base of the formation is commonly marked by an extremely faint negative break of slope a short way above a rounded positive break of slope, which in some parts of the district seems to be caused by the indurated horizon at the top of the Seaford Chalk.

Biostratigraphically, the Newhaven Chalk covers the whole of the *Uintacrinus socialis*, *Marsupites testudinarius* and the *Uintacrinus anglicus* zones and most if not all of the *Offaster pilula* Zone. It crosses the Santonian/Campanian stage boundary that is placed at the Friars Bay Marl in Sussex (Mortimore, 1986). In this district the top of the formation is placed above the Pepperbox Marls as seen in the Pepperbox Quarry (Mortimore et al., 2001) thus extending the range of the formation a little further up-succession than described in Mortimore (1986)

Details

SU14SW

Newhaven Chalk occurs in two outcrops on this sheet.

Site investigation boreholes for the proposed Stonehenge bypass tunnel proved an anomalous sequence of phosphatic Chalk and Newhaven Chalk in the area just south of Stonehenge. Boreholes proved up to about 20m grainy sandy phosphatic Chalk occupying a synsedimentary channel, overlain by Newhaven Chalk. Extensive microfossil samples from the surrounding area has confirmed this interpretation and indicated that the channel trends southwest – northeast from Normanton Down [SU 1150 4145] to Stonehenge Bottom [SU 1268 4224]. This channel is filled by a succession of phosphatic chalk overlain by a core of Newhaven Chalk (of *socialis* and *testudinarius* Zone age). Surface brash of phosphatic chalk is quite rare, suggesting that the floor of the channel contains the phosphates, which thin to the margins of the channel. The length of the channel is thought to be about 1.5 km long, 20 m deep with a maximum width of about 700 m. The eastern end of the channel may abut against a small fault, running north – south along Stonehenge Bottom. Up to 20 m of Seaford Chalk is cut out by this feature locally. This channel is similar in age and style to the channels interpreted from seismic data in the Bournemouth area (Evans and Hopson, 2000).

A small outlier of Newhaven Chalk occurs on the summit of Coneybury Hill [SU 135 415]. Here a sample yielded microfossils indicative of Newhaven Chalk (BGS Zone 18ii). The thickness of the Newhaven Chalk cannot be more than 2-3 m at this locality and no distinctive macrofossils were found.

SU14SE

Newhaven Chalk underlies much of the eastern part of this sheet, between Boscombe Down and Beacon Hill. Here the Newhaven Chalk is about 60 m thick. Typically the base of the Newhaven Chalk forms a prominent double negative feature break at the base of the secondary scarp, but in the Stockbridge – Amesbury area this break usually occurs within the *M. testudinarius* Zone, about 10m above the base of the Formation. The lowest ten metres of the Newhaven Chalk (*Uintacrinus socialis* Zone) tends to caps the spurs extending out from the scarp foot, such as the spur upon which Boscombe Down airfield is sited. The base of the Newhaven Chalk is commonly marked by an extremely faint negative break of slope a short way above a rounded positive break of slope.

Exposures are generally rare, but several scrappy sections can be seen in the disused railway cutting [SU 188 407] along the northern perimeter fence of Boscombe Down Airfield. This cutting exposes many small sections of soft blocky white chalk entirely within the *U. socialis* Zone. Up to 5 m of soft white blocky Newhaven Chalk is exposed and *Uintacrinus socialis* has been collected from several points in this cutting, notably from an exposure at track level at the western end of the cutting [SU 1805 4092]. A small landslide at the northwestern end of the cutting at rail level yielded abundant ossicles and calyx plates of *Uintacrinus socialis* and some oyster spats. Newhaven Chalk may cap some of the ridges which extend west, south-west and south-south-east from here across Boscombe Down airfield, but for the most part these are covered by a variable amount of made and landscaped ground to create the airfield runways and hangers.

SU13NE

On this sheet, Newhaven Chalk underlies the spur of high ground that underlies Boscombe Down airfield and in the extreme southeast corner. On Boscombe Down, the lowest ten metres of the Newhaven Chalk (*Uintacrinus socialis* Zone) cap the spur extending out from the scarp foot. There are no exposures of Newhaven Chalk, except for a few temporary sections on the airfield. Much of the runway is made ground.

SU13SW

About 60 m of Newhaven Chalk occurs on this sheet, capping the hills and dipping into the valleys south of Old Sarum. The prominent double negative feature break at the base of the secondary scarp, extending north of Old Sarum occurs within the *M. testudinarius* Zone, about 10m above the base of the formation. The lowest ten metres of the Newhaven Chalk (*Uintacrinus socialis* Zone) caps the spur of high ground between Old Sarum and Old Sarum Barracks [SU 1500 3350]. The chalk dips to the south, so the southern end of Castle Hill [SU 1480 3150] is in the *Offaster pilula* Zone. There are no significant exposures of Newhaven Chalk.

Jukes-Browne and Hill (1904) identified a site “on the northern side of Old Sarum hill” where 3.66 to 4.57 m of soft chalk with a “few scattered flints not in layers” was found. These beds included *Uintacrinus* and other fossils. The site was not identified during the 2003 survey.

The “Marsupites Band” of Jukes-Browne and Hill (1904) was identified in the cutting west of the railway tunnel to the northeast of Salisbury station. This is located adjacent to Churchill Way North at [SU 1465 3085].

Two large fossil collections reported in Jukes-Browne and Hill (1900) pits at Highfield (Fisherton) and Bishops Down. The latter is one of two possible sites on sheet SU13SE and reported on below.

The Highfield (Fisherton) site has not been positively identified during the 2003 survey. There are a number of sites notified as being places where the Quaternary ‘Fisherton Beds’ were dug in the triangle between the Devizes and Wilton Roads in central Salisbury and limited to the northwest by Highbury Avenue and Highfield Road. Three pits identified in this area are possible candidates but two are now built over. The third at [SU 1335 3060] is indicated on present large scale maps as ‘Playing Field’ and has a significant 5 to 10 m high bluff to the north. It is considered as the most likely locality for the chalk pit that was reported to be 50 feet (15.24 m) deep and been further excavated to 12 feet (3.66 m) below the pit floor. The chalk encountered was described as “soft white chalk; flints are not numerous but occur sparsely along planes 10 feet (3.05 m) apart. Most of them are nearly spherical, from the size of bullets to that of cannon balls.” Jukes Browne and Hill (1904) report that Dr. Blackmore collected 68 species, including the species *Uintacrinus*, *Marsupites* and *Offaster pilula,* and this indicates that much of the lower Newhaven Chalk was represented.

SU13SE

The Newhaven Chalk covers much of the southern and eastern part of the sheet, mainly along the front of the secondary escarpment and on Castle Hill, and the area south of Bishopsdown Farm- St Thomas’s Bridge. Exposures are generally poor and restricted to a few pits. The best exposure is in a small pit a kilometre southwest of Figsbury Ring at [SU 1802 3306]. Here 6-8m of very soft massive blocky smooth white chalk with very few small finger and *Zoophycos* flints is exposed. Specimens of *Echinocorys depressula* and *E. tectoniformis* place it in the *O. pilula* Zone, *E. depressula* Subzone, which suggests at level at about the middle of the Newhaven Chalk.

The old Salisbury memoir (Reid, 1903) states that Newhaven chalk was formerly exposed in a pit on Bishopsdown [SU 1509 3215] (*M. testudinarius* Zone). *M. testudinarius* was also found at or near the prominent break of slope at the foot of the secondary escarpment at [SU 1809 3322]. The boundary with the Seaford Chalk was usually placed just below a small positive bluff about 500 m in front of the base of the main secondary scarp. *U. socialis* was found on top of this bluff at [SU 1670 3271].

SU12NW

The formation outcrops to the south of Salisbury within the broken and degraded secondary escarpment south of Harnham. It is limited further to the south against the extension of the Mere Fault.

The principal exposure of the formation is in the West Harnham Chalk Pit [SU 1280 2880] that is now abandoned. Jukes-Browne and Hill (1904) describe “another large quarry from 60 to 70 feet deep

(18.29 to 21.34 m). In the higher part the chalk is regularly bedded; in the lower part the bedding is less distinct, and it is probably a lower portion of the zone (*Actinocamax quadratus* in their scheme), for the flints, few and scattered, are stained yellow outside. *Act. quadratus* is fairly common in the upper part, but rare in the lower beds, though it has been found in them." The faunal list for this pit (and a nearby pit at East Harnham, see below) is extensive and includes *Offaster pilula* that would indicate that the lower beds are in Newhaven Chalk Formation and the higher beds in the Culver Chalk Formation.

This locality was described in detail by Mortimore et al. (2001). A skeletal log of the succession was produced for the current survey, and confirms Mortimore et al's recognition of the upper Newhaven Chalk and lower Culver Chalk formations (Figure 55). The Telscombe Marls, with associated *Offaster pilula planatus*, are conspicuous markers. The probable correlatives of the Arundel Sponge Bed and Castle Hill Flints were seen in the upper part of the succession.

Plate 31. West Harnham Chalk Pit. Looking NE over Salisbury Cathedral, Telscombe Marls and Meeching Marls indicated (Mortimore, pers. comm. 2005), [SU 128 287].

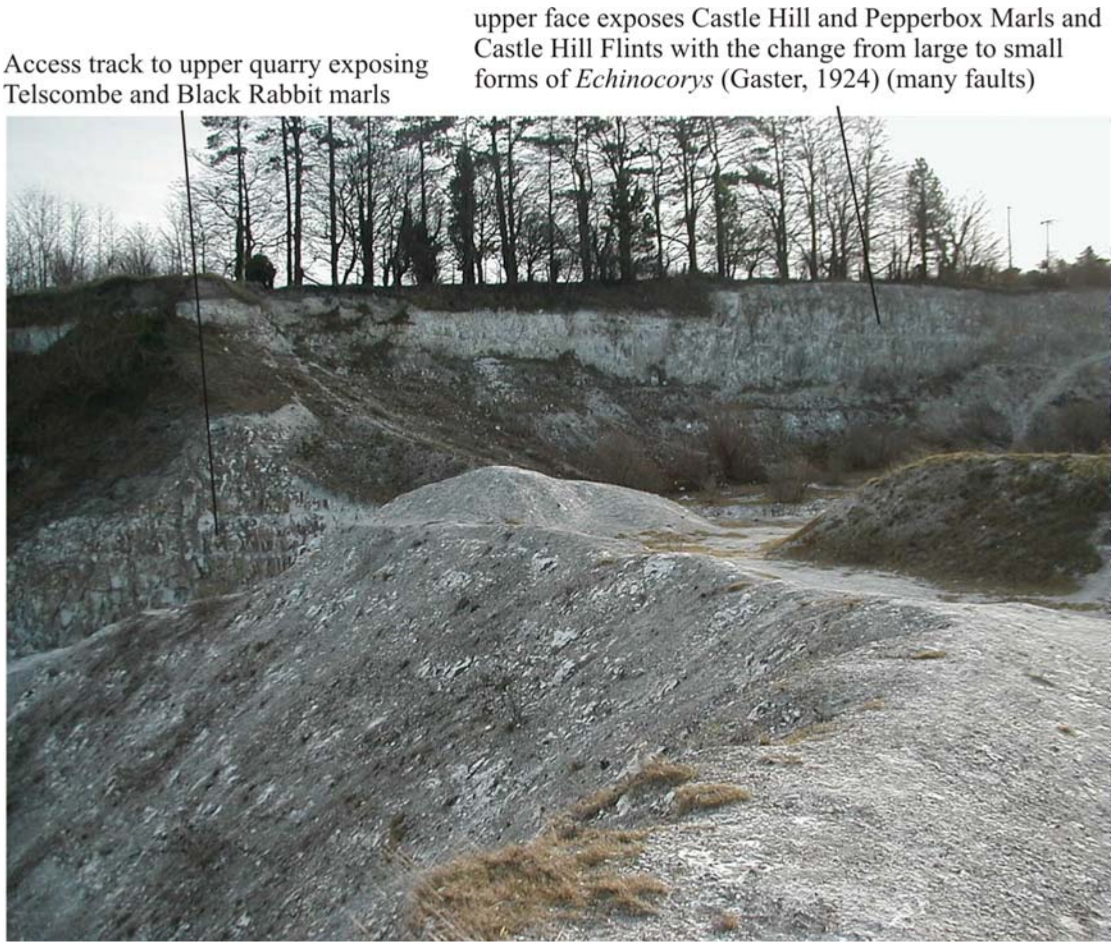


Plate 32: West Harnham Chalk Pit. Looking SE onto the highest beds exposed. Castle Hill, Pepperbox Marls and Castle Hill Flints exposed in upper face. Telscombe and Black Rabbit Marls above access ramp (Mortimore, pers. Comm., 2005).

Plate33 The upper quarry at West Harnham [ST128 287]] (Mortimore, pers. Comm., 2005)

Plate 34 West Harnham Quarry [SU 128 287] (Mortimore, pers. comm., 2005)

Further to the west and to the south of the Harnham Trading Estate is an exposure [SU 1260 2885] (Plate 35) of soft white chalk has a fauna including the crinoid *Bourgueticrinus*, ophiuroid plates and the diminutive rhynchonellid brachiopod *Terebratulina rowei*. One of the specimens is derived from a marly chalk horizon.

Plate 35. Cutting in Newhaven Chalk, Harnham. [SU12600, 28850]. Photo P584738

Terebratulina rowei suggests assignment to the Newhaven Chalk, wherein it is long ranging, with local acmes in the *M. testudinarius* Zone and *O. pilula* Zone. The absence of *Uintacrinus* and *Marsupites* suggests that neither the *U. socialis* or *M. testudinarius* zones are likely to be present, and the position of the exposure with respect to the nearby West Harnham succession suggests that it is not younger than the upper *O. pilula* Zone. Therefore, assignment to the lower *O. pilula* Zone (*E. depressula* Subzone), or possibly the underlying *U. anglicus* Zone, might be indicated.

Jukes-Browne and Hill (1904) include a description for a pit at East Harnham that from the Ordnance Survey six-inch scale maps of 1902 has a narrow footprint from [SU 1380 2860 to 1400 2877] adjacent to the Old Blandford Road. The survey of 2003 did not study this locality in detail, as it is heavily overgrown and degraded. Jukes-Browne and Hill (1904) describe it as "a fine quarry worked in two levels. The lower one shows 50 feet (15.24 m) of bedded white chalk, with only a few scattered flints; the upper level shows about 60 feet (18.29 m) with seven or eight layers of flints at varying distances, sometimes 6 feet (1.83 m), sometimes 10 or 12 feet (3.05 or 3.66 m) apart with only a few scattered flints in the intervening chalk. The beds are regular and dip at about 2° to the south, unbroken by faults."

This description and the included fauna demonstrate a direct equivalence between this exposure and that at West Harnham and confirm the presence of the Newhaven and Culver Chalk formations.

SU12NE

The Newhaven Chalk outcrops over the northwest corner of the sheet and is seen again to the southwest around Nunton and to the southeast on the downs that form the southern flanks of the Alderbury – Mottisfont Syncline.

The old Salisbury memoir (Reid, 1903) and Jukes-Browne and Hill (1904) describe a pit at the crossroads east of Milford that is now identified as the small overgrown pit at [SU 1612 2979]. They considered the 3.05 to 3.66 m of chalk to be low in their *Actinocamax quadratus* zone but there is abundant *Offaster pilula* at this site that would place the quarry in the Newhaven Chalk Formation.

A large pit [SU 1630 2937] near Petersfinger is infilled with waste and rubble and now exhibits no exposure.

To the south near Witherington Ring a small, degraded pit [SU 1837 2501] formerly exposed Newhaven Chalk including *Uintacrinus anglicus*. This pit straddles the boundary with sheet SU12SE to the south where 3.0 m of firm sparsely flinty chalk was noted.

SU12SE

The Newhaven Chalk Formation is confined to the slopes east of the River Avon. With the exception of the pit mentioned in SU12NE above there are no significant exposures. The old railway cutting at [SU 1945 2460] being completely degraded.

SU24SW

Calyx plates of the crinoid *Uintacrinus socialis* were found in field brash between Ann's Wood and Michael's Wood [SU 2135 4297] (Woods, 1999a) and 900 m west-north-west of Amport House [SU 2884 4433], in chalk exposed in the roots of fallen trees 800 m north-west of Parkhouse Corner [SU 2256 4396] (Woods, 1999a) and 800 m east of Quarley Church [SU 2810 4415], on a rifle range 850 north-west of the tumulus on Beacon Hill [SU 2041 4488] (Woods, 1999b), and in a shallow excavation for a barn at Lains Shooting Ground [SU 2763 4440] (Woods, 1999a).

Small crinoid brachial plates taken to indicate Chalk of the 'crinoid Zones' and probably the *U. socialis* Zone, were found in field brash about 650 m west-north-west of the cross-roads between the A338 and the Amesbury Road (Newton Tony) [SU 2015 4132] (Woods, 1999b) and in numerous other places throughout the lower part of the Newhaven Chalk outcrop.

Calyx plates of *M. testudinarius* were found in field brash 400 m west-north-west of Scotland Lodge [SU 2037 4301] (A R Farrant, oral communication, 1999).

SU23NW

The Newhaven Chalk forms much of the outcrop over Porton Down and Idmiston Down to the southeast of the Bourne River. Access to much of this experimental station was severely restricted during the 2003 survey and only surface featuring and soil brash were available to determine the outcrop. Micropalaeontological samples however did confirm the broad distribution of this formation on the slopes below Tower Hill [SU 234 383] and Easton Down [SU 235 358].

Excavations for an old rifle range at [SU 2330 3857] gave a brash of low-density very soft white chalk with small spiky finger flints and zoophycos flints.

Outside the district at [SU 2482 3946] an excavation for a test track exposed a 10 m high vertical face in soft very large blocky to massive bedded chalk without flints but containing some thick-shelled echinoid debris and a number of calyx plates and brachials of the zonal index of *Marsupites testudinarius*.

SU23SW

The formation outcrops widely within the shallow valley around Firsdown. There are very few exposures and much of the ground was in pasture at the time of the survey. The Newhaven Chalk was formerly exposed in the landfill site at Thorny Down but this was closed at the time of the survey in 1999.

SU22NW

On the south side of the Alderbury – Mottisfont Syncline the Newhaven Chalk forms the steep face of the Dean Hill scarp (and anticline) and the shallower slopes into the River Dun valley (essentially the southern limb of the syncline).

There are few exposures but the major quarry at East Grimstead is regarded as an equivalent to that at West Harnham and indeed formerly exposed a thicker succession. The East Grimstead Quarry [SU 227 271] south of the railway was described by Mortimore (1986) and repeated in Mortimore et al. (2001) (Figure 55) and is a key site in the understanding of the formation in the Southern Province of the Chalk Group. Over 44 m of beds were logged and a composite graphic from the 2001 volume is given below.

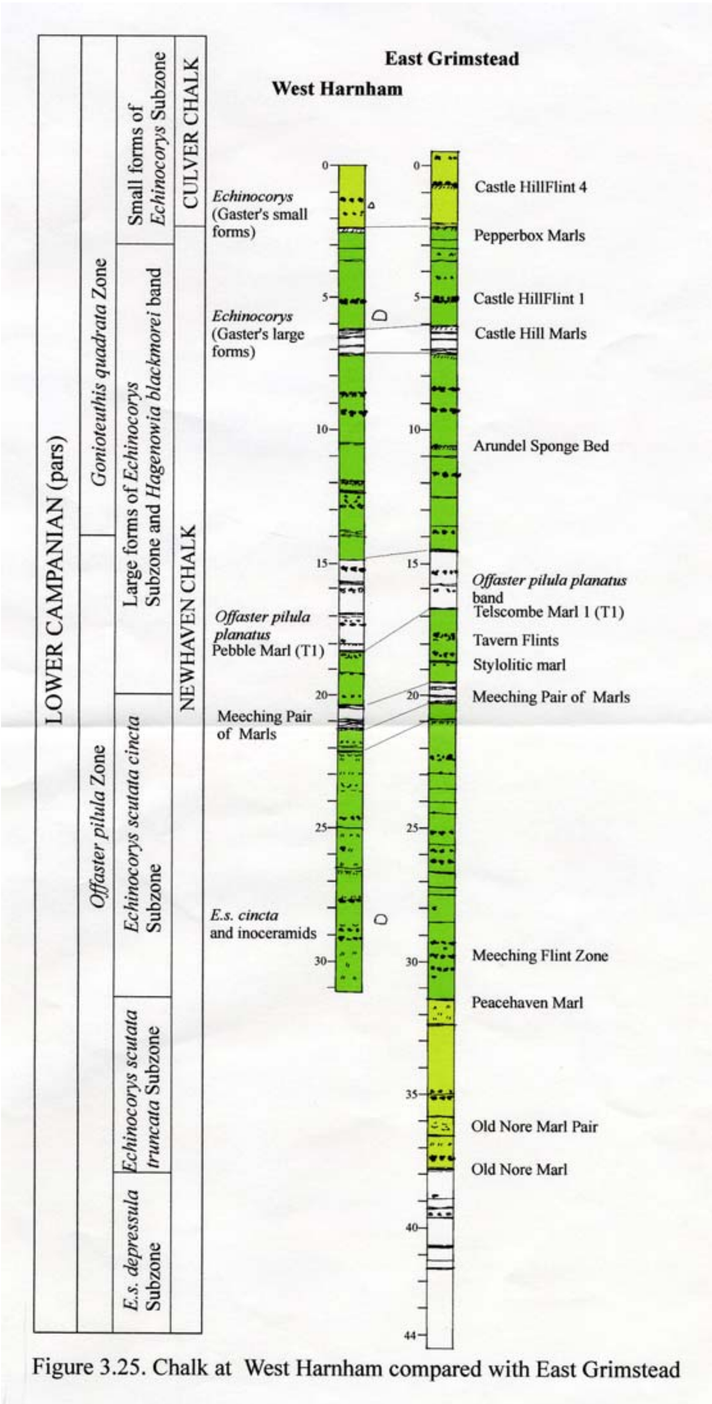


Figure 55: Chalk correlations between the succession at West Harnham and that of East Grimstead (Mortimore et al., 2001, fig 3.25)

SU22SW

The formation outcrops over Witherington Down [SU 205 247] and Standlynch Down [SU 203 240] to the north west of this sheet and as an inlier within the valley south of Pepperbox Hill [SU 214 247].

The Pepperbox Hill chalk pit (formerly referred to as the Old Sarum Limeworks) and otherwise as the Brickworth Lane Landfill site logged in 2003 (Figure 57) exposes over 10 m of soft white chalks with marl seams and flints in the higher part (Figures 56). This is now considered to represent the highest part of the Newhaven Chalk Formation up to and including the Pepperbox Marls themselves (Mortimore et al., 2001). In so doing the top of the Newhaven Chalk Formation includes the Castle Hill Beds of Mortimore (1986) that were formerly regarded as the basal unit of the succeeding Culver Chalk Formation.

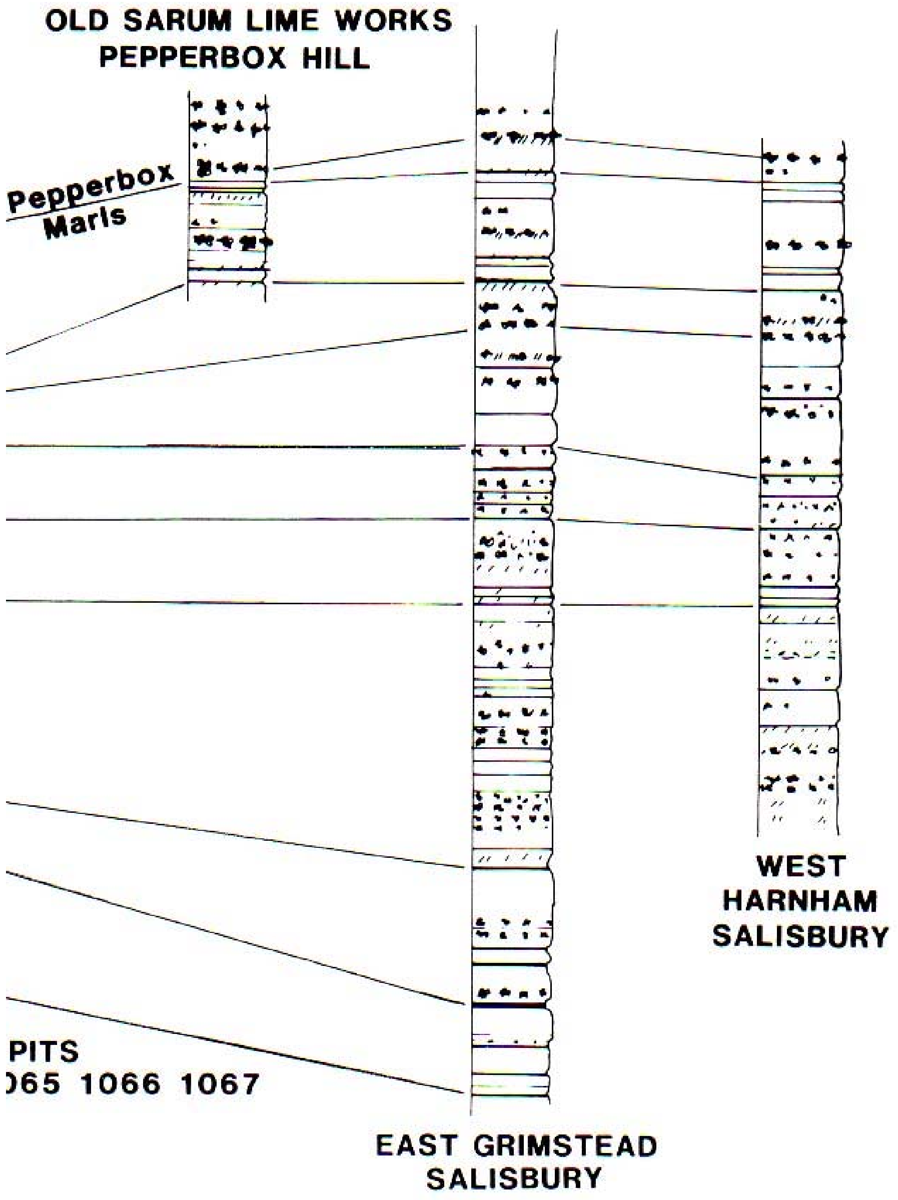


Figure 56. Correlation of the upper Newhaven Chalk at Pepperbox Hill, East Grimstead and West Harnham (Mortimore, 1986)

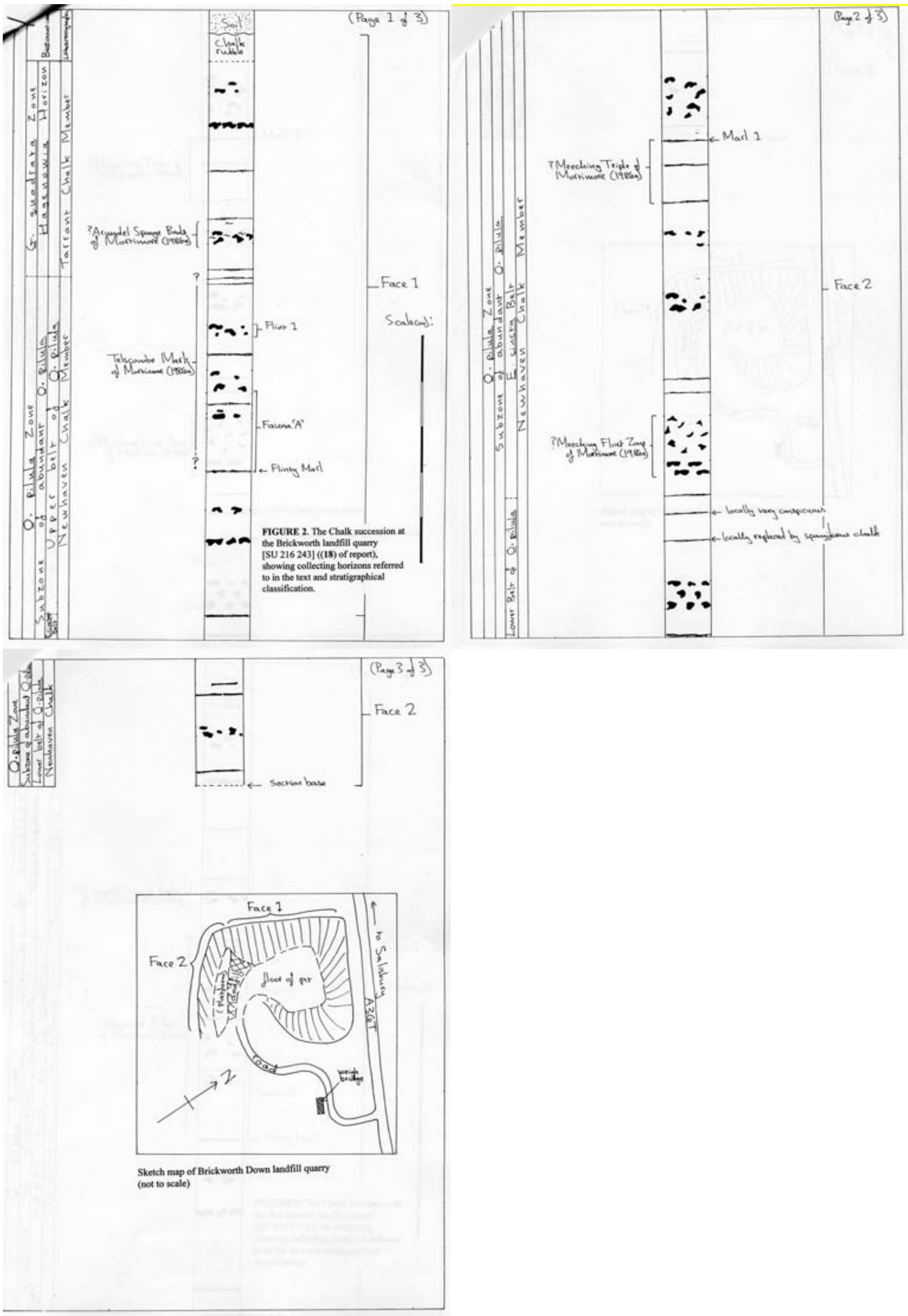


Figure 57: The chalk succession at Brickworth Down Landfill Quarry [SU 216 243]

6.2.6 Culver Chalk Formation

The formation is between 35 and 45 m thick in this district and generally forms the face and crest of the secondary chalk escarpment.

The Culver Chalk is composed of soft white chalks without significant marl seams, but with some very strongly developed nodular and semi-tabular flints. A particular concentration of large flints, the Castle Hill Flints, occurs near the base of the unit as defined (at the Castle Hill Marls) by Mortimore (1986) that is just above the level of the Arundel Sponge Bed (Mortimore, 1986). In mapping terms (following Bristow et al., 1997) the boundary is placed in the upper *Offaster pilula* Zone perhaps as low as the

Telscombe/Meeching Marls of the standard Sussex succession (Mortimore, 1986). In this district the top of the Newhaven Chalk (Mortimore et al., 2001) is taken at the top of the Pepperbox Marls some 4 m higher in the succession as seen in the sections at West Harnham, East Grimstead and at Pepperbox Quarry itself (see above), compared to the Sussex standard. In parts of Dorset and Sussex, the Culver Chalk Formation can be divided into a lower Tarrant Chalk and an upper Spetisbury Chalk (formations in Bristow et al., 1997) but current practice treats these as members of the Culver Chalk (Rawson et al., 2001) (Table 2). The Culver Formation caps the secondary Chalk escarpment and underlies much of the dip slope behind, almost to the Palaeogene escarpment.

The majority of the Culver Chalk outcrop occupies the southeast of the district. Four outliers occur on the hilltops northeast [SU 162 300 to 183 330] of Laverstock; near [SU 210 330] Firsdown; in the north of the district [SU 195 425] as the southern extremity of Beacon Hill, Bulford; and on the eastern margin of the district as extensions [SU 230 365 and 234 385] to the outlier centred around Porton Down and Tower Hill. It is composed of soft, white homogeneous chalks with only sporadic, widely separated groups of marl seams, but with flint seams, some large. In the field, the base of the Culver Chalk is taken just below a strong persistent positive topographic feature coinciding with the appearance of abundant large flint nodules. In places, a negative feature occurs a few metres below this level, and where present this has been taken as the base of the Culver Chalk. Where the secondary Chalk escarpment is not so well developed, for example near Clarendon Palace [SU 182 302], the base of the Culver Chalk occurs at a prominent negative feature break at the base of a small scarp, which in effect is the upper half of the secondary Chalk escarpment. Traced northeast, this scarp becomes much more prominent east of Lopcombe Corner [SU 252 354] due to greater erosion into the Newhaven Chalk. Here, the base of the Culver Chalk occurs about two-thirds of the way up the slope, at the usual position below the positive feature break.

Chalk brash from the Culver Chalk tends to be blockier than that derived from the Newhaven Chalk, but chalks of these units cannot be reliably distinguished on lithological grounds alone, even in small exposures. Some parts of the Culver Chalk (within the *Applinocrinus cretaceus* Subzone) are characterised by abundant bioclastic debris, especially bryozoan debris, but this was not found in the present area. Much of its outcrop is covered by clay-with-flints.

Biostratigraphically, the Culver Chalk mostly or entirely lies within the *Gonioteuthis quadrata* Zone, with the base possibly extending downwards into the *Offaster pilula* Zone in some areas. It is entirely within the Campanian stage (Mortimore, 1986; Bristow et al., 1997).

Micropalaeontological determinations show that the Culver Chalk has been significantly attenuated, with the lower Tarrant Member probably reduced to less than 8 m in thickness in places, and possibly being entirely absent in the extreme south, whilst the overlying Spetisbury Member may well be thicker where this occurs. This attenuation might be a consequence of relatively localised erosion during the Campanian as a consequence of channel development on the contemporary sea-floor (Evans and Hopson, 2000; Evans et al., 2003). It is also possible that part of the Newhaven Chalk was removed by the same erosional process, consequently leaving it thinner, in places, than in the area to the south and east of the district. Alternatively, the reduced thickness of the Culver Chalk may represent a regional northwards thinning of Campanian strata, or an overstep of the lower part of the Culver Chalk by the upper part towards the London Platform. In mapping terms the distribution of the members within the Culver Chalk could only be determinable by close micropalaeontological sampling over wide areas since exposure is limited and the two members do not show separate geomorphological featuring in this area. Such an intensive study is beyond the remit of this survey and the Culver Chalk is in consequence shown undivided.

Details

SU14SE

Culver Chalk caps the top of Beacon Hill [SU 1945 4275]. No significant exposures were noted in this district, but some large rounded and horn shaped flints were noted in the brash.

SU13SE

The outcrop forming the crest of the dissected secondary chalk escarpment and the outlier northeast of Laverstock is sprinkled with small pits, solution dolines and minor scrapes but they provide no significant exposures. Small exposures on a track leading up the scarp face near Clarendon Palace [SU 1782 2998] yielded soft white chalk with large flints and a fauna including many bryozoa indicative of the *G. quadrata* Zone, (*A. cretaceous* Subzone) in the lower part of the Culver Chalk. For the most part it is thought that the Culver Chalk Formation in this area comprises predominantly the lower Tarrant Chalk Member.

SU12NW

The Culver Chalk Formation forms the crest of Harnham Hill [SU 132 286] and further towards the southeast near Odstock Hospital [SU 148 273]. Brash in this area is characterised by large nodular and semi-tabular flints in soft white chalk. The lower part of the formation is found in the two pits at West and East Harnham that are described above in the relevant part of the Newhaven Chalk Formation text.

SU12NE

The principal outcrop on this sheet is to the north and east from Ashley Hill [SU 172 294] to Grims Ditch [SU 198 297] on the crest of the dissected secondary chalk escarpment. West of the River Avon this escarpment re-emerges from Britford towards the Harnhams. In the southeast a narrow outcrop north-eastward from Witherington Ring [SU 185 252] marks the southern steeply northward dipping limb of the Alderbury – Mottisfont Syncline.

There are many small pits across the northern outcrop with the most significant being at Britford at the site of a dairy [SU 1516 2808] (Figure 58, Plate 36). Jukes-Browne and Hill (1904) gave a passing reference to this site as follows. "At Bridford a quarry shows about 30 feet (9.14 m) of the higher beds (of their *Actinocamax quadratus* Zone), bedded chalk, with layers of flints at intervals of about 3 feet (0.91 m), and sometimes less." They did however present a considerable faunal list for this site. The site was visited during the 2003 survey; biostratigraphical detail and a graphic log are presented below.

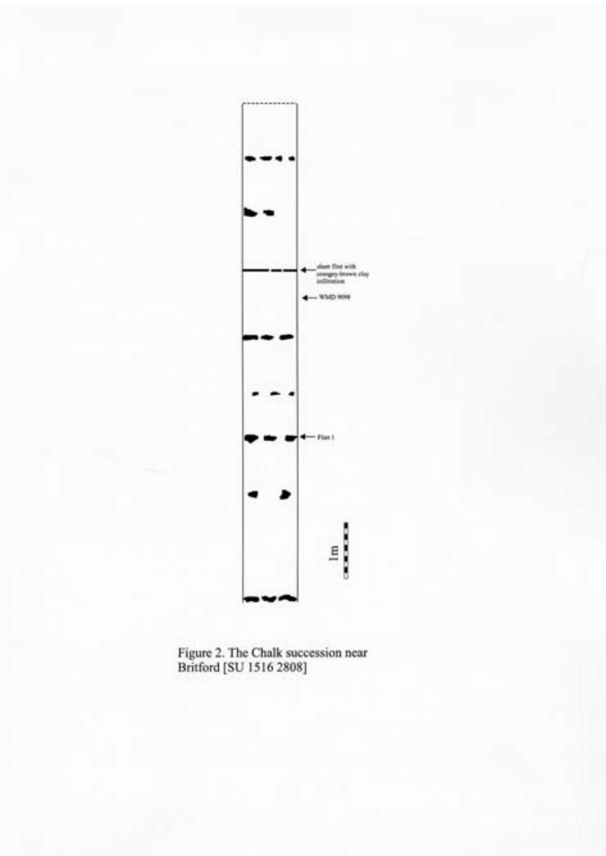


Figure 58: The Culver Chalk Formation succession near Britford [SU 1516 2808]

The succession at Britford comprises firm chalk with regularly developed nodular flints and a conspicuous sheet flint along which there has been infiltration of orangey-brown clay (above).

The sparse fauna includes *Echinocorys* aff. *depressula* and a further partially crushed specimen of *Echinocorys*, but preserving an uncrushed, narrow base. The brachiopod, *Cretirhynchia* aff. *arcuata* was collected from the brash at the foot of the exposure.

Narrow-based forms of *Echinocorys* are characteristic of the *G. quadrata* Zone; they are typically represented by *Echinocorys* ex gr. *marginata*, but the above specimen is too poorly preserved for definite assignment to this species. *Echinocorys depressula* is typical of the lower *O. pilula* Zone, but analogous (perhaps conspecific) morphotypes occur in the lower *G. quadrata* Zone, at which level they are usually assigned to the 'small form of Gaster (1924)'. The 'small form of Gaster' characterises the

Plate 36. Tarrant Chalk Member of the Culver Chalk Formation at Britford. [SU 1516 2808]. Photo P 584725

higher part of the Tarrant Chalk Member, while *Echinocorys* ex gr. *marginata* tends to occur at slightly higher levels, ranging from the top of the Tarrant Chalk to the lower part of the Spetisbury Chalk Member.

Cretirhynchia arcuata is typical of much higher stratigraphical levels, in the high Campanian chalk of East Anglia, so the possible record of this brachiopod in the Britford succession is interesting. The brachiopod may in fact represent part of Gaster's (1924) '*Cretirhynchia limbata*' (again, strictly speaking, a high Campanian species). *C. limbata* sensu Gaster (1924) is a feature of the mesofauna that characterises the *A. cretaceus* Subzone, so its possible ex situ record may signal the presence of the *cretaceus* Subzone in the higher (inaccessible) part of the exposure.

Mortimore (1986a, Fig. 3.19) correlated Britford with Gaster's (1924) Pit 24 in Sussex, which occurs at the top of the *cretaceus* Subzone. Pit 24 has a rich and abundant mesofauna of bryozoans, small brachiopods and occasional *Applinocrinus cretaceus* (Woods, 1995, WH/95/61R). There was no evidence for this fauna in the chalk recently examined at Britford, except for the single possible '*Cretirhynchia limbata*' sensu Gaster.

In conclusion, the succession at Britford almost certainly belongs to the Culver Chalk Formation, but its exact position within the formation is uncertain.

Jukes-Browne and Hill (1904) noted the zone in the railway cutting [SU 1680 2905 to 1707 2891] or possibly the cutting further south at [SU 1730 2881 to 1759 2876] at Ashley Hill without presenting a section. A pit below the level of the railway, north of Ashley Hill House is in the lower part of their *A. quadratus* Zone and considered to be in Newhaven Chalk Formation chalks.

They also describe a "good section of it (their *A. quadratus* Zone) in the railway cutting at Whaddon, which shows soft white chalk, with irregular layers and scattered nodules of flint, and occasional seams of soft marly chalk dipping to the north at about 14°." They presented an extensive faunal list for this site.

The cutting [SU 1942 2562 to 1940 2530] was visited, logged and collected during the 2003 survey (Figure 59, see also Plate 37).

About 20 m of soft to firm, flinty chalk are exposed in this cutting (above). A thin wispy marl occurs c. 3.5 m above the base of the logged section. The fauna includes the belemnite *Gonioteuthis*, a narrow-based form of *Echinocorys* (incomplete), and *Echinocorys* aff. *cincta*.

By association with the specimen of *Gonioteuthis* and the narrow-based form of *Echinocorys*, the *E.* aff. *cincta* is presumed to belong to the 'small form of Gaster', which can resemble (and may be conspecific with) *E. cincta*. Assignment to the lower *G. quadrata* Zone and the lower Culver Chalk Formation is therefore suggested.

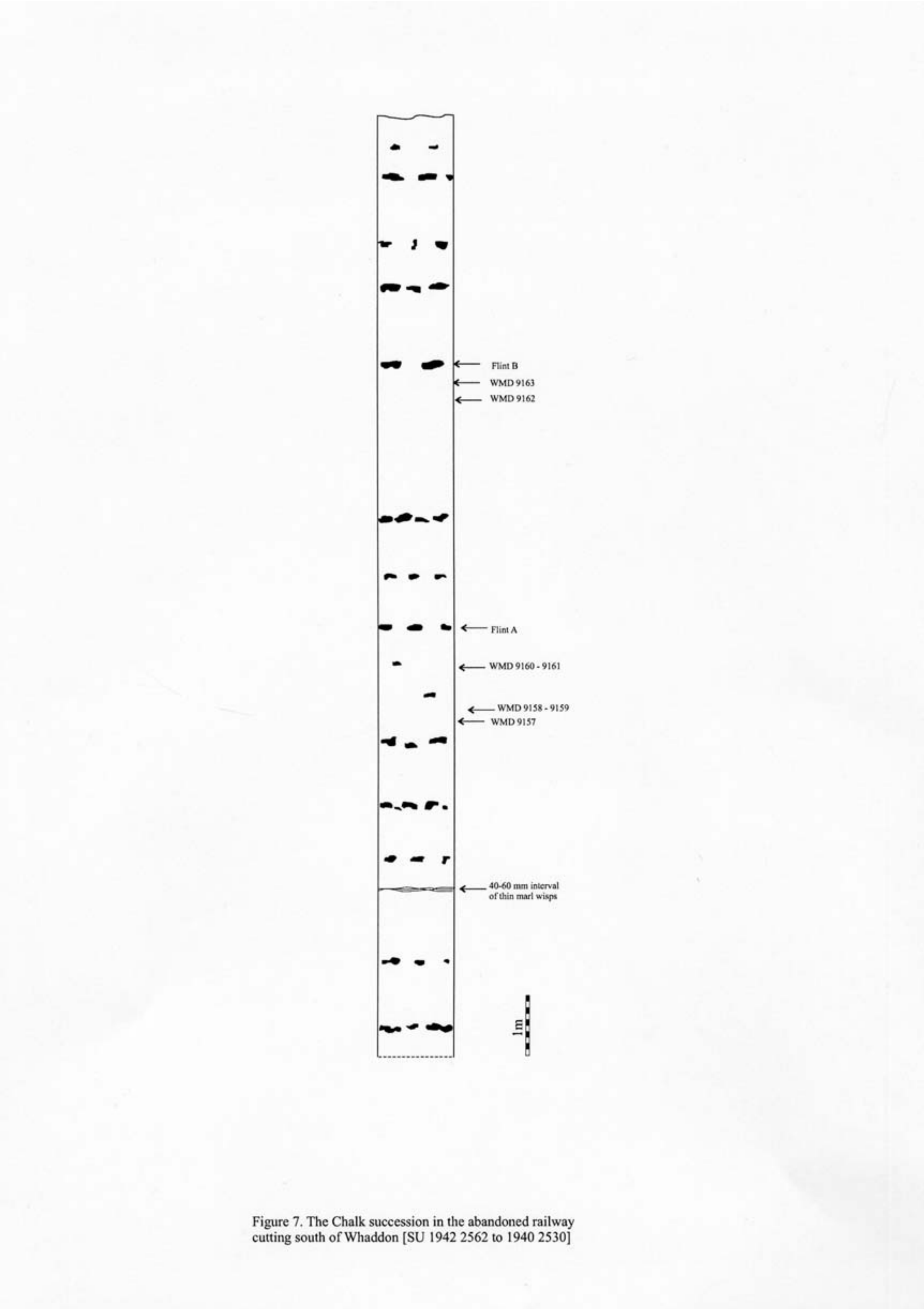


Figure 59: The chalk succession in the abandoned railway cutting south of Whaddon [SU 1942 2562 to 1940 2530]

Plate 37. Old railway cutting in lower Culver Chalk Formation (Tarrant Chalk Member), near Alderbury. [SU 19407, 25535]

SU23NW

Within the district the outcrop is limited within this sheet. Within Porton Down Experimental Establishment the large outlier between Easton Down and Tower Hill impinges over the eastern boundary of this district. There are no exposures and soft white chalk with numerous large flints is seen in burrows and track over this rough scrub landscape.

The northernmost part of the main outcrop of this formation is seen on the southern boundary of this sheet at Battery Hill [SU 350 207]. Here also the formation is recognised by the incidence of large flint in soft chalk.

SU23SW

The outcrop forms the ridge crests either side of the valley that drains southward into the headwaters of the River Dun. To the west the ridge from Pitton Copse [SU 205 307] to Battery Hill [SU 207 349] carries no significant exposure and is heavily wooded in the south. The number of large nodular flints and soft chalk brash identifies the formation and this is further confirmed by micropalaeontology.

To the east the rise from the valley bottom is more abrupt at a clear break of slope. The Culver Chalk Formation underlies this secondary chalk escarpment and the interfluve to the south and east. Much of the interfluve is covered by clay-with-flints and there is little exposure in this area.

On the scarp and its crest there is one significant exposure in the road cutting climbing the scarp face immediately southeast of Pitton. Here three sections between [SU 2130 3118 and 2128 3098] expose about 18 m of smooth, soft, white chalk with regularly spaced large flint seams attributed to the Tarrant Chalk Member of the formation (Figure 60).

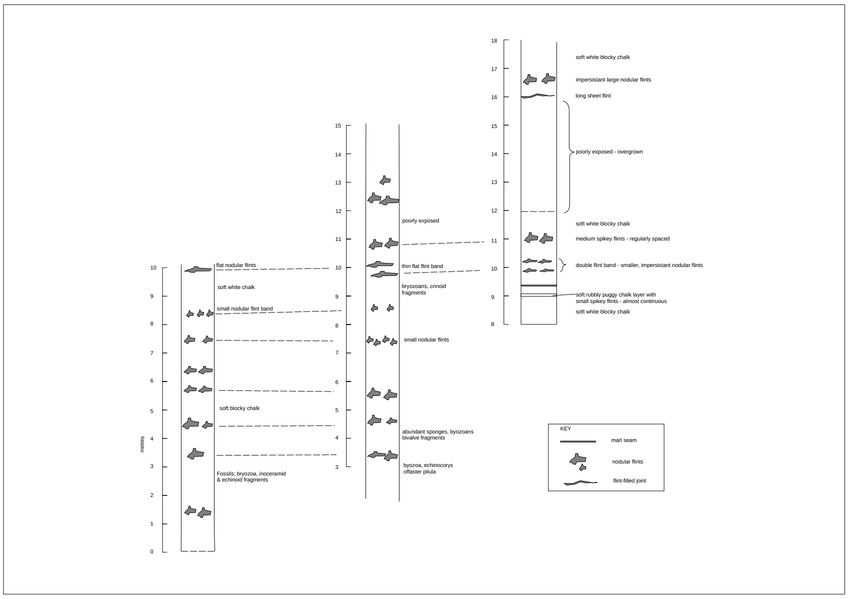


Figure 3: The Chalk succession at Pitton as logged along the road cutting [SU 2130 3118 to 2128 3098] and detailing fossils identified by Woods (1999).

Figure 60: The Culver Chalk Formation succession at Pitton along the road cutting [SU 2130 3118 to 2128 3098]

SU22NW

The formation outcrops to the north of the Alderbury – Mottisfont Syncline around Farley [SU 220 295] and to the south of that structure in a narrow steeply northerly-dipping outcrop between East and west Grimstead. It also forms the crest of the Dean Hill scarp.

The lower part of the Formation is exposed in the quarry at East Grimstead (see section on Newhaven Chalk Formation above and Figure 61 below). Field examination of this quarry originally suggested that the highest levels exposed belonged to the ‘Belt of *Echinocorys cincta*’ of the subzone of abundant *Offaster pilula*. However, detailed examination of the fauna showed the presence of the large *Echinocorys* morphotypes of Gaster (1924) at a level lower in the section and thus the highest fauna identified originally as *Echinocorys cincta* must be the small *Echinocorys* morphotype of Gaster (1924). Thus the highest part of the succession here must be within the lower *Gonioteuthis quadrata* Zone and therefore attributable to the lowermost Tarrant Chalk Member.

The formation is also seen in a small quarry [SU 2172 2648] near Manor Farm at West Grimstead. This section was formerly considered to be entirely within the Portsdown Chalk but may well straddle the boundary with the underlying Spetisbury Chalk Member of the Culver Chalk. The characteristic abundant *Zoophycos* flints typical of the basal Portsdown Chalk are absent from the section; as is the index fossil *Belemnitella.* The presence of *Gonioteuthis* could suggest the basal part of the quarry is below the basal *mucronata* Zone and therefore possibly below the basal Portsdown Chalk. However the evidence is inconclusive either way.

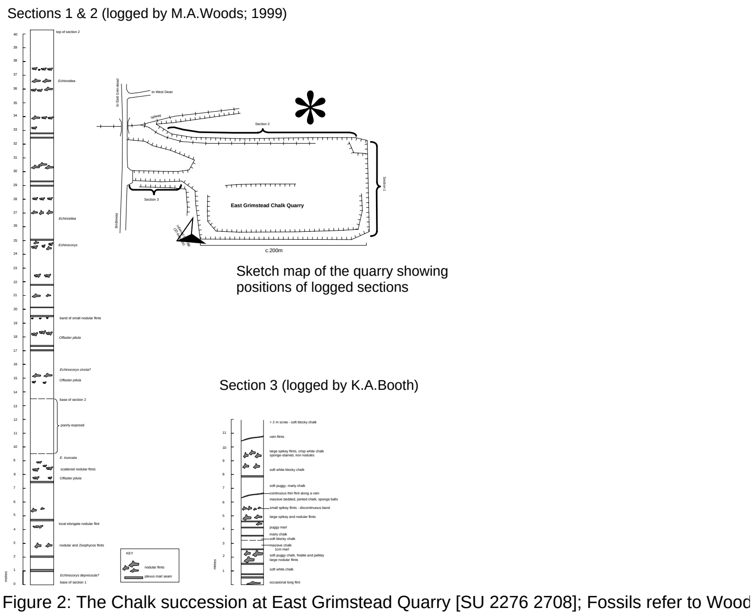


Figure 61: The chalk succession at East Grimstead Quarry [SU 2276 2708]

SU22SW

The Culver Chalk Formation outcrops on the top of the Dean Hill escarpment east of Pepperbox Hill [SU 214 247]. There are a number of degraded and overgrown pits across the crest but none have significant exposures.

6.2.7 Portsdown Chalk Formation

This formation only outcrops in the extreme south of the district, just north of the Palaeogene outcrop in the Dean syncline. It consists of white flinty chalk with common marl seams, the base of which is taken at the Portsdown Marl (Mortimore, 1986, Bristow et al., 1997). In this area the Portsdown Chalk is either very thin (less than 10 m) or absent, having been removed by erosion prior to the deposition of the Reading Formation and London Clay. No clear sections were seen and the only firm evidence for Portsdown Chalk comes from micropalaeontological evidence from a pit at Brick Kiln Copse [SU 1822 2860] that suggests the higher part of the *quadrata* Zone.

Details

SU12NW

The formation forms a thin veneer on the crest of the secondary chalk escarpment between Harvard Hospital [SU 139 281] and the site of the Little Woodbury settlement [SU 149 279]. There are no exposures across this area and the outcrop was identified on the basis of micropalaeontological results.

SU12NE

Only limited outcrops of this formation are identified around the nose of the Alderbury – Mottisfont Syncline.

In this area the Portsdown Chalk is either very thin or perhaps locally absent, having been removed by erosion prior to the deposition of the Reading Formation. There are no significant exposures in the area and the only firm evidence for Portsdown Chalk comes from micropalaeontological evidence from a pit at Brick Kiln Copse [SU 1822 2860] that suggests the higher part of the *quadrata* Zone. The Portsdown Chalk is better exposed to the east around East Grimstead.

Jukes-Browne and Hill (1900) identified a pit at Shootend (now Shute End), “northwest of Alderbury, between the branching of the roads [SU 1735 2815] to Downton and to Southampton”. Its exact location is uncertain as there is a house built at this site. They described, “the Chalk here seen is very soft and white, with few flints, those that occur consisting of solid black flint without any crust—merely a yellow coating. *Belemnitella mucronata* is fairly common.” Their faunal list is extensive with 38 species recognised.

SU22NW & SU22SW

The Portsdown Chalk Formation only has outcrops to the south of the Alderbury – Mottisfont Syncline. To the north of this structural feature the formation is cut out beneath the sub-Palaeogene erosional surface. On the southern limb the formation only has a limited outcrop near Manor Farm West Grimstead around the small pit noted above (see Culver Chalk Formation entry). Elsewhere along this southern limb it is uncertain as to whether there is a thin succession of the formation immediately adjacent to the Reading Formation outcrop.

Further south the Portsdown Chalk Formation forms the ground adjacent to the small Palaeogene scarp. There are numerous small pits in the area of Brickwork Park [SU 226 237] but none have significant exposures.

7. PALAEOGENE

The principal outcrop of Palaeogene strata is to be found within the Alderbury – Mottisfont Syncline in the southeast of the Salisbury district. In the extreme southeast an outcrop of Reading Formation strata indicates the north-western extremity of the Palaeogene in the Hampshire Basin proper. In this district the Palaeogene strata were traditionally described as the Reading Beds, London Clay and Bagshot Beds. These equate more or less with the modern lithostratigraphy as shown below.

Group	Formation	Traditional Nomenclature
Bracklesham Group	Wittering Formation	Bagshot Sand
Thames Group	London Clay Formation	London Clay
Lambeth Group	Reading Formation	Reading Beds

In this district the succession ranges between 55 and 85 m in thickness but this must be considered as approximate since the stratal thicknesses are difficult to judge within the asymmetric Alderbury – Mottisfont Syncline.

Much of the succession was encountered in the Alderbury Borehole SU12NE7 [SU 1965 2672]. This borehole must lie close to the axial plane of the asymmetric syncline. It proved 239 feet (72.85 m) of strata that are described in detailed lithologically.

Unit	Lithology	Thickness m	Depth m
Superficial deposits	Topsoil	0.30	0.30
	Yellow sand	0.91	1.22
	Gravel	0.30	1.52
Wittering Formation	Yellow sand	2.74	4.27
	Running sand	3.66	7.92
	Gravel	0.61	8.53
	Yellow sand	3.96	12.50
	Running sand	4.57	17.07
	Carbonaceous material	0.91	17.98
London Clay Formation	Black clay	1.83	19.81
	Grey clay	0.61	20.42
	Green grey clay	10.06	30.48
	Brown clay	3.05	33.53
	Grey clay	3.66	37.19
	Stone	0.30	37.49
	Brown clay	6.40	43.89
	Gravel	0.30	44.20
	Brown clay	2.44	46.63
	Gravel	0.61	47.24
Reading Formation	Grey clay	4.57	51.82
	Brown clay	5.79	57.61
	Grey clay	1.52	59.13
	Red clay	2.44	61.57
	Brown clay	2.74	64.31
	Red clay	2.74	67.06
	Dark red clay	0.91	67.97
	Grey clay	1.22	69.19
	Mixed clay	0.61	69.80
	Light grey clay	0.91	70.71
	Green sand	0.91	71.63
	Sandstone	0.46	72.09
	Green sand	0.76	72.85
?Portsdown and Culver Chalk formations	Chalk and flints	49.07	121.92

Whilst the borehole provides a relatively well-described log, the exact horizons dividing the three units encountered are not certain and hence the thickness interpretation of these units is open to some debate. It is known that the topmost part of the London Clay Formation to the southeast of the district contains a sand unit (Whitecliff Sand Member) that if present here would extend this unit upwards. Thus reducing the thickness of the Wittering Formation. Within the Palaeogene strata described here the term gravel is interpreted to mean the pebble beds that are known to occur within the lower part of the London Clay Formation, indeed often separate the major units within the Palaeogene as well. These can be thin or absent in places and it may therefore be possible that the thick grey and brown clays beneath the lowest gravel may be the basal part of the London Clay Formation. Thus increasing its thickness relative to the Reading Formation below. The thin green sand and sandstone beds at the base of the Reading Formation surmounted by colour-variegated clays agrees well with the known local occurrences. Indeed these lower sands frequently contain oysters elsewhere. Thus the borehole could be interpreted with the highest of the Palaeogene gravels (at 7.92 to 8.53 m) representing the base of the Wittering Formation and the grey clay between 57.61 m and 59.13 m being the basal unit of the London Clay Formation. In so doing the thicknesses of the units would be 7.01 m for the Wittering Formation, 50.60 m for the London Clay Formation and 13.72 m for the Reading Formation. This would accord more accurately with the estimates derived from the outcrop and with the thickness estimates given in the old memoir (Reid, 1903).

7.1 Reading Formation

Palaeogene strata occur along the southernmost portion of this district and as isolated outliers capping hilltops elsewhere e.g. Cockey Down (Sidbury Hill and Beacon Hill are just outside the district to the north and east). The basement bed of the Reading Formation unconformably overlies the Culver Chalk and the Portsdown Chalk, and comprises a greyish green clayey sand with abundant sub-angular to rounded, corroded and pitted glauconite-stained flints; and brown sandy clay with well rounded flints with pockets of orange sand. In this district there are no exposed sections. Above this basal bed, the Reading Formation is lithologically highly variable and comprises mottled red-yellowish or lilac-brown silts and clays with occasional fine-medium and coarse-grained red cross-bedded ferruginous sands with clay intraclasts and small well rounded patinated flint pebbles. Concentrations of large oysters are known to be present in the basal part of the formation. Towards the southeast the formation comprises principally fine-to medium-grained sand with only minor amounts of clay and represent a major fluvial channel within the otherwise mottled clay, floodplain, over-bank deposits that generally make up the unit.

Small outliers of lilac-reddish brown silty pebbly clay were noted at the top of Cockey Down, Laverstock [SU 169 315]. The areas of Reading 'Beds' at [SU 203 342] south of Battery Hill and on Clay Pit Hill [ST 993 424] near Codford (see details below) were not substantiated during the present survey and appear to be disturbed Palaeogene material closely associated with clay-with-flints.

Details

ST94SE

The Reading Formation was formerly identified during the original geological survey at Clay Pit Hill [ST 993 424]. This site, also called Clay Pit Clump and centred around [ST 9942 4228] on the map is an area of large-scale solution within a square-shaped piece of woodland. This extensive hollow is about 100 m across and has a very undulating surface. It appears man-made for the most part with numerous rectilinear pits and scars with deeper circular hollows (perhaps indicating narrow solution pipes on the floor of the hollow).

When described in 1857 by Prestwich, and reported in Jukes-Browne (1905), he considered the deposit to be "in situ, and protected by being in a large pipe". However, a distinctive clay-with-flints deposit at a higher level on the adjacent hill to the northeast, itself carrying solution hollows, suggests that the deposit within Clay Pit Clump cannot therefore be considered as in situ. Indeed the scanty evidence within this overgrown area would suggest that there is little left of the solution hollow fill as chalk can be seen in burrows and in minor exposures around and within the depression. Investigations in 1972 by the Survey (then called the Institute of Geological Sciences) indicated that at least 19.20 m of sandy deposit was encountered in seven auger holes. Because there are indications of chalk within the floor of the depression and the variable depth to chalk encountered (from 1.37 m) in these boreholes some are presumably placed over deeper solution pipes. See below for a description of the units encountered in the deepest of those seven holes. Prestwich (1857) stated that the section was much obscured with traces of mottled clay, yellow and white sands, a carbonaceous bed and concretions of ironstone but "in one hole the section is clear: - white gravel 2 to 10 feet (0.61 to 3.05 m) over white siliceous sand 10 feet (3.05 m)". He gave a further general order of superposition as: -

Yellow clayey and sandy drift, full of quite angular yellow flints and small quartz pebbles 1 to 2 feet (0.30 to 0.61 m).
White flint pebbles and quartz pebbles 6 feet (1.82 m).
White sand, carbonaceous clay, mottled clay 10 feet (3.05 m).

The field log for borehole ST94SE6 [ST 9945 4246] encountered the following strata to 19.20 m without reaching chalk: -

Deposit	Lithology	Thickness m
Clay-with-flints and disturbed Palaeogene strata	Loam, dark, peaty overlying fawn sandy clay with orange streaks; a few flint pebbles and one tiny quartz pebble	0.91
	Clay, pale orange with grey streaks, sandy, very pebbly, with rounded, white-patinated flint pebbles up to 8 cm across and occasional well-rounded flint pebbles with battered surfaces; some smaller, fresh, dark flint pebbles; continuing in pebbly sandy clay below 1.70 m with some small rounded chalk and flint pebbles op to 3 cm across, scattered angular flint fragments and many small well-rounded quartz pebbles up to 5 mm across.	1.53
	Gravel, pale brown, comprising abundant rounded flint pebbles up to 8 cm across in a matrix of very coarse, poorly sorted sand containing abundant tiny well-rounded quartz pebbles up to 5 mm across; flints generally have thick white patinas; a few angular flint fragments; rare well-rounded flint pebbles with battered surfaces; becoming pale orange and slightly clayey below3.96 m.	3.35
	Clay, bright orange, brick red and fawn, silty or sandy, occasionally laminated; rare dark carbonaceous traces; some fragments very sandy with small angular flint chips.	1.22
	Sand, yellowish brown, silty, fine-grained, slightly clayey, with scattered small flint chips and occasional small flint pebbles up to 3 cm.	1.22
	Sand, orange-brown, coarse-grained, very gravelly, poorly sorted, slightly clayey in part, many tiny well rounded quartz pebbles up to 15 mm across and dark grey angular flint fragments; a few rounded flint pebbles; becoming brown below 9.30 m with tiny quartz pebbles and flint pebbles up to 5 cm across; also a few lumps of sandy clay (?cavings).	1.83
	Sand, orange-brown, medium grained, clayey, poorly sorted, containing many small angular flint fragments and tiny sub-rounded quartz pebbles; occasional flint pebbles; some lumps of whitish silty clay.	0.76
	Clay, orange-brown, very silty and very sandy, with scattered tiny flint chips.	1.52
	Sand, pale fawn, medium- to coarse-grained with some white patinated flint pebbles and some flint chips; many tiny well-rounded quartz pebbles; occasional chalk pebbles; many fragments of varicoloured clay, some pure and some sandy.	0.77
	Sand, brown, medium-grained, clayey. Poorly sorted, containing lumps of varicoloured silty and very sandy clay; occasional lumps of pure whitish clay; a few small flint chips and pebbles.	0.76
	Clay, orange-brown, very sandy with some tiny flint chips; a few flint pebbles (?cavings).	0.76

	Sand, pale fawn and some whitish grey, medium-grained, fairly well sorted with sub-rounded grains, many lumps of whitish grey and pale fawn clay, some very silty or sandy	1.52
	Sand, pale brown, coarse grained, poorly sorted with many lumps of whitish grey and medium grey sandy clay; a few flint pebbles (?cavings)	1.22
	Clay, pale to medium grey, stiff mainly sandy	0.31
	Sand, orange-brown, medium-grained, poorly sorted with many tiny, well-rounded quartz pebbles; some lumps os sandy clay (probably from overlying bed).	1.52+

In the Quaternary Research Association annual field guide for the meeting held at Bristol (1977) this area was discussed. Since the only fossil evidence known from the site was a Quaternary brackish water species of *Elphidium*, the fact that no reworked Cretaceous nor in situ Palaeogene foraminifera are known from the site and that there were no deposits of comparable lithology in the nearest Palaeogene deposits, the deposit was not considered to be Palaeogene in age but it was hypothesised that the sediments may be of Pliocene or early Quaternary age.

The area is shown as worked ground on the large scale maps of the area but this is too small to show on the 1:50 000 scale generalisation.

SU13SE

A small outlier of the Reading Fm was noted at the top of Cockey Down, Laverstock [SU 169 315]. No active pits were seen in this area, but a small area of lilac-reddish brown silty pebbly clay can be seen in ploughed fields. Also, small very well rounded pebbles are locally abundant in the superficial deposits in this area.

SU12NE

The Reading Formation outcrops in a narrow band around Alderbury on the western end of the Alderbury – Mottisfont Syncline. No significant exposures were seen in this area. However, several large thick-shelled oysters associated with greenish clay were found near Hendon Copse at [SU 1816 2895].

Reid (1903) described bores put down through 40 feet (12.19 m) of mottled clay “at the house close to the junction with the London Clay” This has been interpreted as meaning Alderbury House [SU 1813 2682] in the past but could equally mean Alderbury Hill House at [SU 1756 2819] which more accurately fulfils the description of being close to the junction of the London Clay. Both have lodges and the further descriptions in the memoir would suggest the author was referring to a lodge [(?) SU 1739 2819] (at Alderbury Hill House) where “green sand with a bed of oysters were met” and later to a “lodge belonging to the house close to the high road” (Alderbury House) where a bore (SU 12 NE 14 [SU 1794 2690]) passed through 10 feet (3.05 m) of this sand passing into Chalk of the *mucronata* zone. As an added confusion the lodge for Alderbury Hill House has a well (SU 12 NE 13 [SU 1748 2808]) which shows 12 feet (3.66 m) of clay and sand attributed to the Reading Formation on Chalk of the *mucronata* zone for a further 63 feet (19.20 m). Despite this confusion the information given indicate about 50 feet (15.24 m) of Reading Formation of which the lower 10 to 12 feet (3.05 to 3.66 m) are glauconitic sand.

The formation must have been visible in the cuttings for the railway [SU 1955 2590] south of Matron’s College Farm and at [SU 1991 2603] but only red mottled clay is easily seen in brash near these localities.

A borehole at Alderbury Farm SU 12 NE 8 [SU 1825 2595] gave the following log: -

Unit	Lithology	Thickness m
Fourth River Terrace deposits	Brown clay	3.66
	Ballast	0.61

Reading Formation	Brown clay	1.22
	Red clay	6.71
	Green sand	2.13
Portsdown and Culver Chalk formations	Chalk and flints	19.20

A further boring SU 12 NE 19 [SU 1967 2600] is poorly described as undifferentiated London Clay and Reading formations to 40.54 m on Chalk. However the mapped margin of the Reading Formation strata is within 170 m to the south and the thickness encountered would indicate a dip of about 18° to the north for the base of the Palaeogene strata locally.

SU22NW

There are no significant exposures on the northern crop of the Reading Formation within this sheet and the formation is recognised on the brightly coloured soils above a small negative break of slope at its base. To the south the narrow outcrop is also similarly identified, but green sandy clay and clayey sand can be augered close to the lower junction.

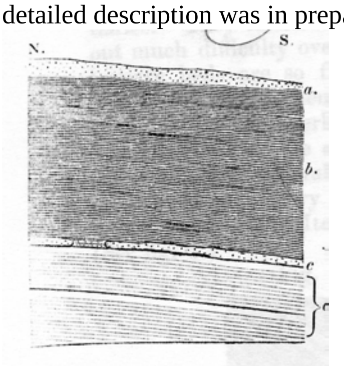
SU22SW

The Reading Formation, principally in sand facies. Is identified within a small scarp south and east of Brickworth House [SU 225 241]. Here there are no significant exposures and the formation is identified principally on its sandy brown soil cover. In the west of the outcrop mottled grey and pink-coloured clay is augered.

7.2 London Clay Formation.

The London Clay occupies a small area in the extreme south-eastern corner of the district along the axis of the Alderbury – Mottisfont Syncline. It comprises of grey or brown (olive green when unweathered) often micaceous silty clay, and usually becomes more sandy and pebbly towards the base. It occupies the gentle dip slope behind the minor Reading Beds escarpment. The formation is approximately 35-50 m thick in the district. The outcrop is often covered in pasture with surface drainage that commonly sinks at the margins of the syncline into the chalk.

The Clarendon Hill section along the railway cutting from [SU 1827 2844 to 1881 2796] provided the only detailed succession within the lower part of the formation (see details below). Prestwich (1850) gave a section (Fig 2 p. 257, Figure 62 herein) that was repeated in the memoir (Reid, 1903). Further details were given in Elliott (1945). With the exception of the Alderbury Borehole (above) which provides outline lithological detail the only detailed section in the area that permits division of the constituent units as proposed by King (1981) is along the 'Alderbury Bypass (A36) constructed between 1976 and 1978. Here King (1981) provides a summary section with a note suggesting that a detailed description was in preparation.



a. Ochreous flint gravel

b. London Clay: dark bluish grey sandy clays

c. Large tabular masses of sand with a calcareous cement, a few small rounded flint pebbles

d. Alternating thin beds of sand and thicker beds of mottled clay

Figure 62: Section at Clarendon Hill (Prestwich,1850) [SU 1827 2844 to 1881 2796]

Details

SU12NE

The Clarendon Hill section along the railway cutting from [SU 1827 2844 to 1881 2796] provided the only detailed succession within the lower part of the formation until the Alderbury Bypass was constructed. The London Clay was formerly very well exposed in the road and railway cuttings through Clarendon Hill (Salisbury memoir; Reid, 1903) where alternating thick and thin beds of sand over mottled chiefly red clay were seen underlying large tabular masses of pure green sand and scattered flint pebbles. Above were dark bluish grey sandy clays with numerous oysters. The locality was celebrated for its well-preserved fossils. Prestwich (1850) gave a section (Fig 2 p. 257, Figure 62 herein) that was repeated in the memoir (Reid, 1903). Approximations from his figure based on his scaling suggest the following section:-

Unit	Lithology	Thickness m
Superficial deposits	a. Ochreous flint gravel	0.30 to 0.61
London Clay Formation	b. London Clay; dark bluish grey sandy clays with numerous *Panopae*, *Ostreae* and *Pinnae*	4.88 to 5.49
	c. Large tabular masses; composed, some of almost pure green sand, and others of coarse ochreous sand, with calcareous cement. A few rather small rounded flint pebbles are scattered through these blocks	0.30 to 0.45
Reading Formation	d. Alternating thin beds of sand and thick beds of mottled clay; chiefly red	2.44 to 3.35

Further details were given in Elliott (1945) following major re-sloping and drainage after a major landslide event. His more detailed logging is regarded as being entirely within the ‘b’ beds described by Prestwich (1850). Although the thicknesses seen in 1945 appear to be too great for direct comparison with those given in 1850.

Unit	Lithology	Thickness m
London Clay Formation	4. Brown clay with *Venericardia*. Scattered ferruginous concretions. *Turritella*-bed (4A) near base	3.66
	3. Blue clay, very fossiliferous	1.83
	2. Septaria with *Panopea*	0.30
	1.Stiff dark blue-grey clay. A *Pinna*-bed (1B) occurs at the top, just below the line of septarian, and 6 ft (1.83 m) lower is a bed of large oysters (1A). Large unfossiliferous concretions with outer ferruginous shell occur at the base, just above rail level. The basal clay is glauconitic	6.10

Elliott added the following notes for each of his numbered beds: -

Bed 4A. This seam is crowded with broken *Turritella*. At one point a lenticle of lignite with large rounded flint pebbles was found: possibly a drifted tree. Some foraminifera and ostracods occur
Bed 4. *Venericardia planicosta* Lamarrk, form *clarendonensis* S V Wood, common, often iron-stained. The ferruginous nodules yield small bivalves. Microzoa scarce. This bed seems to show the effects of sub-surface oxidation
Bed 3. This bed is rich in fossils, both numerically and in variety of species. Most of the rich gastropod fauna described by previous workers would appear to occur here. The preservation is excellent, and sometimes equal to that of a recent shell. The majority of the molluscan species from other beds occur here also. Microscopically the bed was extremely rich in foraminifera, ostracods, small mollusca and *Dittosaria wetherelli* Busk; echinoderm debris and *Ditrupa plana* (Sow.) occur.
Bed 2. Septaria with *Panopea*, *Natica*, *Aporrhais*, etc.
Bed1B. Grey clay crowded with *Panopea*. Numerous examples of *Pinna affinis* J. Sowerby, and many foraminifera and ostracods. *Dittosaria wetherelli* Busk.
Bed 1A. Several courses of abundant *Ostrea pulcherrima* S V Wood, the lower ones with clay-stone

filling, the higher ones detached valves. The attached fauna consisted of *Paracyathus crassus* Edw. and H. (common), *Calyptraea* sp, *Conopeum* sp and serpulids. This bed is rich in well-preserved foraminifera and ostracods, echinoderm spines and fragments of test, minute mollusca, Dittosaria sp., and holothurian spicules.
Bed 1. This clay is relatively barren. Occasional examples of *Ostrea* sp., and (rarely) *Aporrhais sowerbii* (Mant.) and *Natica* sp. were found. Micro-fauna poor: a few foraminifera, ostracods, otoliths and shell debris

The divisional scheme proposed by King (1981) is adopted for the section exposed (Figure 63 and 64) in the Alderbury bypass constructed between 1976 and 1978, in part along and adjacent to the abandoned railway line. This effectively re-exposed the whole section and indicates that the basement bed of the London Clay (the Oldhaven Formation of King, 1981) underlies his A3, B1, B2 and C divisions of the London Clay Formation. In total about 37 m of beds were exposed but a large part of his division B2 was decalcified and showed no calcareous microfauna.

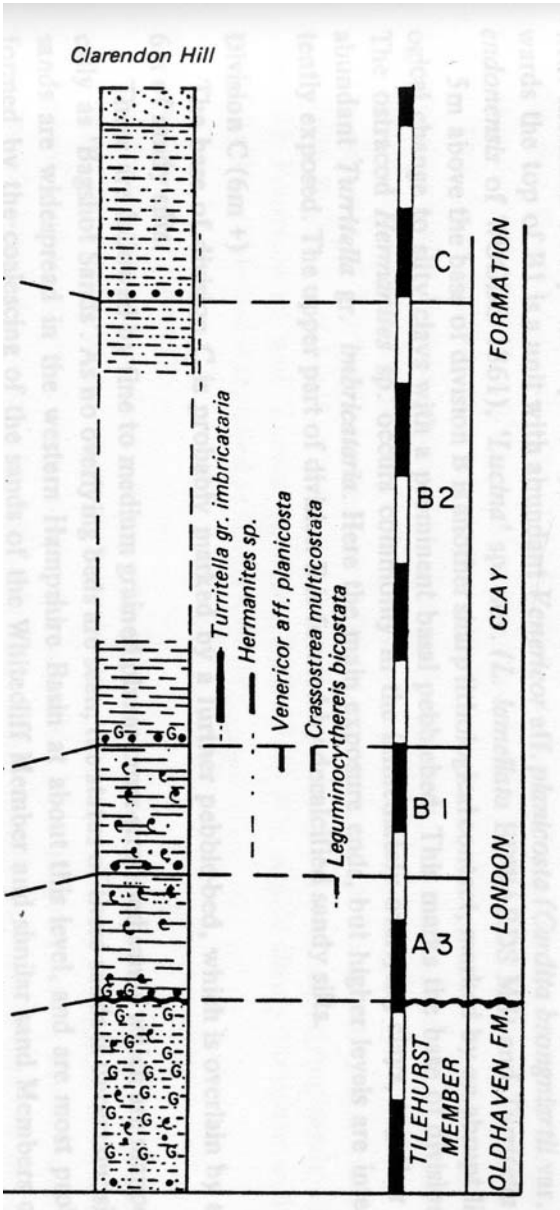


Figure 63: The Oldhaven Formation and London Clay Formation in the Clarendon Hill section (King, 1981) [SU 185 283]

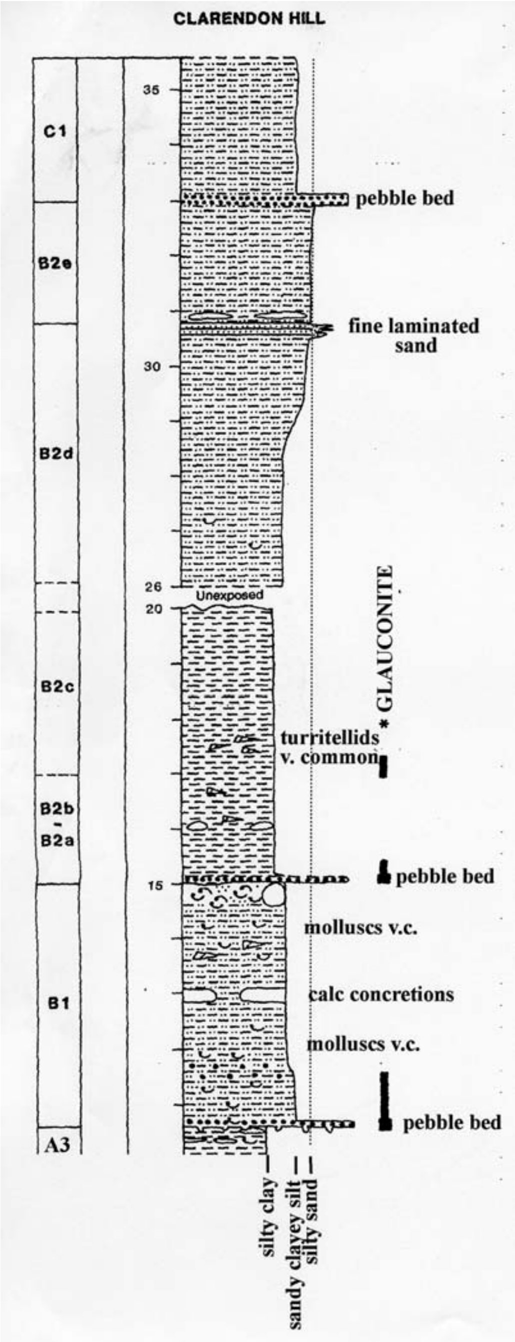


Figure 64: Clarendon Hill (King, unpublished section pers. Comm. 2005) [SU 185 283]

Elsewhere in this sheet area there are no clear sections, although it was formerly worked for brick clay on the Clarendon Estate [SU 1860 2880], where there is a poor 2m section of silty pebbly micaceous orange-brown clay. The memoir (Reid, 1903) describes 2.44 m of brown clay with fossils attributed to the 'basement-bed' of the formation.

SU22NW

The outcrop of the formation is broad on the northern limb of the Alderbury – Mottifont Syncline south of Farley [SU 218 295] but there are no significant exposures. The soils are clayey and sandy with rare well-rounded flint pebbles. Numerous small streams and ditches drain the area and here the upper ochreous brown weathered clay can be seen frequently. In general these soils are wet and the area is in consequence mainly pasture and forest.

The outcrop is narrow on the southern limb reflecting the steeper dip of the strata here. There were no significant exposures seen during the present survey but the memoir (Reid, 1903) includes a brief mention of the basement-bed exposed at "the brickyard at West Grimstead [(?) SU 206 265] shows 8 feet (2.44 m) of sandy clay dipping north."

7.3 Wittering Formation

Above the London Clay Formation is a succession of thinly bedded sands, sandy ironstones and clays that are attributed herein to the Wittering Formation at the base of the Bracklesham Group. The memoir (Reid, 1903) describes them "as false-bedded ferruginous sand, with lenticular masses of pipe-clay and with thin beds of ironstone." There were no significant exposures noted during the present survey and the outcrop in the core of the Alderbury – Mottisfont Syncline is delimited by the occurrence of yellow and red-brown fine- to medium-grained sand brought up in auger holes and by the very sandy soils. In the area of Alderbury common this sandy soil also contains appreciable amounts of well-rounded flint pebbles.

Details

SU12NE

The memoir gives the following details and where possible the descriptions have been matched to approximate grid references where these could be determined.

"On the top of Alderbury Hill at the point where the road to Ivychurch leaves the Southampton Road (this is the old road and not the bypass), a pit [SU 1847 2745] shows five feet (1.52 m) of ferruginous sand with some pipe clay and ironstone."

"At the south end of the same hill a large pit [(?) SU 1935 2680] shows about 30 feet (9.14 m) of false-bedded ferruginous sand with pipe-clay in the upper part, the lower part being much obscured." The 1901 Ordnance Survey maps show this as an 'Old Canal' with a small pit area indicated adjacent to the road. It is presumed to be the pit shown in Plate 38.

Plate 38. Sand-pit, Whaddon, 4 m. SE of Salisbury. Looking WSW. Sand-pit in Wittering Formation (Bagshot Beds), Whaddon. This formation comprises current-bedded ferruginous sand. Lenses of pipe-clay and thin irregular beds of ironstone are often present. [SU 1935 2680]. P 205719.

“At Whaddon, on the east side of the rail (this is presumed to be the old mineral railway that is now the A36 Alderbury Bypass) and close to the high road a pit [SU 1985 2641] (a number of small pits indicated on the 1901 Ordnance Survey sheet) shows ten feet (3.05 m) of brown sand and this sand is also shown in the road cutting.”
SU22NW

“Another pit [SU 2053 2653], a quarter of a mile west of West Grimstead and close to the high road, shows yellow and pinkish false-bedded sand with a lenticular layer of pipe-clay.”

8 QUATERNARY

The Quaternary deposits include all the superficial deposits in the district, principally the clay-with-flints, various fluviatile sediments and an assortment of periglacial head deposits. There is a considerable time gap (c. 50 Ma) between the deposition of the Palaeogene strata and the oldest Quaternary deposits in this district. The gap represents the time during which the Palaeogene strata were deposited across the whole of southern Britain and subsequently removed following uplift along the Wealden axis. Within the Quaternary there is a shorter but no less significant time gap between the formation of the clay-with-flints and of the younger drift deposits. A general relationship between the Superficial deposits is given in Figure 65.

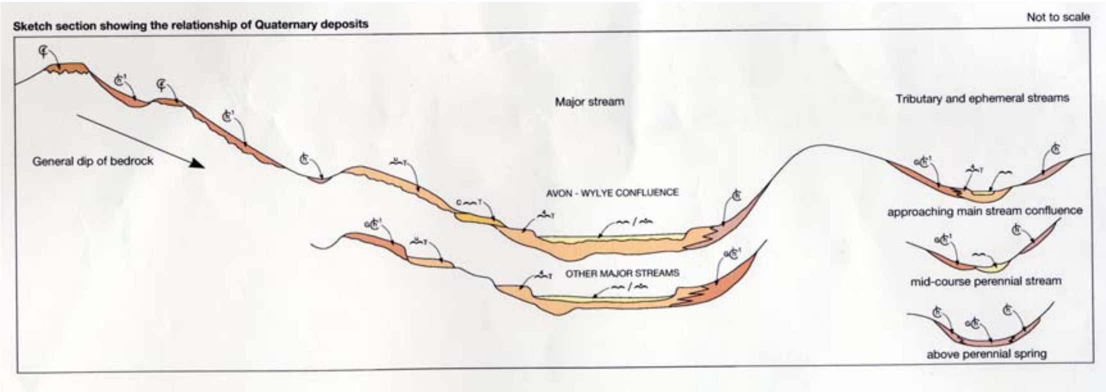


Figure 65. The general relationship between the superficial deposits within the Salisbury district

8.1 Clay-with-flints

The clay-with-flints is primarily a *remanié* deposit created by the twin agencies of the modification of the original Palaeogene cover and solution of the underlying Chalk. It is typically composed of orange-brown or reddish brown clays and sandy clays containing abundant flint nodules and pebbles. At the base of the deposit the matrix becomes stiff, waxy and fissured, and of a dark brown colour with relatively fresh nodular flints stained black and/or dark green by manganese compounds and glauconite. In places, notably on the high ground around Salisbury, very gritty hard coarse sandstone pebbles and small rounded sarsens (pebbles of very hard fine-grained sandstone) occur. On many of the hilltops around Salisbury, the clay-with-flints deposit also contains a gravelly admixture of sub-angular to sub-rounded, worn, stained, and rolled flint fragments that are almost certainly derived from river deposits. Some of the more gravelly patches were formerly mapped as 'Plateau' gravels, but no useful purpose is served by maintaining this tenuous distinction.

The clay-with-flints is most widespread on the high ground underlain by the Seaford Chalk Formation along the Great Ridge between the Wylye and Nadder Valleys. It covers the higher parts of the secondary chalk escarpment founded on the Culver Chalk Formation in the vicinity of Pitton [SU 213 313] and the interfluves to the north and south of the Ebble valley where it is underlain by the Seaford Chalk and Lewes Nodular Chalk formations. There were few good exposures of this deposit within the district and it was mapped on the basis of its characteristic reddish brown sticky clayey soil with nodular, often stained (orange), flints. In general it forms the flat top to hills and long dipslope spurs. The base is taken at the strong positive feature around the margins of these crests. For the most part it represents the eroded remnants of solution pipe fills and the Palaeogene cover. Its distribution reflects the remnants of the relict pre-Tertiary erosion surface. Deposits are estimated to be between 2 and 8m thick, but will be much thicker over the solution pipes that may extend 10m or more into the underlying Chalk. Within these pipes it is not uncommon to find disturbed fine- to medium-grained multicoloured sand and stone free clay that are commonly thought to be Palaeogene in origin. These pipes are generally detached from the Palaeogene outcrop and closely associated with a clay-with-flints cover and are mapped herein with the clay-with-flints. The deposit is closely associated with older head (Ch1) which is a solifluction deposit derived directly from the clay-with-flints.

The margin of the clay-with-flints is sharply defined on scarp edges but the boundary becomes diffuse on the Chalk dip slopes where it often merges with head deposits. The occurrence of surface suffusion solution hollows (dolines) is a characteristic feature of the thinner clay-with-flints outcrops and along its margins, and the distribution of these features can be a useful indicator of the margin of the deposit. In places their distribution takes on a rectilinear pattern that may reflect the underlying jointing pattern within the chalk where joint intercept loci form a preferred site for surface water recharge of the Chalk aquifer and doline development.

Evidence from outside this district suggests that the clay-with-flints is developed in a number of phases and closely associated with periglacial climates.

Details

ST94SE & SU04SW
(Interfluve north of the Wylye and west of the Till)

The area of Clay Pit Hill adjacent to a spread of clay-with-flints was mapped as Reading Formation during the previous survey. Seven auger boreholes investigating this solution pipe fill in 1972 demonstrate that it is a complex feature of limited lateral extent but of highly variable depth. Two boreholes were still in the fill of the pipe at 19.20 m depth whilst others within the pit area encountered chalk between 1.37 m and 13.41 m. This suggests that the quarried area of Clay Pit Clump is a shallow solution bowl-shaped feature within which deeper and narrower solution pipes extend to great depth, possibly to the local water table present at the time of formation. The fill is predominantly of varicoloured fine- to medium-grained sand with some thin beds and laminae of pale clay. Pebble beds were noted but often attributed to cavings (see notes for Reading Formation). These beds are demonstrably not in situ Reading Formation but may be derived from a former cover of this formation. Their close association with the nearby clay-with-flints, which itself carries dolines indicating further solution pipes, the bedded nature of the fill and the deposits lack of Palaeogene fauna strongly suggest a lengthy period of deposition post the mid-Miocene uplift of the area. The extent of the quarry, the hummocky floor and the fact that in situ chalk is observable at various localities within and to the margins of the diggings suggests that infill material is now only present within the deeper pipes. The area is not shown on the 1:50 000 scale published map because of its small size.

Four small patches of clay-with-flints occur in this area. They are characterised by a dark brown to orange brown stiff sandy clay soil with angular and nodular flints. Deeper ploughing brings clods of stiff, waxy red and bright orange clay to the surface and these can survive lengthy exposure before breaking down into granule-sized cubic-shaped fragments. The four areas carry common dolines across the whole outcrop of the clay-with-flints and this is generally regarded as an indication that the deposit is thin. There are no boreholes within the outcrop areas to confirm this statement and it is also likely that deeper occurrences of the deposit will be found at the doline sites. The outcrop north of Yarnbury Castle [SU 0370 4150] occurs on the Parsonage Down SSSI, an area of unimproved Chalk grassland. Here the contact between the thin chalky rendzinas and the clayey soil developed on the clay-with-flints is marked by a sudden decrease in the number of anthills and a corresponding increase in the number of gorse bushes. A second small patch occurs farther west at [SU 0140 4250], where orange clay fragments were seen in the soil. However, both these deposits are very thin with Chalk locally present. Slightly thicker outcrops where chalk is not seen within the plough are located near to Clay Pit Hill [ST 999 427] and [SU 017 425] on Deptford Down.

ST93NW, NE, SW & SE
(Western part of the Great Ridge)

This area is the highest part of the Great Ridge (between 210 to 185 m OD) from Fonthill Bushes eastward through Stockton Wood to The Bake. The area is heavily wooded in part but there are numerous areas where the ridge has been ploughed and the characteristic dark brown to orange brown stiff sandy clay soil with angular and nodular flints and clods of stiff, waxy red and bright orange clay are seen. This area has a high concentration of dolines but there may be many more since they cannot be readily identified within dense woodland. This high incidence may possibly reflect the proximity of the present land surface to the original base-Palaeogene erosion surface.

There are few natural exposures other than degraded ditches showing a very flinty soil resting on orange or red brown stiff clay.

SU03NW, NE, SW & SE

(Eastern part of Great Ridge)

This part of the Great Ridge between the Bake and Grovely Hill [SU 08 33] shows a consistent fall eastward from about 185 m to 145 m OD. The large outcrop of clay-with-flints in the area demonstrates the classic soil lithology of stiff brown, red and orange sandy clay with angular flint clasts. These heavy wet clay soils generally form the wooded areas on the flattish tops of the hills.

Dolines are common over the open ground and it is suspected that they are also present within the woodland areas where they are not easily identified. There are few natural exposures and ditches tend to degrade quickly. There are no boreholes within the area that give details of the lithology or the thickness of the deposit.

SU02NW & NE
(Netton Down area)

A large area of clay-with-flints covers the crest of the primary chalk escarpment between the Nadder and Ebble valleys. The outcrop centred on Flamstone Farm [SU 062 284] and with spur-top outcrops running southward from the scarp crest between the valley systems is defined by the characteristic stiff brown, red and orange sandy clay with angular flint clasts. A temporary excavation at the reservoir [SU 0575 2881] showed the deposit to have a limited thickness ranging between 0.5 and 1 m. Here it consisted of weathered flints in a brown sandy clay matrix. A series of solution hollows are associated with its boundary with the underlying and in places they form linear alignments possibly reflecting the underlying joint pattern in the chalk.

There are no boreholes to demonstrate the thickness of the deposit but is most likely to be thickest over the higher part of the crest.

SU02SW, SE, SU12NW, SW & SE
(Knighton Hill to Clearbury Ring south of the River Ebble)

Numerous outcrops of the clay-with-flints are shown on the interfluves south of the River Ebble valley. All were identified from the characteristic stiff brown, red and orange sandy clay soil with angular flint clasts.

Boreholes at Jervoise Farm [SU 0923 2354] indicate 1.22 to 1.52 m of “clay with flints” but there are no other boreholes to confirm the thickness of these deposits.

SU14SW, SU13NW & SU13SW
(The River Avon and north of Salisbury)

There are numerous small patches of clay-with-flints on the interfluves rising from the River Avon valley. With the exception of the outcrop at Castle Hill [SU 147 323] they are concentrated on the highest ground to the west of the river. The outcrops are identified from their characteristic stiff brown, red and orange sandy clay soil with angular flint clasts. In the vicinity of Hill Farm [SU 1172 2354] near Bemerton Heath the clay-with-flints is closely associated with the older head that is derived from it. Boreholes in this area suggest that the derived older head is between 3 and 5 m thick and this is also likely to be the thickness of the clay-with-flints itself. Both deposits rest on an uneven chalk surface.

SU13SE, SU12NE & SU23SW
(Salisbury and the area north of the Alderbury – Mottisfont Syncline)

The clay-with-flints is found as small patches and extensive spreads on the crest of the secondary chalk scarp near Laverstock and Pitton. East of Laverstock the outcrop is mainly covered by woodland and there are a few exposures of the upper part of the deposit in ditch sections but elsewhere it is identified from its characteristic soil. The boundary is quite sharply defined on the scarp top but is diffuse on the dipslope away from the scarp. Here the presence of dolines helps to identify the boundary where the deposit is not in woodland.

A number of boreholes in the vicinity of Burroughs Hill [SU 164 303], Laverstock indicate that the clay-with-flints in this area is generally between 1.5 and 6.0 m thick but that its contact with the underlying chalk is very uneven. The upper part of the clay-with-flints in this area is sandy and may represent a thin development of older head.

SU22NW & 22SW
(Dean Hill area)

Two outcrops at Long Plantation [SU 209 240], on Standlynch Down and at [SU 225 255] east of Pepperbox Hill are identified from their characteristic flinty orange clay soil. There are no exposures.

8.2 Head (Older Ch1)

Older head consists of a series of deposits ranging from flinty gravels to orange brown or reddish brown clays and sandy clays containing abundant flint nodules and pebbles. It is derived from the clay-with-flints deposits and the underlying bedrock by solifluction and solution. It is found on upper valley slopes below the plateau. The flints in older head are generally much more shattered than those in the clay-with-flints due to solifluction processes and frost shattering. The downhill boundary is taken where the deposit thins and Chalk becomes apparent in the soil, or at the negative break of slope bounding the relatively flat lying ground underlain by finer grained valley head deposits. Older head commonly grades imperceptibly into head gravel, and then there is no marked break of slope. The uphill boundary is taken at a positive break of slope at the edge of the clay-with-flints or the plateau from which the clay-with-flints has been removed, and again is often a transitional boundary.

Several large sheets of older head occur in this district, often capping interfluves and on upper valley slopes. Its distribution bears little relationship to the aspect of the slope. Most are no more than a few metres thick. The deposits merge laterally into areas with only a thin flinty veneer and in these cases the presence of chalk in the soil is used to delimit the mapped edge of the head.

This deposit represents the earliest periglacial material in the area and was probably much more extensive in the immediately post-Devensian period. It is thought to be the source from which most of the younger Quaternary deposits are derived and its development and subsequent removal probably covered a considerable time span.

Details

ST93NE, 93SW & 93SE
(Western Great Ridge area)

There are only a five small areas on shallow slopes adjacent to the clay-with-flints where this deposit is mapped but elsewhere a chalky orange flinty soil can be seen on upper valley slopes. It is thought that the steepness of the slopes around this part of the Great Ridge is sufficient to prevent accumulation of soliflucted material. The deposit is differentiated from the clay-with-flints on the generally more sandy soils with a content of significantly more angular, broken and smaller flints.

SU03NW & 03NE
(Eastern Great Ridge area)

Three long tongues of older head occur on the spurs leading northward from the Great Ridge into the Wylye valley. Each spur has a significant slope into the valley but non-chalky orange-brown silty sandy soils with angular flints are still preserved on the spur tops above breaks of slope into the minor valleys.

SU13NW, 13NE, 13SW
(Avon and north Salisbury area)

It is in this area that the relationship with the clay-with-flints is most clearly seen, particularly on the interfluve between the Wylye and Avon valleys north west of Salisbury. Whilst much of the clay-with-flints cover on the plateau has been removed there are significant spreads of the derived older head preserved on the nearby upper valley slopes and apparently overlying the in situ clay-with-flints.

Numerous boreholes and trenches, completed for the A36 road scheme, in the area west of Hill Farm [SU 117 333], north of Salisbury, demonstrate a complex of similarly described lithologies attributable to the clay-with-flints and older head and also demonstrate the uneven nature of the chalk surface beneath. Here the older head (generally silty, very sandy, orange brown clay with rounded and broken flints) overlies clay-with-flints sensu stricto (orange brown, sticky, stiff, silty clay with nodular and angular flints) on the flat spur top and overlaps the deposits on the slopes away from the spur top. The thickness of the older head is variable buts tends to increase away from the spur top.

SU13SE, SU12NE, SU23SW & SU22NW
(Salisbury and the area north of the Alderbury – Mottisfont Syncline)

Outcrops of older head closely associated with the clay-with-flints are mapped on the slopes below the general plateau surface. There are no boreholes that indicate thickness and lithology and the deposits are delimited on the basis of their sandy, pebbly orange-brown soil and its position on slopes below the general level of the plateau.

8.3 Head Gravel. GCh1

This deposit is very similar lithologically to gravelly head but occurs on lower valley sides. The deposit is a coarse or very coarse, poor to moderately sorted flint gravel, with an admixture of fluvial rounded to sub-angular rolled worn flints and rare angular large, often broken nodular and coarse gravel-sized flint set in a greyish brown to orange brown clayey, silty, fine- to coarse-grained sand matrix. Its gravelly nature serves to distinguish it from head and its occurrence on significant slopes distinguishes it from terrace deposits.

In some places the deposit forms a distinct sloping bench several metres above the present valley floor but in others any such terrace that might have existed has been degraded. Although their topographic position suggests that these deposits belong to an older generation of head deposits, some reworking of the older deposits will have occurred in most places. The deposit is thus a mix of periglacial solifluction deposits derived from the Chalk, Palaeogene, clay-with-flints and older head deposits, intermixed with fluvial gravels derived from older degraded river terrace or head deposits. Solifluction has transported the material down slope so that they now interdigitate with the deposits flooring the present valleys. The type, size and shape of pebbles and cobbles in these deposits resembles that in the gravelly head more than that in other forms of head, and they are therefore thought to have formed in a similar fashion.

It is most frequently identified in valleys above the perennial stream-head and may be regarded as valley infill that has not been consistently reworked by fluvial processes to create well-defined terrace aggradations (i.e. its is effectively immature terrace).

Details

SU03SE
(NE Wilton area and Lower Wylye valley)

Narrow outcrops above the alluvium and terrace benches in the lower reach of the Wylye valley and the Nadder valley west of Wilton have been designated as head gravel. They generally have an upper surface that has a considerable fall into the valley and may either be interpreted as degraded terrace material of an earlier stream or as soliflucted and hill creep materials that have not been reworked by fluvial action. Borehole SU03SE8 [SU 0883 3304] to the west of the Salisbury to Warminster railway and some 8 metres above the general level of the floodplain indicates 2.7 m of the deposit as described below: -

Deposit	Lithology	Thickness m
Head gravel	Topsoil	0.20
	Firm to stiff dark brown clay with some angular fine-to coarse-grained flint and subrounded to rounded fine- to medium-grained chalk gravel.	0.80

	Very stiff light brown calcareous sandy very silty clay with some angular fine- to coarse-grained flint and subrounded to rounded fine- to medium-grained chalk gravel.	1.70
Chalk	Chalk structureless over white chalk with flints	7.30+

See Figure 73 in the alluvium section for a sketch section across the Wylye valley incorporating this borehole.

SU14SW, SU13NW, SU13SW & SU12NW
(Avon Valley area)

Numerous outcrops adjacent to the flat-lying terrace, head and alluvium are mapped in the Avon valley from Amesbury in the north to Salisbury in the south. There are few boreholes and none have good descriptions of the deposit. 6.10 m of deposit is proven in borehole SU13NW14 [SU 1356 3797] near Great Durnford.

SU13NE, SU13SE, SU12NE, SU24SW & SU23NW
(Bourne River area)

There are numerous small outcrops of this deposit on the lower valley slopes and closely associated with gravelly head, alluvium and terrace deposits in the Bourne valley. There are no boreholes that indicate lithology or thickness that can be quoted.

8.4 Gravelly Head. gCh

The gravelly head is essentially alluvial and head materials in valley bottoms from which the fine-grained silt and clay material has been flushed by periodic water flow, either during the depositional process or later by ephemeral stream flow. The resulting deposit is a coarse or very coarse, poor to moderately sorted, clast supported, sub-angular to sub-rounded, flint gravel, with generally little or no fine-grained material. In this district, this deposit occurs in the floor of the River Till near Winterbourne Stoke and in the Bourne River upstream of the perennial spring in both cases at a position in the valley where ephemeral winter runoff flushes finer material out. The valley floor where this deposit occurs usually contains a well-defined, often dry, stream channel. Downstream of the perennial springs, the gravel is usually overlain by over-bank alluvial deposits of silt, sand and peat.

The near-surface part of the deposit has been decalcified, presumably by running water. While most of the flint clasts resemble those found in head, and are predominantly angular, some are subangular or sub-rounded and have evidently undergone transport by water. Jukes-Browne (1908, p. 56) states ‘sometimes the gravel is sharp and shingly without admixture of sand or loam, but in places it is sandy, and sometimes the stones are embedded in a chalk-sand or chalky paste’.

This valley-bottom gravel is interpreted as the product of both solifluction and fluvial transport in a periglacial environment. Note that solifluction can occur on slopes of as little as 1º (Ballantyne and Harris, 1994) and that lobes of soliflucted material could have travelled along a valley floor for distances of hundreds of metres, if not kilometres. It is envisaged that material transported into the valley bottom by mass-movement was progressively reworked by seasonal stream flow. Under permafrost conditions no infiltration of surface waters would occur and during a spring thaw the valleys might carry a considerable flow for short periods. This would tend to rework the mass-movement deposit, removing fine-grained material and abrading the clasts. Some chalk clasts would survive short periods of fluvial transport, especially if they remained frozen. However, such reworking would be confined to the active layer (above the permafrost), which is likely to have been less than 1 m thick, and the alluvial gravels are themselves likely to have been subsequently reworked by cryoturbation and to have been buried by later mass-movement deposits.

Within the district the formation of these valley-floor gravels is thought to have been dominated by mass-movement processes, and so they have been named as a form of head. This gravelly head is in part shown on the older geological maps as ‘alluvium’. It differs from the deposits here recognised as alluvium in being predominantly very coarse and very weakly bedded. Other parts are shown on the older geological maps as ‘River and Valley Gravel’ or ‘Valley Gravel’. While these terms are accurate, they are imprecise and are not used in the current BGS scheme of nomenclature for superficial deposits. Moreover, some areas previously shown as ‘Valley Gravel’ are now shown partly as gravelly head and partly as head. The presence of a central channel is taken as a simple criterion to separate head from gravelly head where these occur in the bottom of otherwise similar valleys.

Details

SU04SE

The alluvial tract immediately north of Winterbourne Stoke presents a brash of very coarse angular flint gravel and there are many springs at this locality. The deposit is differentiated as gravelly head on the map (see below). At least one metre of gravel can be seen in the banks of the River Till. Water can be seen issuing from the gravels at many places between Manor Farm (just north of the old A303) and [SU 0810 4159]. In this section the stream is locally incised in a channel up to 1.5 m deep. A borehole SU04SE 19 [SU 0781 4105] shows 18 feet (5.49 m) of “white gravel” over chalk. This whole area is the major source of the till during wet seasons and the gravel is regularly flushed during those periods.

SU13NE, SU24SW & SU23NW
(Bourne above Idmiston)

Gravelly head is mapped above the perennial stream head of the Bourne River upstream of Idmiston. There are no boreholes within this area that give details of thickness or lithology but bankside exposures in the dry stream bed indicate at least 1.5 m of fine- to coarse-grained flint gravel which is generally clast-supported. The matrix is variable from fine to medium sand to clayey silt and rare organic debris.

8.5 Head Ch

Head is a heterogeneous group of superficial deposits that have accumulated by solifluction, hillwash and hillcreep. Essentially it is very gravelly silty, sandy clay to clayey sandy gravel, with variable proportions of coarser granular material, with an earthy texture. The clasts are primarily of large nodular and coarse gravel-sized flint. It is regarded as a periglacial deposit resulting from the solifluction of Chalk, Palaeogene and clay-with-flints material. The term includes the chalky, flinty materials that were formerly mapped as 'dry valley deposits'. Head is in part shown on the older geological maps of the area as ‘River and Valley Gravel’ or ‘Valley Gravel’. While these terms are accurate, they are imprecise and are not used in the current BGS scheme of nomenclature for superficial deposits.

In general Head comprises pale yellow-brown, silty, sandy clays. The pebble content varies depending on the local bedrock source and is noticeably more pebbly where material is derived from areas with a Palaeogene cover. Similarly, head derived from Seaford Chalk, contains far more fresh large nodular or broken angular flints. Most of the dry valleys on the Chalk have a head deposit covering the valley floor (Plate 39 but see also Plate 27). This is usually thickest and most prevalent in the lower reaches of the dry valley network, where the gradient lessens markedly, but can be absent where the valley is narrow or steep. In many cases, the lower limit of the head deposits occur at the highest springhead, where it becomes reworked and merges into the alluvial deposits and the coarser less clayey gravelly head. Where seen in section head often demonstrates cryoturbation structure in its uppermost few metres (Plate 40).

Head is very rarely exposed, and due to the considerable flint content cannot be regularly penetrated with a soil auger. The thickness of most head deposits in the area is therefore unknown. Borehole records suggest that the head is mostly less than 2 m in thickness, but could locally attain 5 m or more. The map user should be aware that large parts of the area shown as bedrock with no overlying superficial deposit do actually carry a thin (generally less than 1.0 m), extensive, but discontinuous blanket of head possibly of varying age.

Details

Head is ubiquitous in the district within the minor dry valleys and it is inappropriate to include sheet-by-sheet descriptions. There are many small exposures throughout the district in ditches, along tracks and in man-made cuttings; few show the full succession locally but demonstrate the local derivation of

Plate 39. Dry valley head fan. Foxhole Bottom, Codford St. Mary. [ST 9804 3951]. Photo P598775

Plate 40. Solifluction features in flinty head, Harnham. [SU12433, 28917]. Photo P584737

the material e.g. the head deposits in the headwater area of the River Nadder carry much limestone and chert debris, those crossing the Upper Greensand carry much chert and sand whilst those over the chalk tend to have an upper flinty clay layer above a clayey and silty, weathered chalk gravel. For the most part the deposit is identified by the change in soil and the flattened profile of transects across the valley bottom. Head is limited down-valley where there is a permanent stream.

8.6 River Terrace Deposits (Brickearth)

This term is reserved for the deposits formerly called Brickearth or in some papers the Fisherton Deposits or Fisherton Brickearth. These were exposed in a number of brick-pits between Quidhampton [SU 113 310] and the city centre Old Manor Hospital site [SU 136 304], north of Salisbury Railway station. The outcrop shown on the map has been identified on the basis of its generally flat or low southerly slope and associated silty clay soils with some pebbles, between the gravel rich soils of the fourth terrace flat to the south and the clayey gravels on the steeper slopes to the north. The deposits rest on the fourth terrace (see below) forming the north bank of the River Nadder floodplain. It is plain from the descriptions in the literature that the deposit thins upslope to the north where progressively more soliflucted materials interdigitates with the deposit. The brick-making industry in this area ceased around 1900 and descriptions in the memoir (Reid, 1903) essentially reiterate those of Prestwich and Brown (1855). Since that time all of the sites have degraded and the majority were built over as Salisbury expanded north-westward into the Bemerton district. It is not clear whether all of the occurrences mentioned in the early literature are related, indeed those described by Prestwich and Brown (1855) as being “east-north east of Wilton in the railway cutting” [? SU 110 313] and “on the railway beneath the High road near Bemerton” [? SU 123 308] are now mapped as a valley head deposit albeit perhaps overlying ‘brickearth’ although generally with a greater flint gravel content perhaps indicating subsequent remobilisation incorporation of head.

Delair and Shackley (1979) gave a valuable account of the Fisherton Brickpits including their known stratigraphy and faunal lists (to which readers are recommended), and published the first locality map placing the former named sites in the context of the present road network (Figure 66). Green et al. (1983) gave an account of sediments and included faunas exposed at temporary sections [SU 138 302], at the junction of the Devizes and Wilton Roads northeast of the Railway Station at Fisherton in 1974, during the construction of the Salisbury northern relief road (Figure 67). They gave the name of the Fisherton Terrace to the underlying coarse gravel materials, whilst Delair and Shackley (1979) referred to the same gravel as the Bemerton Terrace.

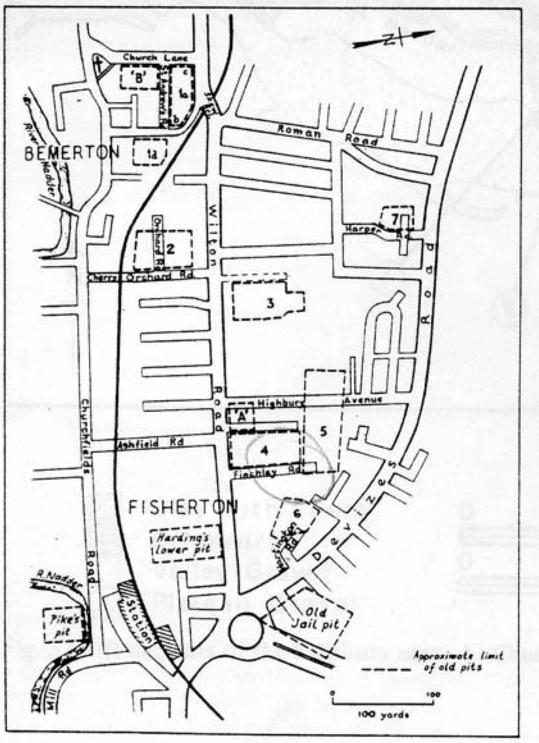


Figure 66: Locations of the former Brick Pits in the Fisherton/Bemerton area.

The ‘brickearths’ have yielded a rich fauna of mammals and mollusca whilst they were being worked in the early to late 19th century and the beds achieved some notoriety because of the distinct ‘Arctic’ character of the mammals identified. Reference to these deposits goes back as far as Lyell (1827) and there are numerous references to them in the latter half of the century (Prestwich and Brown, 1855; Blackmore, 1864, 1867; Evans, 1864; Tylor, 1869; Blackmore and Alston, 1874; Kennard and Woodward, 1901). Reid (1903) in the memoir for the district also recognised that “the associated land and fresh-water mollusca call for no remark, they are all living British forms”. Delair and Shackley (1979) suggest that the Fisherton mammalian fauna must date to “the extreme end or at the very beginning of an interglacial, in particular the last (Ipswichian) interglacial” and went on to say that the molluscan fauna “suggests that a substantial proportion of the fauna lived during the cool *Pinus* zone” and that “it is not improbable that the more thermophilous animals survived into the early Devensian”. This age interpretation is further substantiated by evidence from the included hand-axe morphology. Green et al. (1983) examined the molluscan and ostracod assemblages from their exposure and concluded “the age of the Fisherton fauna cannot be demonstrated conclusively” but went on to suggest that the ostracods represent an early Devensian age whilst the mollusca indicate an early rather than late glacial episode.

The deposit is very variable and comprises both fluviatile and soliflucted beds. The most comprehensive account of the lithologies present is found in Green et al. (1983). Four “groups” are described and given in order of superposition below: -

Lithology	Interpretation
d. STONEY CLAY, confined to the uppermost part of the sections where it comprises dark reddish-brown clay containing bleached angular flint fragments. Sharp lower boundary in places piped into underlying sediments	Solifluction material
c. SANDS and LOAMS, these occur either on the gravel or as isolated masses apparently within the gravel. Their texture is variable. The most common sediments are greenish grey sands which may be succeeded upwards by buff-coloured silty clays. Sands are coarse-grained passing up into fine-grained Bedding is often preserved but is usually disturbed. Calcareous material is locally abundant either as sheets on bedding planes or as shell material in masses at the base with tubular structures perpendicular to the bedding. In general they lack the high silt content associated with true aeolian ‘brickearth’ deposits	Probably represent a mixture of alluvial sand and silt and clay in backwater situations with some slopewash
b. GRAVEL, comprises coarse, iron-stained river gravel, composed largely of flint. In places it penetrates the chalk rubble in steep-sided pipes, but is itself penetrated by overlying sediments so that its thickness is variable. Contact with the underlying chalk rubble is sharp.	Fluviatile
a. CHALK RUBBLE, comprises poorly sorted angular and subangular chalk fragments, and broken but unrolled flints in a paste of chalk debris. In places this material occurs as crude beds alternating with beds of less compact chalk rubble containing sand and rolled flint. In the lower part of the rubble, thin seams of fine chalk gravel occur. Upper surface uneven	Downslope accumulation by hillwash/creep and solifluction and minor fluviatile reworking

Further descriptions from the literature are given in the details below.

The thickness of the deposit is very variable. Green et al. indicate that the deposit is at least 3 m thick but do not state whether the base rests on in situ chalk. Prestwich and Brown (1855) gave a section at Mr Harding’s Brickpit (see below) that shows up to 34 feet (10.36 m) of beds resting on undisturbed chalk. Topographically the surface of the terrace and ’brickearth’ are between 51 and 58 m above OD.

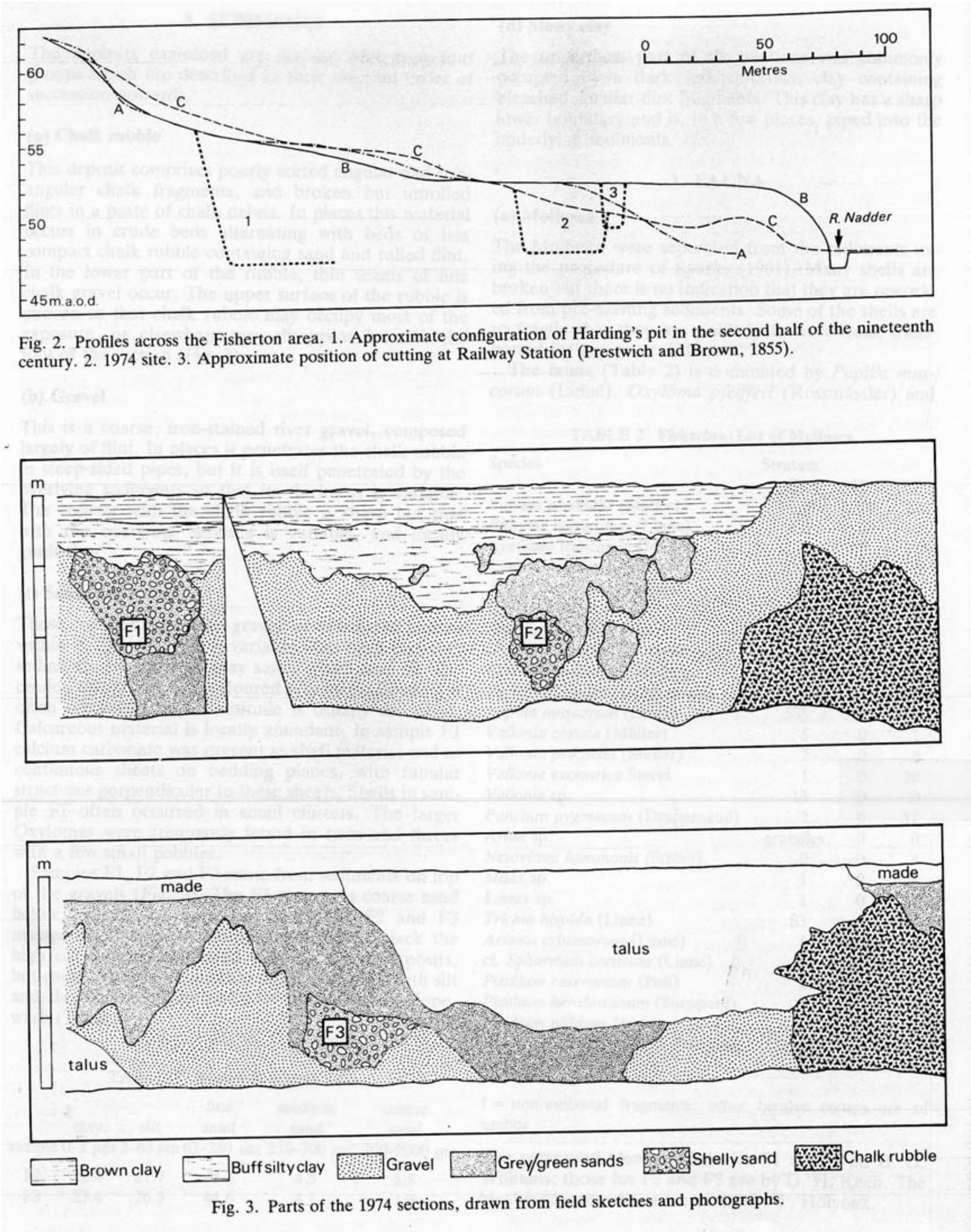


Figure 67: The sediments exposed at temporary sections [SU 138 302] at Fisherton in 1974 (Green et al, 1983, fig. 3)

Details

SU13SW
There are no exposures of this deposit remaining but degraded overgrown faces can still be seen at numerous of the localities mentioned in the literature.

The cutting ENE of Wilton [SU 110 313 or? SU 104 316 or? 101 319] was described in Prestwich and Brown (1855) see tabulated description and Figure 68 below. The description is probably of head on the valley slope, topographically above the level of the 'brickearth', and head is mapped at various localities along this stretch of the line.

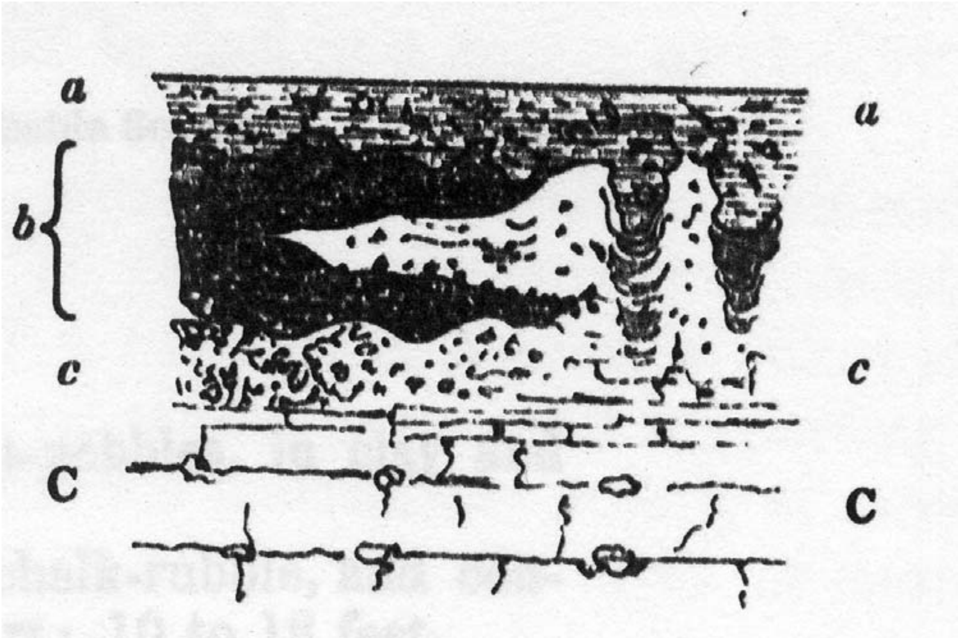


Figure 68: Section in the railway cutting ENE of Wilton (Prestwich and Brown, 1855)

Deposit	Lithology	Thickness m
? 'Brickearth'	a. Brown earth and flints.	0.61 to 0.91
	b. Coarse gravel, consisting chiefly of subangular flints, with pieces of chert, ironstone, sandstone and some flint pebbles, in brown clay more or less sandy.	1.52
Weathered Chalk	c. Chalk rubble, upper portion 'waved; passing laterally into 'b' (a few *Sucineae* and *Helices* are found in this rubble).	2.13
Seaford Chalk Formation	d. Chalk.	unmeasured

The location of the railway cutting in relation to the Wylye Valley is also shown diagrammatically in Figure 73

Further east Prestwich and Brown (1855) noted another similar occurrence in the "section on the railway beneath the high road near Bemerton [SU 123 308]. This is again probably a description of valley infill incorporating both slope head and the 'brickearth'. In this case a remnant of the in situ 'brickearth' is also present.

Deposit	Lithology	Thickness m
Head	Earth and gravel	0.30
	Gravel, chalk rubble, clay and Brickearth mixed	0.91
	Brickearth, with a few dispersed angular flints and some shells (*Sucineae* and *Helices*).	2.44
	Patch of coarse gravel, as above, with a base of 'brickearth'.	0.30
Brickearth	Brickearth, rendered porous by numerous very fine Serpula-like perforations; only a very few angular flints, and no shells,	3.05

The Harding's Pit (presumed to be the topographically lower of the two located by Delair and Shackley, 1979) at [SU 135 304] is now obliterated (initially by the Hospital and by later developments on the site) is described by Prestwich and Brown (1855) (Figure 69). Their description is tabulated below and shown graphically in Figure 70.

Deposit	Lithology	Thickness m
Soliflucted material	a. Earth and flint rubble, variable.	0.30 to 0.61
	b. Rubble of angular flints, fragments of chalk, flint pebbles, in clay and brickearth.	1.22 to 1.83
Brickearth	c. Brickearth, mixed with variable masses of flint- and chalk-rubble, and containing bones and a few shell, chiefly in the lower part.	3.05 to 5.49
	d. Light-coloured fine marl, full of well preserved shells, and a few bones.	0.30 to 0.61
Terrace/ Soliflucted material	e. Flint- and Chalk-rubble, with sand and clay, only upper surface exposed.	?3.05 to 1.22
Seaford Chalk	f. Chalk	unmeasured

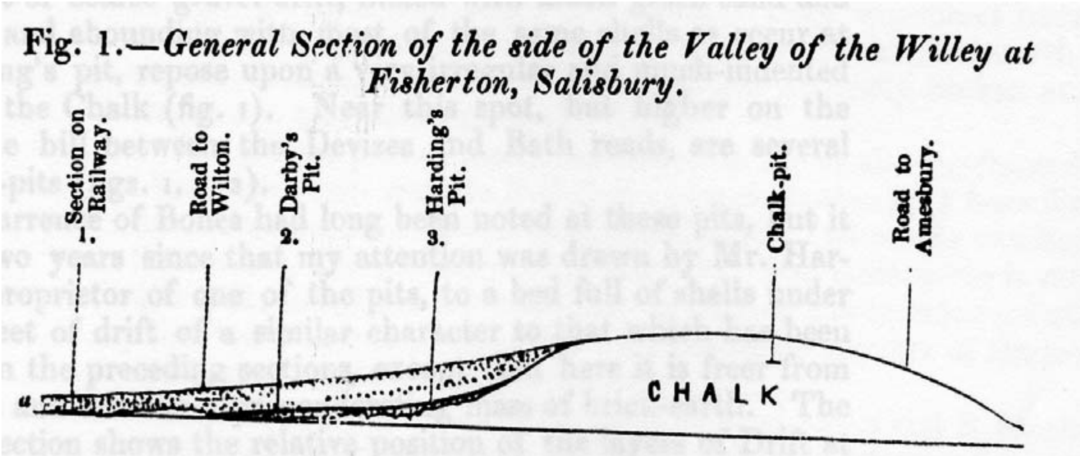


Figure 69: General section of the 'Willey' Valley at Fisherton, Prestwich and Brown (1855)

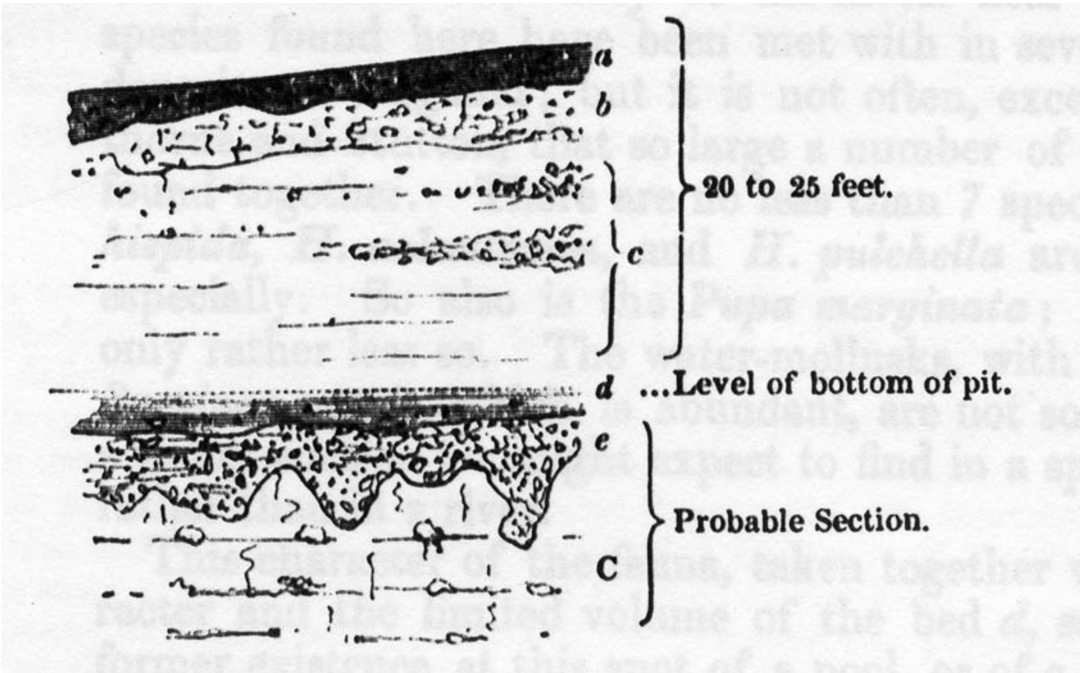


Figure 70: The section at Mr Harding's Brick Pit, Fisherton (Prestwich and Brown, 1855)

8.7 River Terrace Deposits (1 to 9 and Undifferentiated)

River terrace deposits are associated with all of the major rivers in the district. With the exception of the younger terraces (first and second) associated with the River Dun in the west all the rivers are confluent with the Hampshire Avon and with which they must share the history of terrace development. Outside the district to the south a full suite of terraces has been designated including the highest topographically associated with the development of the proto-Solent and forming gravelly spreads on the interfluves. Younger terraces found within the present valley topography are related to base levels of the River Avon system. Higher terraces exist but are not geomorphologically very distinct (with the exception of those of the lower Avon and River Dun) and have been labelled as undifferentiated. Many of these higher terraces and have undergone weathering and degradation by solifluction and grade both upslope and down slope into spreads of gravelly head deposits of various types.

The topographically highest terraces in this district are designated as the eight and ninth and are between 30 and 45 m respectively above the floodplain on the left or eastern valley side of the lower Avon. Their designation follows that developed for the lower Avon outside the district to the south around Ringwood and Bournemouth. In this district the very limited outcrops are characterised by clayey sandy angular flint gravel soils. There are no exposures or boreholes that indicate thicknesses for the two terraces but they can be no more than 5 m thick at most. Whilst the lower boundary above the relatively steep bedrock slopes into the Avon valley is sharp, laterally and upslope the spreads are less clearly defined and the eighth and ninth terraces cannot be separated in places due to remobilisation of the higher terrace spread down-slope.

The term river terrace deposits undifferentiated is used within this district to identify gravel spreads on the lower valley slopes that show some crude or degraded terrace surface. It is this generally flat surface that differentiates this deposits from other gravelly slope head deposits but the surface brash may well have the same appearance. The deposits are generally separated from the valley fill by a bedrock bluff that is usually between 15 and 20 m above the floodplain and the gravel flat usually has a slight rise to between 25 and 30 m above the floodplain.

The large outcrop upslope from the ‘Fisherton Brickearth’ is likely to be a composite of soliflucted material and terrace material. There is a steep bluff, covered in clayey gravelly soils, of some 15 m above the mapped Brickearth that culminates at a marked positive break of slope mirroring the 76 m contour (perhaps also reflecting a thin head deposit over a buried bedrock feature high in the Seaford Chalk Formation). Above this level the soils are much more gravelly on a shallower slope and this may well represent a higher level of terrace material (between 25 and 40 m above the floodplain).

The deposit is mapped on the north flank of the River Nadder around Dinton and Baverstock [SU 014 314 to 034 317], north of Ugford [SU 084 312] and between Wilton and Fisherton. A small outcrop in the grounds of Godolphin School at Milford Hill [SU 152 299] and on the interfluve between the Avon and Bourne valleys, was investigated by Harding and Bridgland (1998). They designated the outcrop as ‘Higher Terrace Gravel’ at about 30 m above the floodplain and equated it with Terrace 7 of the Avon as classified by Kubala (1980) (therefore terrace 8 utilising the classification adopted on Ringwood to the south). Only one small outcrop was identified south of the River Nadder, at Temple Copse [SU 098 304] on the Wilton Estate. Although designated as undifferentiated because of its isolation its height of about 40 m above the floodplain level would suggest that it may be the most upstream occurrence of the ninth terrace. Descriptions of the gravel from Harding and Bridgland (1998) indicate a mixed lithology with four ‘end members’ (white chalk debris, white bedded chalky gravel, dark yellow brown clayey gravel and greenish clayey sand) and variations between. They strongly suggest that much of the deposit was originally chalky but has suffered extreme decalcification.

Only the fourth terrace has been identified extensively in the district, and occurs at around 1.5-5m above river level and separated from the alluvial flat be a small bluff. No sections have been seen in this terrace, but field brash consists of abundant well-rounded to subangular and broken flint gravel, with clasts of varying sizes. Some are stained and rubified, and are probably derived from the clay-with-flints. Many outcrops along the margins of the alluvial plain are identified in the Nadder, Wylye Avon and Ebble valleys. They are best developed within the Wylye/Nadder/Avon confluence area around Wilton and Salisbury (Plates 41 and 42)

The lowest terrace of the River Avon in this district is the third mapped around Charlton-All-Saints [SU 177 238]. South of the district on the Ringwood and Bournemouth sheets this terrace becomes more extensive and two further and younger terraces are also designated.

Within the River Dun catchment (a tributary of the River Test to the east) two levels of terrace accumulation have been identified on the basis of two positive breaks of slope adjacent to the floodplain and some 5 metres above. These terraces may well be a single accumulation with erosional features relating to a down-cutting event. The soil comprises very flinty sandy silty clay.

Very similar mammalian faunas to those found within the so-called Fisherton Brickearth (see above) have been identified within the deposits associated with the valley bottom sub-alluvial gravels of the Wylye, Nadder and Avon. Indicating, particularly the regular finds of *Mammuthus primigenius* a similar age, at the beginning of the Devensian, for all of these deposits.

Details

The terrace deposits are widespread throughout the district but have not been widely exploited as a source of aggregate. Consequently there are no major exposures and few small-scale pits. Notable occurrences are given above and detailed descriptions on a sheet-by-sheet basis are inappropriate. Descriptions of the fourth terrace are incorporated within the description of the alluvium below.

Plate 41. Flinty terrace deposits exposed in drainage ditch River Avon near Witherington Farm. [SU 17659 26186]. Photo P 584731

8.8 Alluvium.

The alluvium in the district comprises a complex interdigitation of three distinct lithologies; sandy gravel (in places chalky), peat and fine-grained sandy muds (and muddy sands). In places a fourth unit of chalky, gravelly, sandy, silty clay is regarded as solifluction material derived from the steeper valley sides. This unit mapped as part of the alluvium is generally buried by fine-grained over-bank deposits along the margins of the alluvial tract in the broader streams.

The sandy gravel, generally found at depth below fine-grained over-bank deposits is of variable thickness. It is composed of fine- and coarse-grained clasts of subangular to rounded flints with subordinate amounts of chalk, quartz, quartzite and sandstone, and rare exotic rock types. The fine- to medium-grained matrix has a variable silt and clay content. Within the headwaters of the River Nadder the gravel fraction contains appreciable quantities of limestone derived from the Portland and Purbeck groups in the substrate. This limestone content is likely to be diluted downstream to its confluence with the rivers Wylye and Avon and thereafter become only a minor or rare constituent of the gravel fraction. This sandy gravel unit represents the bed-load of the stream probably laid-down in cold or cooler phases of climate and generally therefore likely to have been deposited within a braided stream environment with numerous channels separated by low-lying gravel bars. The exact relationship of this unit to the adjacent terrace and gravelly head deposits is not clearly demonstrated in boreholes and exposures and they may well be a single unit on which the over-bank materials have accumulated. As there is generally a small bluff, which marks the lateral extent of the floodplain, the higher gravels are conventionally mapped as terrace.

Plate 42. Flinty terrace deposits exposed in drainage ditch River Avon near Witherington Farm. [SU 17745 26016]. Photo P 584732

The peat material is intimately associated with the fine-grained over-bank deposits laid down within a mature stream environment. It occurs in beds and as disseminated fragments a dark-brown or black organic material with varying admixtures of silt and clay, and is usually fibrous and spongy. Its presence indicates areas of slow-flowing waters and significant plant growth and is most commonly, in this district, associated with sedge and reed-bed development within the larger alluvial tracts but may also be the result of organic accumulations in floodplain marginal situations where there is a significant shrub and wet-woodland (commonly called alder-carr woodland after the main tree species encountered). There are currently limited areas of peat accumulation within the present floodplain. These may be remnants of naturally wet slow-flow backwaters or initiated by man (since the Middle Ages) in cut-off channels created during the creation of navigable streams. The surface distribution of peat within the floodplain has not been attempted during this survey because the relationship between the over-bank deposits and the organic beds is complex, the deposits are frequently thin and many of the accumulations are associated with man-made features. Thin peat units can be expected enclosed within the other deposits of the alluvium as mapped in this district.

The principal unit of the alluvial tract is the fine-grained sandy muds (and muddy sands) representing the mature over-bank flood deposits that have gradually built up the floodplain above the level of the gravelly braided stream deposits. The deposit usually comprises pale grey or silvery grey, wet, sticky muds (an admixture of silt- and clay-grade material) with varying proportions of very fine- and fine-grained sand and may contain shell material as individuals or in thin shell beds. It contains peat and disseminated organic material (see above) and commonly includes very thin fine-grained gravel beds of flint and chalk. These gravel lag deposits, often no more than a string of pebbles, represent the initial deposits of flood events. The more peaty soils tend to be in the backwater marshy areas away from the main flow. However, most of the rivers within the district have been subjected to extensive modification by man to create navigable streams, water meadows and mill leats, hence, the original valley floor morphology is often no longer preserved.

The alluvium in the district is generally around 4-5m thick, of which the top 2 to 3 m is of the over-bank deposit type. In places, particularly where rivers merge, a thicker gravel unit at the base increases the overall thickness of the deposit. Details are given below derived from borehole evidence. Generally only the fine-grained over-bank deposits are seen in exposure and these are generally of limited vertical extent. The cross-sections are based on available boreholes but are generalised in places. In places the fluviatile material is proven to considerable depths below the localised base of the deposits. These thicker successions may reflect normal deposition where riffle and pool morphologies are prevalent in the bed of the stream. However the most extreme examples are probably related to solution of the chalk bedrock and these structures may only have limited lateral extents.

Details

ST94SW

There is very little information on the floodplain within this sheet in the BGS records. The memoir (Bristow et al., 1999) gives a general description for the upper Wylye floodplain deposits. Here the alluvium is generally an upper unit of mottled grey and brown, or orange-brown commonly organic or peaty, silt, silty clay and clayey sand with only scattered clasts, and a lower unit of sand and gravel with a clay matrix in places. In general the gravel comprises predominantly flint with some quartz and quartzite with a significant content of locally derived sandstone from the Upper Greensand Formation. Eastward the sandstone content decreases by dilution from material brought into the main stream by tributary valleys that drain the chalk hinterland.

ST94SE

The Chitterne Brook crosses this sheet from northeast to south and is one of the principal north (or left) bank tributaries of the River Wylye. Alluvium is confined to a narrow channel between 150 and 300 m wide. For much of its length across this sheet the brook is dry during the summer months and there is a stream-flow augmentation scheme that operates to maintain flow through Codford to the south. There are winter springs between [ST 9835 4277 and 9804 4254] and again to the south around [ST 9724 4100] which gain head sequentially from the south as the groundwater table fills in wet months.
The brook flows throughout its length during exceptionally wet seasons and higher winterbournes are known upstream to the north outside this district where the stream deposits are found in the Berril Valley within the MoD holdings on Salisbury Plain.

Surface observations show that there is a thin (0.5 to 1.5 m) thick unit of greyish brown silty clay to fine-grained sandy clay with rare chalk and flint pebbles resting on fine- to coarse-grained angular flint gravel with some chalk fragments and rounded pebbles. The gravel is in many places clast supported with only minor interstitial chalky sand matrix suggesting that the deposit is regularly flushed of its finer material.

ST93NW
Only a small area on the margin of the River Wylye floodplain impinges on the northeast corner of this sheet. There are no details

ST93NE
The floodplain of the River Wylye crosses the northern part of the sheet between Boyton in the west and Bapton in the east. Generally a broad flat plain the floodplain up to 500 m wide it narrows west of Stockton to as little as 150 m. The floodplain is bounded by shallow slopes founded on terrace deposits on the southern flank westward to Sherrington and from there to the western margin of the sheet on the northern flank. Elsewhere the floodplain is limited against steep slopes in chalk.

The floodplain is characterised by pasture, both improved and unimproved depending on the degree of drainage, and wet woodland marginal to the main channel. The soils are pale grey brown silty clay with little flint gravel and are peaty with calcareous tufa granules in places (e.g. [ST 981 386]).

Boreholes and trial pits for the A36 in the Giggan Street area [ST 973 394] show that the over-bank fine-grained material is of limited thickness and rests on fine to coarse gravel in a muddy sand matrix.

Borehole ST93NE14b [ST 974 395] gave the following representative log; -

Deposit	Lithology	Thickness m
Alluvium	Topsoil	0.30
	Soft, brown, slightly sandy, silty clay with fine chalk gravel	0.70
	Medium dense black and white slightly sandy fine- to coarse-grained subangular to angular flint gravel with cobbles. Top of gravel is clay-bound.	1.30
	Soft, greyish white, chalky, clayey silt with occasional fine angular flint gravel	0.90
Chalk (West Melbury Marly Chalk Formation)	Weak weathered chalk on interbedded limestone and argillaceous chalk	35.10
Upper Greensand Formation	Bluish green, fine- to medium- occasionally coarse-grained sandstone	3.00

A deep drainage ditch adjacent to Sherrington Lane [ST 9604 3958] was dry at the time of survey and showed 1.20 m of finely bedded grey silty clay and gravelly, sandy clay resting on 0.8 m+ of fine- to coarse-grained flint gravel in a yellow brown clayey sand matrix. At [ST 9603 3953] to the south in the same ditch a 0.20 m seam of black fibrous reed peat intervened between the gravel and the overlying over-bank deposits.

ST93SW

There is a narrow (50 m or less) floodplain for the stream that drains Fonthill Lake and valley. The stream is fed by numerous springs that mark the top of the Kimmeridge Clay Formation on the flanks of the valley.

ST93SE

Two minor streams drain south south-eastward from springs at Chilmark [ST 9685 3269] and north of Teffont Magna [ST 9855 3288] to form north (or left) bank tributaries of the River Nadder. Both have very narrow floodplains. Bank-side exposures show thin (1.0 to 1.5 m) gravelly (generally limestone and sandstone clasts), grey, sandy, silty clay. When dry the streams are seen to flow over a locally derived gravelly bed and in places over in situ bedrock.

In the southeast of the sheet the 200 m wide floodplain of the River Nadder is characterised by unimproved pasture and exposures are limited to bank-side sections above water level. These are generally in over-bank fine-grained sandy silty clays with minor peat beds and gravel ‘stringers’. Where visible the stream flows on a gravel bed.

ST92NW

The narrow floodplain within the Fonthill valley joins the headwaters of the River Nadder near Tisbury Station (on sheet ST92NE). There is no information on the lithologies within either valley but the alluvium is expected to be thin and have a generally clayey nature and probably resting on a limestone-rich gravelly lag deposit.

ST92NE

The River Nadder floodplain crosses the northwest of this sheet between Tisbury and Panter’s Bridge. It is joined on the north bank by the stream draining from Fonthill Lake and on the southern flank by a stream draining the area from Ansty to Swallowcliffe and by a stream flowing through Fovant. Each has a narrow alluvial tract but there is no information regarding lithology other than the surface soils that are pebbly silty clays.

Within the Nadder valley the alluvial tract is broader (up to 300 m) and forms a sinuous flat predominantly in pasture. There are few exposures other than bank-side bluffs that generally show fine-grained deposits resting on gravel. Trenches indicate that at least 4.0 m of alluvium is present in the valley but that within this thickness the relative proportion of over-bank silts and clays and underlying gravel is variable.

ST92SW & ST92SE

Only a narrow alluvial tract of the headwaters of the River Ebble is mapped passing through Ebbesbourne Wake. There are no descriptions of the deposit from this area.

SU04SE

The River Till rises in Shrewton and takes a meandering route southward through Winterbourne Stoke on its way to a confluence with the River Wylye to the south. The alluvial tract is between 100 and 250 m wide and is mainly in pasture.

The alluvial tract immediately north of Winterbourne Stoke presents a brash of very coarse angular flint gravel and there are many springs at this locality. The deposit is differentiated as gravelly head on the map (see below). At least one metre of gravel can be seen in the banks of the River Till. Water can be seen issuing from the gravels at many places between Manor Farm (just north of the old A303) and [SU 0810 4159]. In this section the stream is locally incised in a channel up to 1.5 m deep. A borehole SU04SE 19 [SU 0781 4105] shows 18 feet (5.49 m) of “white gravel” over chalk. This whole area is the major source of the River Till during wet seasons and the gravel is regularly flushed during those periods.

Upstream of [SU 0810 4159] the surface alluvium becomes very clayey with boggy patches. The style of the river channel becomes much wider and shallower, with no springs, and continues in this manner up to the sewage works at [SU 0742 4262] and into Shrewton.

South of Winterbourne Stoke, the alluvium is locally quite peaty, especially in the field south of the Church. A number of springs were identified during the survey.

SU03NW

The broad alluvial tract of the River Wylye crosses this sheet from Fisherton de la Mere in the west to Little Langford in the east. Generally between 400 and 700 m wide the flat valley floor is restricted to about 200 m at Steeple Langford where gravels of the adjacent terrace rise gently above the floodplain on both the northern and southern flanks. This is probably the site of a natural fording place on the river and is followed by Duck Street connecting Steeple and Hanging Langford. In general the edge of the alluvium is mapped at a slight bluff formed at the edge of the adjacent terrace or head deposits. Immediately to the east of Duck Street the floodplain is almost entirely taken up by old gravel pits that are flooded and now form a nature reserve and fishery. There are no records of this extraction area in BGS archives but is likely to have been worked post 1926 when maps of Wiltshire show the area as a common.

Boreholes for the A303 crossing between Deptford and Wylye demonstrate the relationship between the alluvium and the adjacent terrace a sketch section is shown in Figure 71.

SU03NE

This sheet covers the confluence of the River Till and the River Wylye close to Serrington [SU 068 370] near Stapleford.

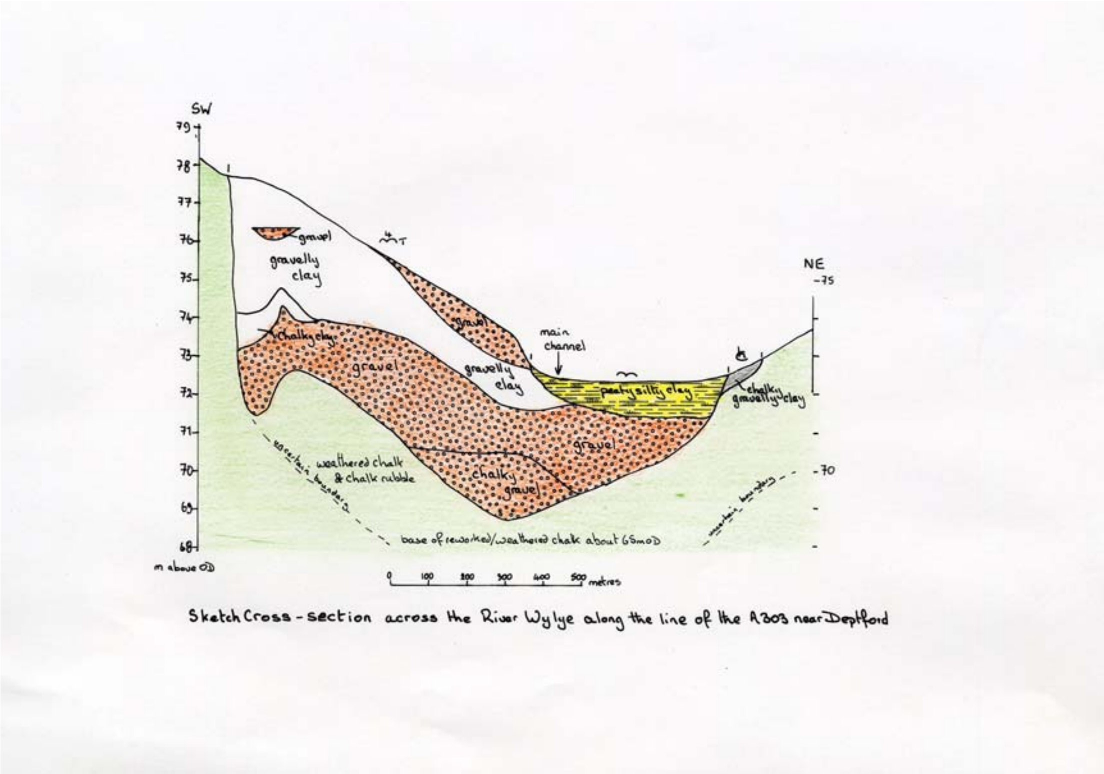


Figure 71. Sketch Section of the Alluvium and terrace deposits at the crossing of the A303, [SU 009 380]

The River Till drains from north to south from Berwick St James to Serrington. The alluvial tract is flat and generally 250 m wide. The alluvium is flanked by gravel-rich head and terrace deposits that form shallow slopes above a marked break of slope.

The River Wylye flows eastward from Little Langford in the west to the confluence with the River Till from where the river turns sharply to the southeast through the Wishford's. The broad (300 to 450 m) flat alluvial tract in the west narrows to 150 to 250 m through the Wishford's where it is confined between steeper valley sides carrying terrace and head deposits.

Natural exposures are confined to the banks of the primary stream where thin fine-grained sandy silty clay with thin peat seams and rare calcareous tufa is seen resting on a gravel base.

Boreholes, drilled across the valley for the A36 road scheme, demonstrate the close relationship between the alluvium and the terrace/head deposits on the adjacent shallow slopes. Two sketch sections based on these boreholes are given below (Figure 72).

SU03SW

The middle reaches of the River Nadder cross this sheet from west to east as a broadening flat-lying alluvial tract. For the most part this floodplain is bounded to the north by shallow slopes founded on terrace deposits whilst to the south the floodplain is limited by a marked break of slope developed within the various bedrock lithologies. This would indicate that the river has migrated southward over time.

Other than bank-side exposures of fine-grained sandy silty clay over gravel within the main channel the area presents few natural exposures and there are no boreholes that penetrate this deposit. However it is presumed that there is a variable thickness of over-bank fine-grained alluvial material that includes peaty deposits, overlying a variable thickness of flint gravel.

The floodplain is generally between 250 to 400 m wide but narrows markedly to the west of Catherine Ford Bridge [SU 0096 3063] where the limestones of the Purbeck Group form the substrate. The area is characterised by unimproved pasture with sedge and reed growth in marginal wet areas.

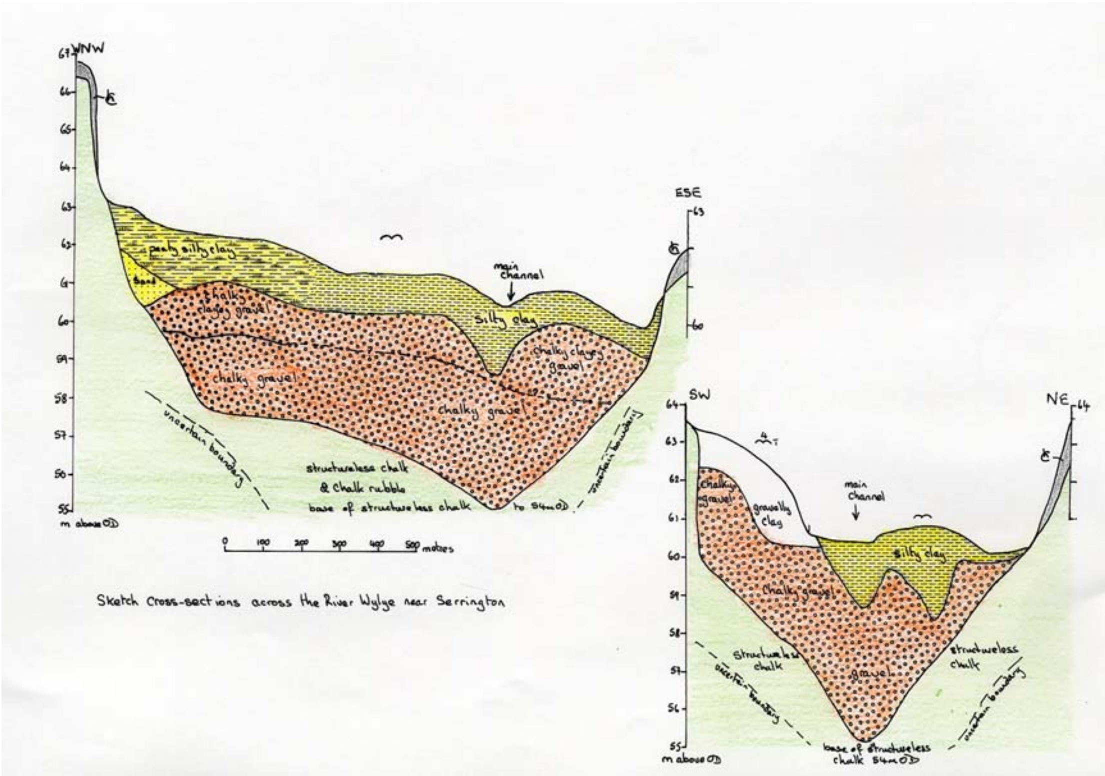


Figure 72: Sketch section across the River Wylye south of Serrington, [SU 070 365].

SU03SE

Two major streams cross this sheet. From west to east the River Nadder has a broad floodplain passing south of Barford St Martin, between North and South Burcombe and eastward into Wilton. The River Wylye enters the sheet near South Newton in the north and flows south south-eastward into Wilton.

Both rivers have broad flat floodplains bounded by shallow slopes founded on head or terrace deposits or by a sharp feature at the margin of the chalk.

The intensity of drainage increases in both valleys towards Wilton and much of the floodplain is given over to improved pasture or arable farming. Other than the shallow bank-side exposures within the main stream and major ditches there a few natural exposures. These exposures demonstrate a variable thickness of over-bank fine-grained alluvium resting on fine to coarse flint gravel. Peat intervenes in places, in marginal wet woodland and as thin peat beds within the silty clay that make up the flood material. Boreholes demonstrate the relationship of the alluvium to the underlying gravel and gravelly terrace deposits. Figure 73 shows the relationship in the lower reaches of the Wylye and Borehole SU03SW14 [SU 08663 31049] tabulated below demonstrates the succession within the River Nadder near Ugford.

Deposit	Lithology	Thickness m
Alluvium	Topsoil	0.35
	Soft Clay	0.65
	Loose light yellow and grey brown silty sandy fine- to coarse-grained gravel with occasional cobbles. Composed of subangular to rounded sand to medium gravel sized chalk fragments and subangular to rounded sand to cobble sized flint fragments. Occasional fine- to medium-grained gravel sized sandstone fragments observed	2.40
Seaford Chalk Formation/ Lewes Nodular Chalk Formation	Weathered chalk to hard nodular chalk	16.95+

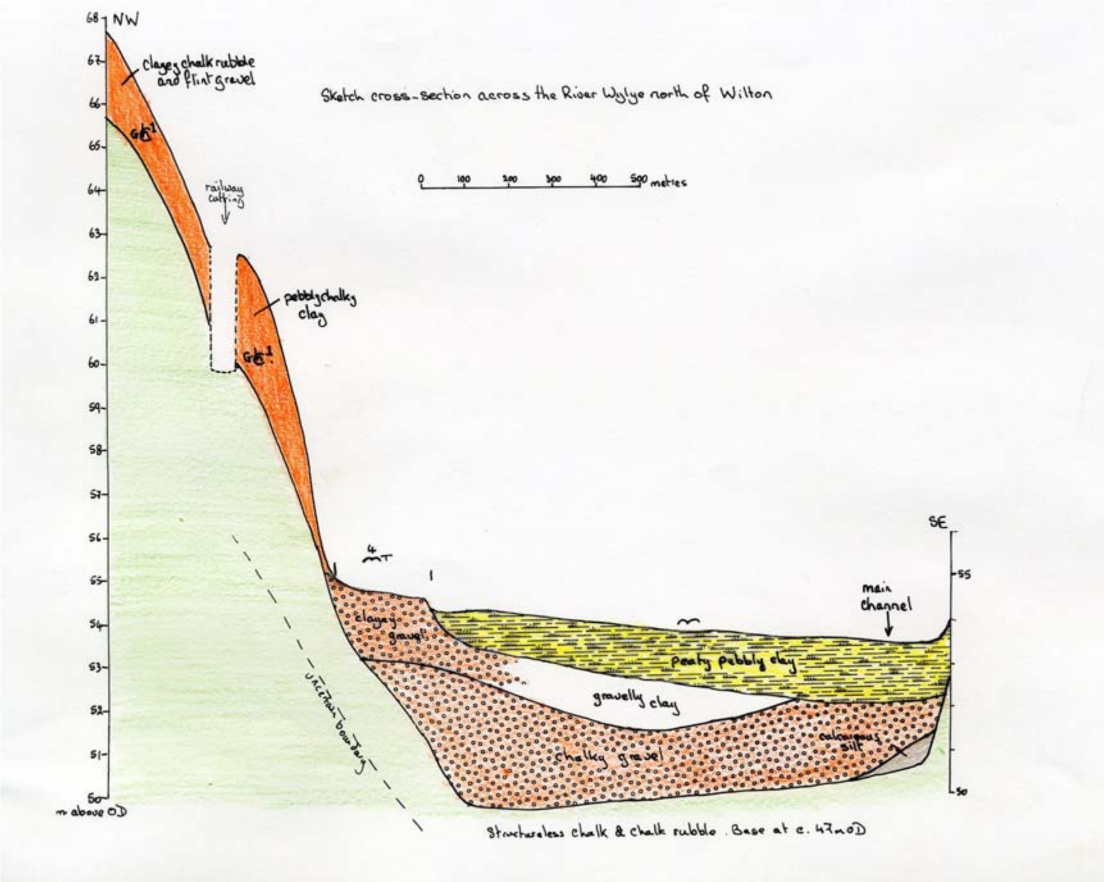


Figure 73: Sketch section showing the relationship of the alluvium and terrace deposits around Wilton, [SU 090 330]

SU02NW

The alluvium is mapped in three localities on this sheet. To the north the headwaters of two minor south bank tributaries of the River Nadder drain the area north of the primary chalk scarp. Here a narrow flat within the valley floor carries a sandy silty clay soil.

To the southeast the narrow valley carrying the headwaters of the River Ebble is found west of Broad Chalke. To the west of this village the alluvium forms a narrow flat below a minor slope break in a much broader valley flanked by terrace deposits.

Only minor exposures in the banks of the main channel of the river were seen and these showed gravelly, sandy, silty clay. The stream is seen to run on a gravel base in many places.

SU02NE

The middle reaches of the River Ebble cross the southern part of the sheet between Knighton and Stratford Tony. The broad flat alluvial tract increases in width from 100 m or less in the west to 150 to 300 m in the east and is flanked for much of its length by shallow slopes underlain by terrace deposits. East of Bishopstone the southern flank of the valley rises sharply where the chalk scarp has limited the southward migration of the river. The alluvial flat is characterised by pale grey brown silty pebbly soils and only bank-side exposures were visible during the survey that showed variable grey sandy silty clay resting on flint gravel.

SU02SW

Only narrow outcrops of alluvium associated with the headwaters of the River Ebble were mapped on this sheet. There are no details.

SU14SW

Part of the River Avon crosses the south-eastern part of this sheet as a large meander pair centred around West Amesbury. The broad floodplain (150 to 250 m) is cross-cut by many drains and much of the outcrop shows peaty wet silty clay soils. There are no boreholes within this stretch of the river to confirm the depth of the gravel that is seen in places along banks beneath the fine-grained over-bank deposits.

SU14SE

The River Avon meanders across the western part of this sheet between Amesbury and Durrington (outside the district to the north) and is joined by the major east bank tributary of the Nine Mile River in Bulford (also outside the district to the north). Narrow outcrops of terrace deposits on the inside curve of the meanders flank the broad flat alluvial tract but elsewhere there is a sharp slope break at the base of very steep chalk slopes. This part of the river is often referred to as the gorge but this is something of a misnomer.

In the vicinity of the Countess Roundabout on the A 303 the north bank of the river is marshy with wet willow and alder woodland and peat has been mapped. A series of boreholes west to east along the A 303 show the relationship of the peat to the alluvium. A sketch section based on these boreholes is given in Figure 74 below.

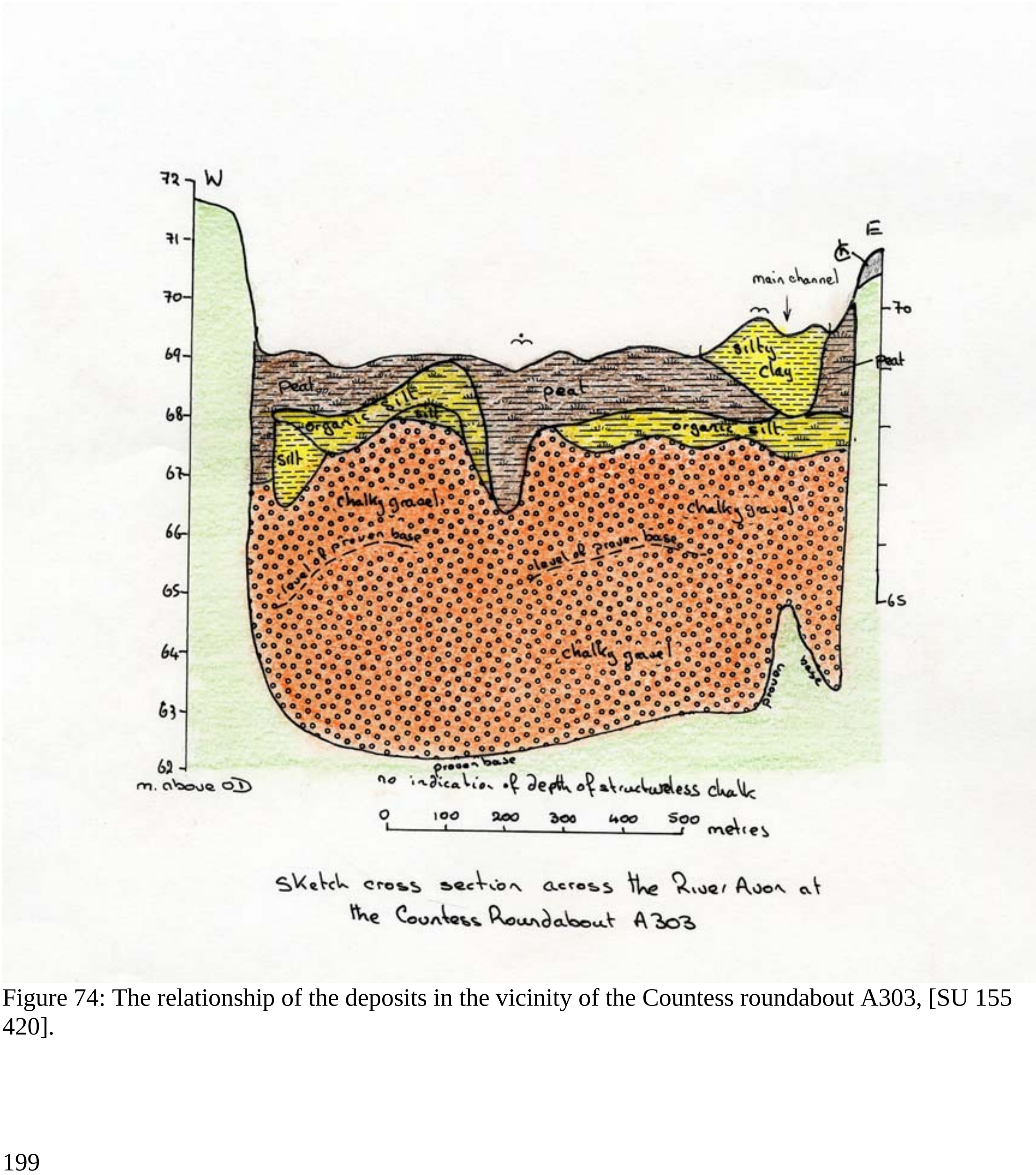


Figure 74: The relationship of the deposits in the vicinity of the Countess roundabout A303, [SU 155 420].

SU13NW

The River Avon meanders in its 'gorge' from Wilsford southwards to Lower Woodford. The flat alluvial tract is cross-cut with drains adjacent to the main channel and the fields are generally of both unimproved and improved pasture. Head and terrace deposits are proven adjacent to the alluvial flat. There are few exposures other than within the banks of the major channel but two boreholes for the A36 Salisbury Bypass scheme at Middle Woodford give a general succession in the valley.

Borehole SU13NW22 [SU12287 35721]

Deposit	Lithology	Thickness m
Alluvium	Topsoil	0.25
	Soft grey, frequently iron-stained, slightly sandy clay, with a little fine-grained to medium-grained flint gravel, frequent shells and shell fragments, and a little organic matter	1.00
	Very soft dark brown fibrous peat	0.80
	Medium dense to dense grey and dark brown, silty, sandy angular to subangular fine- to coarse-grained flint gravel, with a little to some subangular to rounded mainly fine- to medium-grained chalk gravel. Occasional flint cobbles	2.20
Lewes Nodular Chalk Formation	Weathered to intact chalk with flints	16.05 m +

Borehole SU13NW23 [SU12209 35667]

Deposit	Lithology	Thickness m
Alluvium	Topsoil. Very soft dark brown, very clayey peaty silt with a little angular fine to medium flint and subrounded chalk gravel. A few shells and shell fragments.	0.40
	Soft dark brown very clayey organic silt with much fibrous material and a little angular fine- to medium-grained flint gravel and a little rounded fine- to medium-grained chalk gravel, with occasional shell fragments and intact shell.	0.40
	Very soft brown very clayey very peaty silt with occasional rounded to angular fine- to coarse-grained flint gravel and occasional rounded fine- to medium-grained chalk with occasional shell fragments and intact shell.	0.80
	Loose, becoming medium dense sandy angular to subrounded fine- to coarse-grained flint gravel with occasional cobbles and a little subrounded fine- to medium-grained chalk gravel. Much chalk below 4.00 m.	3.40
Lewes Nodular Chalk Formation	Weathered to intact chalk with flints	11.00 m +

SU13NE

The Bourne River meanders in an incised valley across the southeast of the sheet between Boscombe in the east and Winterbourne Gunner in the south. The alluvium is mapped from the perennial head [SU 197 382] north of Idmiston.

A single borehole on this sheet samples the alluvium on this sheet but it did not penetrate the full thickness of the deposit (see below). One interesting feature of the succession is the redeposited structureless chalk that indicates that the margins of the channel as it developed were also active in terms of deposition and this unit may well represent a localised solifluction lobe or landslide.

Deposit	Lithology	Thickness m
Alluvium	Topsoil and clay	0.15
	Firm grey-brown clay with many medium- and fine-grained chalk gravel sized clasts	1.83
	Dense fine-, medium- and coarse-grained flint and chert gravel	2.13
	Soft to firm redeposited structureless chalk	1.07
	Compact medium- and coarse-grained gravel with some chalk	1.37 m+

In places the alluvial tract is wet and boggy indicating the presence of peat (e.g. at West Gomeldon [SU 181 359]).

SU13SW

This sheet is cut by the River Avon in its deeply incised valley from Lower Woodford in the north to the St Pauls area of Salisbury in the south. The broad alluvial plain of the River Nadder crosses the southwest of the sheet from Wilton Park through to Netherhampton. The two streams have a confluence to the south on sheet SU12NW.

Within the River Avon the alluvial tract broadens from about 200 m in the north to up to 400m in the south where it is also flanked by shallow slopes founded on terrace deposits. Within this stretch of the river a single borehole (SU13SW34 [SU 12729 33285]) at Avon Bridge near Old Sarum penetrates the whole succession. A descriptive log is included below.

Deposit	Lithology	Thickness m
Alluvium	Topsoil	0.40
	Soft, light to dark brown plastic amorphous peat occasionally fibrous intermixed with soft light grey-brown and dark brown sandy silty clay with some fibrous matter, occasionally shell fragments; sandy mainly chalk. Below 1.10 m with a little fine gravel.	0.95
	Medium dense sandy, angular to subangular fine- to coarse-grained flint gravel, with occasional cobbles and a little rounded fine- to medium-grained chalk gravel. Sandy in uppermost 0.90 m. Below 4.20m becomes very sandy. Chalk content generally increasing with depth.	3.35
Seaford Chalk Formation	Structureless, becoming bedded white Chalk with flint seams	17.78 +

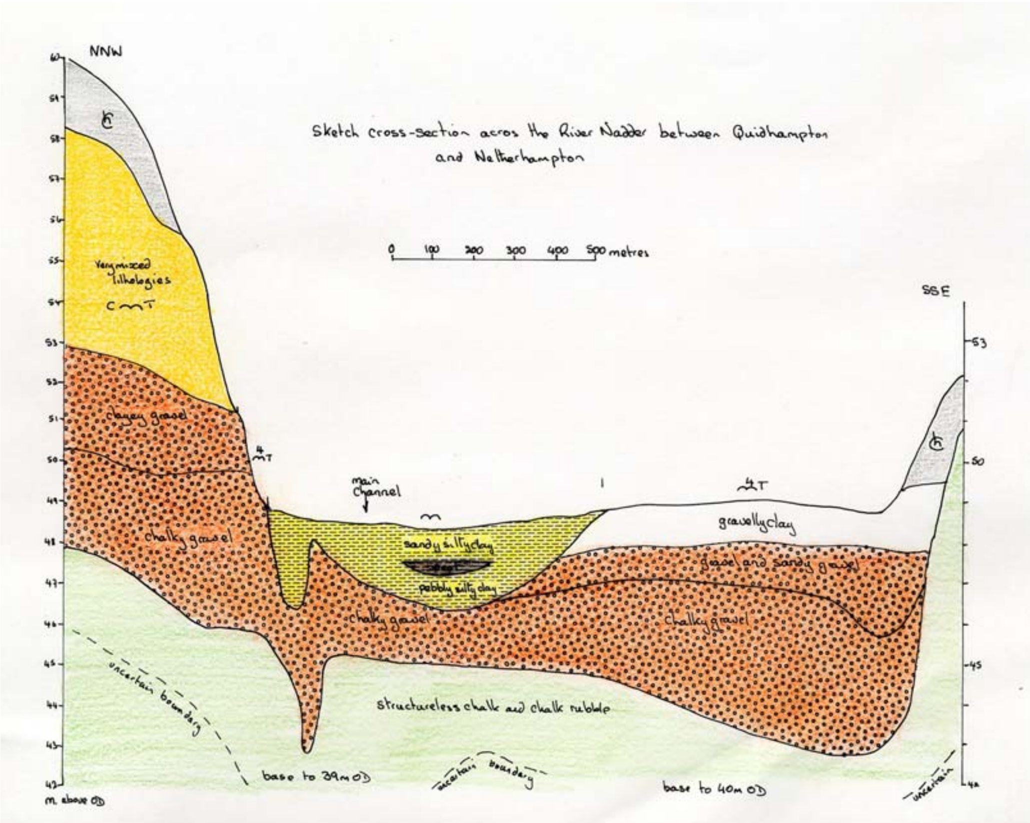


Figure 75. Sketch section across the River Nadder floodplain from Quidhampton to West Harnham, [SU 11 30 to SU 11 29]

In the south of the sheet the River Wylye has its confluence with the River Nadder south of Quidhampton on the broad alluvial plain east of Wilton Park. There are many bank-side exposures of fine-grained over-bank material resting on variably clayey fine- to coarse-grained flint gravel. There are a number of small areas within this floodplain where peaty deposits are identified associated with dark grey silts and clays. Two such occurrences at Boys Meadow Withybed [SU 114 308] and Bull Plot Withybed [SU 120 304] are areas of wet boggy alder and willow woodland where the poor exposures show thin peat and very humic silty clay. In the vicinity Broken Bridges Cottages [SU 127 303] peat development is more widespread and associated with reed and osier development as well as willow. The many drains that cross-cut this very wet area all show dark grey to black fibrous peat interbedded with grey very soft humic silty clay overlying gravel in the deeper main channels.

Boreholes for the A36 road scheme cross the floodplain from Quidhampton towards West Harnham (on sheet SU12NW to the south). A sketch section (Figure 75) showing the relationship between the lithological units of the alluvium and adjacent terrace deposits is given above based on an interpretation of those boreholes.

SU13SE

The Bourne River crosses the eastern half of this sheet from Winterbourne Dauntsey in the north to Laverstock Mill Bridge in the south. The alluvial tract is bounded laterally by terrace and head deposits for most of its length. A borehole at St Thomas's Bridge [SU 163 322] gives the general succession of over-bank deposits resting on gravel whilst a nearby trench gives detail within these over-bank sediments. Both are given below.

SU13SE22 [SU 16414 32212]

Deposit	Lithology	Thickness m
Alluvium	Topsoil	0.30
	Soft grey-brown peaty clay with a little fine- to coarse-grained angular to subrounded mostly flint gravel: traces of decayed vegetation: occasional silt inclusions: becoming clay bound gravel at base	0.70
	Loose light brown sandy angular to subangular fine- to coarse-grained mostly flint gravel: occasional cobbles.	2.40
Newhaven and Seaford Chalk formations	Structureless weathered chalk over soft white chalk with few flints to	26.8+

Trial Pit SU13SE79 [SU 16319 32196]

Deposit	Lithology	Thickness m
Alluvium	Topsoil, black silt with numerous rootlets	0.25
	Soft light brown, orange brown mottled clay with occasional subrounded chalk gravel	0.20
	Soft black peat with some rootlets.	0.05
	Soft brown, becoming light brown clay with occasional subrounded fine-grained chalk gravel and some roots	0.10
	Soft black peat with some roots	0.05
	White silt with in situ partially decayed rootlets throughout	0.30
	Light grey sandy gravel. Gravel predominantly subangular to subrounded fine- to coarse-grained flint with some cobble, subrounded to rounded fine- to medium-grained gravel. Some decaying roots	0.70
	White sandy subrounded fine- to medium-grained chalk and subangular to subrounded fine- to coarse-grained flint gravel with occasional flint cobbles.	0.85+

Two further boreholes south of Hurdcott [SU 171 338] give similar successions.

SU13SE24 [SU 16725 33307]

Deposit	Lithology	Thickness m
Alluvium	Topsoil	0.25
	Soft to firm brown clay	0.35
	Loose light brown very clayey subrounded to subangular fine- to coarse-grained mainly flint gravel with some cobbles, a little rounded fine-grained chalk gravel	0.90
	Loose light brown very clayey subrounded to subangular fine- to coarse-grained mainly flint gravel with occasional cobbles and some rounded fine-grained chalk gravel and a little soft light brown sandy silt	1.00
	Loose slightly sandy subrounded to rounded mainly chalk gravel with occasional cobbles and some coarse-grained flint gravel.	1.50
Seaford Chalk Formation	Structureless weathered chalk on soft white chalk with flint seams	16.0+

SU13SE26 [SU 16870 33551]

Deposit	Lithology	Thickness m
	Soft brown topsoil	0.55
	Very soft to soft brown to grey-brown slightly silty clay with occasional angular fine- to medium-grained gravel and shell fragments intermixed with dark brown plastic amorphous peat: scattered flint gravel	0.85
	Very loose, becoming loose, sandy angular fine- to coarse-grained flint gravel with occasional subrounded to rounded fine- and medium-grained chalk gravel, gravel becoming predominantly fine- to medium-grained	2.00
Seaford Chalk Formation	Structureless weathered chalk on soft white chalk with flint seams	16.6+

SU12NW

In the north the sheet is crossed by the broad floodplain of the River Nadder to its confluence with the River Avon at [SU 1397 2968]. To the south the River Ebble crosses from west to east on a broadening floodplain.

The deposits associated with the floodplain of the River Nadder are shown in Figure 75 above (see SU13SW).

There are no boreholes to show the depth of the alluvium in the Ebble valley but bank side exposures show a variable thickness of peaty clay and silty clay overlying flint gravel.

SU12NE

This sheet carries the broad floodplain of the River Avon from near its confluence with the major right bank tributary of the River Nadder south of Salisbury to south of Bodenham. The left bank tributary of the Bourne River has its confluence with the Avon at [SU 1555 2906] and the right bank tributary of the River Ebble joins the Avon at [SU 1705 2603].

The lower reaches of the Bourne River are penetrated by only one borehole close to the confluence with the River Avon. The succession encountered is similar to that for the description on sheet SU13SE to the north. This borehole SU12NE99 [SU 1552 2928] shows 1.5 m of made ground on over-bank deposits described as 0.5 m of soft to firm brown stony clay, resting on 5.2 m of medium dense sand and gravel with cobbles and Chalk.

There are no boreholes to confirm the succession in the lower reaches of the River Ebble.

Within the Avon valley a line of boreholes for the A36 Salisbury Bypass crosses the floodplain between Petersfinger and Britford. Interpretation of the deposits encountered within these boreholes gives the clearest picture of valley cutting and sediment aggradation history within the district and perhaps act as models for the other major streams. A sketch section based on those boreholes is shown below (Figure 76). The boreholes indicate that there is flint-rich gravel beneath both the alluvial over-bank deposits and the marginal terrace and head deposits. The base of this gravel has an irregular base with between 6 and 8 metres of topography. It is not clear if these are an original feature representing riffle and deep pool situations in a braided stream environment or whether they reflect later solution of the underlying chalk post deposition. Two boreholes penetrating the west side of the floodplain indicate chalk gravel below the flint-rich gravel and this is thought to represent the earliest infill of the valley perhaps eroded away by the incoming flint-rich gravel or incorporated into it. This chalk-rich gravel is obviously water-worn and is likely to represent the reworking of chalk scree from the adjacent valley sides whilst the landscape was relatively bare of vegetation or where the river has created an unstable chalk bluff.

Above the flint-rich gravel the boreholes indicate a complex infill history. Pebbly clays representing solifluction lobes, mapped as head on the steeper slopes marginal to the main terrace and channel, overlie parts of the terrace flat and abut the floodplain on the eastern flank. At about this time in the valleys development it is thought that there was a further period of down-cutting into the gravel infill. This erosional period created the low terrace bluffs that act as the mapping limit of the terrace and point to the age equivalence of the terrace deposits and sub-alluvial gravel. Following this down-cutting the valley again began to fill with sediment. This infill comprises two principal, laterally equivalent, sand and peat units that rest with a reasonably level base on the flint-rich gravel. These perhaps represent a period when flow was concentrated into two channels (depositing sands) either side of a medial marsh (where peat accumulated). The association would indicate lower stream velocities and perhaps a limited braided or meandering environment. Fine-grained over-bank deposits representing the final stage of infilling of the valley overlie and in places cut through the sand/peat infill. This represents the low flow meandering phase of the rivers most recent history.

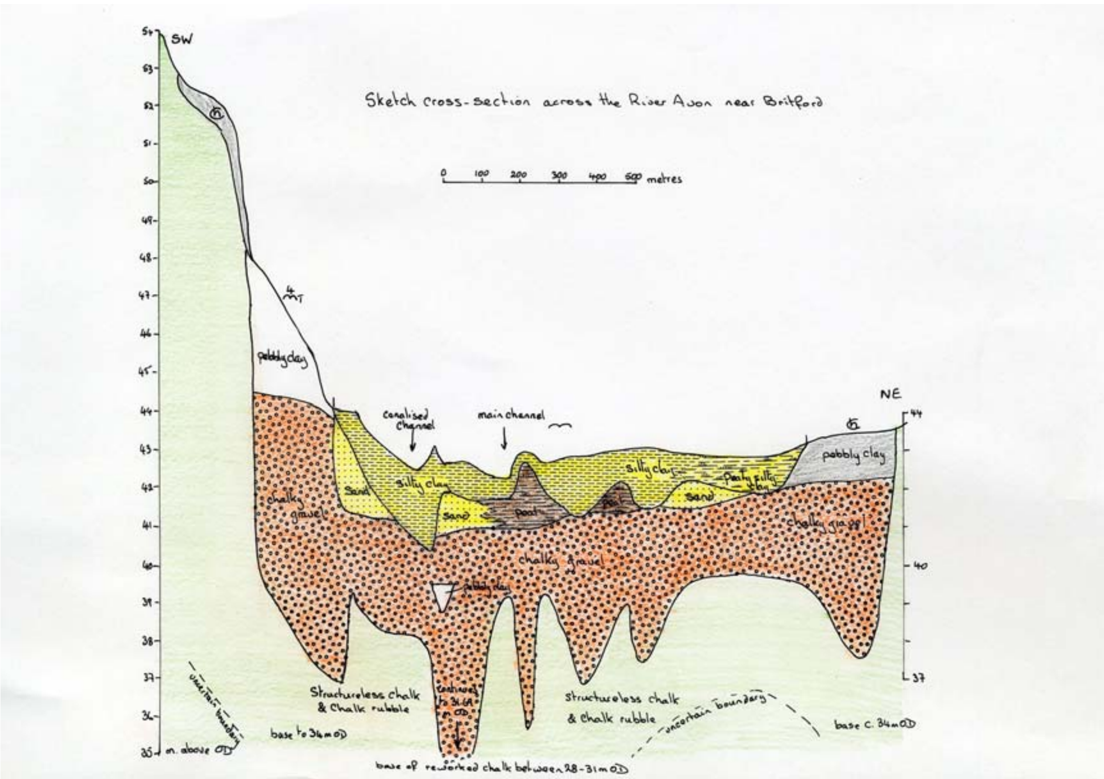


Figure 76: The valley fill of the River Avon near Britford, [SU 15 28]

Southward from Britford the alluvium of the floodplain is divided around a medial slightly raised area, on which the village lies, underlain by gravels that is mapped as fourth terrace. This emphasises the dual channel feature of the river in this area.

Even further south near the confluence with the River Ebble only a narrow area of alluvium is mapped cutting through the broad expanse of terrace gravel.

SU12SE

South of the broad expanse of terrace at Boderham the outcrop of the over-bank deposits expands before again becoming confined adjacent to Charlton-All-Saints. A single borehole on the margins of the floodplain at [SU 1766 2430] indicates 10.36 m of "washed gravel and some coarse sand" resting on 81.08 m of chalk with flints.

SU24SW and 23NW

Above the perennial spring and Idmiston the Bourne River flows on a gravel-rich head and there are no over-bank deposits attributed to alluvium mapped.

SU22NW

The River Dun 'rises' at a lake [SU 2052 2890] in the valley east of Clarendon House and a permanent stream flows across the Palaeogene deposits preserved in the Alderbury – Mottisfont Syncline. Here a narrow wet flat close to the stream is underlain by brown humic silty clay with rare pebbles.

Where this stream passes off the Palaeogene strata the surface flow is reduced at a number of sinks into the chalk. The section of the River Dun from East Grimstead to the east is dry for the driest month of the year. Here the alluvial flat becomes more gravelly perhaps indicating that the surface over-bank fine-grained material is 'wasting' into the underlying gravels.

8.9 Peat

Peat is the term used for deposits of an organic nature that are generally fibrous and contain discernable organic material, but the term can also cover richly organic fine-grained sediments that demonstrate a fibrous nature. In general the peat deposits found within chalk streams in southern England are of the alder-carr or reed-bed type. They represent accumulations of fibrous organic material within floodplain marginal woodland or reed/sedge beds in slow flowing backwater situations. They often contain appreciable amounts of trapped fine-grained organic muds and notable shell detrital beds. In special circumstances where carbonate-rich groundwater infiltrates the peat units, deposits of calcareous tufa or nodules of this carbonate precipitate occur. The presence of this precipitate is controlled by relative concentrations of carbonate and the chemistry of the water within the sediment.

Within the district there is only one area of peat delimited by mapping (see below) but beds of fibrous, black, peat and peaty silty clay are known to be present within the mature river valleys closely associated with the alluvium. In general these deposits are buried and where they are present at surface they are either found over very limited areas or their intricate inter-relationship with fluvial over-bank fine-grained deposits precludes their delimitation. Thus it can be expected that peat units exist within alluvium mapped within the lower reaches of the rivers Bourne, Avon (in the gorge north of Salisbury), Till, Nadder (above the confluence with the Wylye) and Ebble. Within the rivers Wylye, lower Nadder and the Lower Avon peat deposits are known from borehole data and small areas of reed and sedge vegetation delimit permanently wet ground within which peat is likely to be a major constituent of the substrate.

Details

Details of concealed peat deposits, where these are proven, are given in the section on alluvium.

SU14SE

Only one significant area of peat has been mapped in the district. At the Countess roundabout, on the A303 just north of Amesbury [SU 153 420], site investigation boreholes have proved over 2 m of peat in the floor of the Avon valley. These deposits are intercalated with coarse gravels, silts and clays (see Figure 74 above). Thin or small deposits of peat are common within the alluvium but are intercalated with the alluvium and are not mapped separately. A section demonstrating the relationships of the deposits in the valley is given in the relevant details in the alluvium section above.

8.10 Artificial ground.

The major occurrences of made, worked, infilled and landscaped ground are noted on the 1:10 000 scale maps within the district. Not all are transferred onto the published 1:50 000 scale Salisbury Sheet 298. Within urban areas the amount of artificial ground is often difficult to determine and its limits often masked by the built environment. Whilst most of the villages are on natural ground the larger urban areas (particularly within industrial estates, development parks and post-war housing estates) have suffered a large amount of landscaping and the degree of ‘cut and fill’ is often impossible to determine. The artificial ground shown on the maps within those areas is probably an underestimate.

Worked ground delimits areas where natural resources have been extracted. In this area Chalk is the most commonly extracted material for the manufacture of cement, as a filler and whitening agent and as an agricultural dressing. In the west the Portland and Purbeck groups are the source for architectural stone and extraction has occurred since Roman times. There are few sand and gravel workings perhaps reflecting the generally poorer quality of the aggregate locally. In the past most villages had a small brick and tile quarry to supply local needs. In this area the Gault Formation, the various lithologies within the Palaeogene and a number of the Quaternary deposits have been utilised in the past

Made ground is a term used to denote areas where additional material foreign to the site has been deposited above the natural ground surface. For the most part occurrences are related to road and rail embankments and archaeological sites (commonly identified by a symbol on the base maps). Modern road and rail developments are generally made up of ‘engineered fill’ designed to carry the loads expected and therefore considered to be more stable than that created by the excavations for archaeological earthworks and other features. Notable examples are the Boscombe Down runway that was built-up during the 1940’s and 50’s, the large area of made ground on which the Churchfields industrial estate is built in south Salisbury and the leisure facility south of Stratford sub Castle in the Avon valley.

Infilled ground is used to delimit areas where former sites of extraction have been utilised for landfill. The type of fill is often difficult to determine but sites are known to have been used for both household waste and inert fill.

9 HYDROGEOLOGY

The principal aquifer within the district is within the Chalk Group. Public water supplies are also won from the Upper Greensand Formation although this resource is more important to the west in the Wincanton and Shaftesbury areas. Local supplies are won from the Portland Group (and possibly the Purbeck Group) and to a lesser extent the Palaeogene and Quaternary strata. Although this latter source probably taps the underlying bedrock aquifers with which the deposits are in hydraulic continuity. Brief notes on the hydrogeology are given below but readers are recommended to the reports on minor aquifers (Jones et al., 2000) and major aquifers (Allen et al., 1997) that give valuable overviews of the water resources. Stream sinks are known at the margin of the Palaeogene strata and at the base of the Gault Formation

9.1 Chalk hydrogeology

The Chalk is a microporous limestone and water flow is generally along fissures and joints that can become enlarged due to solution. As a consequence of its nature the hydraulic properties of the Chalk are complex. There is a high storage potential in saturated chalk but its microporous character with pore throat sizes measured in microns, means that unfractured chalk has high porosities but low transmisivity rates and is therefore slow to release its resources. Indeed unbroken chalk does not normally drain under gravity. Its value as a water resource comes from its ability to release and transport water along bedding planes, joints and through macro and micro fractures which give the rock mass a high permeability (and provide much of its usable storage). The Chalk is often regarded therefore as a dual porosity aquifer.

Permeability is generally only developed towards the top of the Chalk through the unsaturated and into the top of the saturated chalk where fracturing and circulating groundwater is prevalent. With depth fracturing declines due to increased overburden, change in lithology and a general reduction in circulating groundwater. As circulating groundwater has a significant role in the enlargement of inherent fractures the base-level to which the aquifer drains locally becomes important in enhancing and maintaining flow.

Springs issuing from the chalk fall into two categories. Those related to overflow from the main water table and those resulting from major lithological changes in the rock mass intercepting water migrating through the aquifer. Springs resulting from lithological changes are found for example at the base of the Chalk where it overlies the Gault Formation or impermeable Upper Greensand (permeable Upper Greensand is in hydraulic continuity with the Chalk and the two aquifers act as a single resource); at the contact in the Grey Chalk Subgroup where the chalk becomes significantly more argillaceous (i.e. at the boundary between the West Melbury Marly Chalk and Zig Zag Chalk formations); at the top of the Plenus Marls Member below the fissured Melbourn Rock Member; and at other stratigraphical levels where marl seams, rock bands or continuous flint seams become locally important in the succession. Springs that occur on the dipslope of the Chalk are usually at valley bottom sites where the water table intersects the surface. During periods of low rainfall when the water table falls these springs successively dry up down the valley. They are reactivated again as water tables rise during wet periods hence their name as ‘winterbournes’ or simply ‘bournes’.

The hydrogeology of numerous of streams within the district (the Bourne River, Nine Mile River, River Till, Chitterne Brook) are dominated by groundwater flow from the Chalk. Hence the lithological properties of the Chalk and the geological structure will have an important influence on how the streams behave and the aquifer functions.

Each formation will have differing aquifer properties resulting from the lithological control on fracture style and spacing, the presence or absence of marl seams, and the frequency and style of flint bands. Marl seams, bedding planes, sheet flints and tabular flints are all horizons where downward percolation of water may be impeded. Dissolution occurs and conduits often form where flow is concentrated along these horizons. The strength of the chalk is also important. Fractures in very soft chalk are often sealed by remoulded chalk putty, and thus form aquitards or even aquicludes. Joints in harder, nodular chalks often remain open and thus solution cavities can develop more readily.

The Grey Chalk Subgroup (West Melbury Marly Chalk and Zig Zag Chalk formations) comprises alternating layers of clay rich marls and thin limestone bands. The limestone bands have more open vertical joint sets, which feed water to the interface with the underlying marl. These marl layers can give rise to perched water tables. The Cast Bed (at the base of the Zig Zag Chalk Formation) is also known to form a perched water table and associated spring lines in the Dover area (Mortimore 1993). In this district this horizon outcrops along the southern flank of the Vale of Wardour and in the headwaters of the River Wylye. In general, the Grey Chalk is far less permeable than the White Chalk Subgroup.

Similar perching of the water table and horizontal flow occurs at the base of the Holywell Nodular Chalk Formation at the base of the White Chalk Subgroup. Here the hard nodular Melbourn Rock Member and the overlying shelly nodular unit is extensively fractured by steeply inclined conjugate joints. The underlying clay rich Plenus Marls Member, which impedes vertical water movement, is not jointed but dissipate stress sub-horizontally, so opening fractures in the Melbourn Rock. Spring lines occur at this level throughout southern Britain and in this district, and have been exploited for water supply, for example at Holywell, near Eastbourne (Mortimore 1993), the type site of the Holywell Nodular Chalk Formation. The New Pit Chalk and the Newhaven Chalk also display well-developed conjugate joint sets, which often dissipate along marl seams. These marl seams are often the loci for dissolution as water flows down the joints until it meets a marl seam and is forced to flow horizontally. This is not so apparent where the marls are thin or absent over synsedimentary highs.

Like the Holywell Chalk, the Lewes Chalk is hard and nodular, but also has extensive large nodular and sheet flint seams. Joint sets tend to be relatively open steeply inclined conjugate sets. These joints are often solutionally enlarged, as they are more pervasive and are more likely to remain open than in the softer chalks. Small solution cavities are known to have developed along the sheet flints, for example in the upper Lewes Chalk at a quarry at Upper Woodford [SU 1235 3700].

Both the Seaford Chalk and the Culver Chalk formations are massively bedded soft to medium hard pure chalks with regular orthogonal joints. They are characterised by numerous large tabular and sheet flint horizons. Large conduits are known in the Seaford Chalk at Beachy Head (Waltham et al., 1997, Reeve, 1979) where flow is concentrated along a sheet flint and at Shoreham Cement works (Mortimore 1993) along faults and master joints. The Seven Sisters Flint is also known to exhibit solutional cavities on the Sussex coast and possibly does so in this district.

Details of yields and flows are held at BGS Wallingford and within the physical properties document Allen et al. (1997). Below are details of significant springs identified during the survey. Rivers and streams elsewhere across the district are maintained by runoff and base recharge where the groundwater surface intersects the valley floor deposits.

Details

ST93NE

Spring at Boyton Manor [ST 9542 3959] feeds a cold black pond and short stream that is culverted beneath the road to join [ST 9535 3968] the River Wylye downstream of Boyton Bridge. This spring must rise close to the West Melbury Marly Chalk and Zig Zag Chalk formational boundary.

Springs at Sherrington [ST 9588 3903 and 9612 3899] issue from within the Zig Zag Chalk Formation at about the level of the base of the so-called ‘White Bed’ of Jukes-Browne and Hill (1903).

ST93SE

Springs issue from the Lewes Nodular Chalk Formation at [ST 9685 3269] in Chilmark and again [ST9698 3257] further downstream adjacent to the Mere Fault but the water sinks into the streambed during dry spells (during the survey in October 2003) a short distance to the south [ST 9705 3248]. This stream resurges through the alluvium and at a spring [ST 9695 3185] emanating from the Purbeck Group at the northern end of the ‘Chilmark Ravine’

In Teffont Magna there is a complex hydrological situation with numerous springs, ‘spring heads’ and overflowing ‘wells’. A number of springs form a group around [ST 9856 3287] rising from the Lewes Nodular Chalk Formation north of one element of the Mere Fault. The stream is enhanced by additions from springs at [ST 9873 3275], near Fitz Farm House [ST 9877 3265] and in the vicinity of Moon

Cottage [ST 9882 3243] and Manor Farm [ST 9899 3245]. At these latter three sites water emanates from the West Melbury Marly Chalk Formation outcropping between the two elements of the Mere Fault but the water is likely here to reside within the Upper Greensand Formation that is in direct hydraulic contact. South of the Mere Fault the stream flow is further enhanced by a spring at [ST 9888 3236] emanating from the steeply northward dipping Upper Greensand Formation

SU04SE

Numerous springs occur over a 600 m stretch of the River Till just north of Winterbourne Stoke between Manor Farm (just north of the old A303) and [SU 0810 4159]. Here water can be seen issuing from very coarse poorly sorted flint gravel at many places. Some springs are small trickles, but some issue a significant amount of water. The water is probably associated with the top of the Lewes Nodular Chalk Formation that occurs at or just below rock-head in the valley floor. This is a classic location for karstic development. In summer, these springs may form the perennial head of the stream, but in very dry periods this stretch of the river is dry and water does not emerge until further down the valley. A pair of other minor springs occurs further down valley in the reach just south of Winterbourne Stoke church.

SU03NE

The perennial head of the River Till is at Berwick St James. Here the dry streambed enters the sheet area south of a marked spring at [SU 0775 3964] (not active during the survey in October 2003). Springs providing a constant flow occur widely in the water meadows north of Duck Street [SU 074 395]. Southward the river flows over a widening floodplain to its confluence with the River Wylye near Stapleford.

SU03SW

There are very few springs emerging from the Chalk on this sheet. The biggest spring occurs just to the north of Baverstock adjacent to Manor Farm. Here water emerges from coarse gravel at the side of the lane at [SU 0296 3257] close to the line of the Mere Fault where it is cut by another minor fault. This fails in dry weather and water rises further down valley at [SU 0245 3173].

SU13NE

The perennial springhead of the River Bourne is to the north of Idmiston at [SU 1961 3777]. Further upstream springs were noted at [SU 1951 3800 and 1969 3821]. They were seem to be flowing in September and November respectively in 1999 during the survey of that district.

9.2 Minor aquifers

9.2.1 Jurassic strata

The Portland Group and to a lesser extent the Purbeck Group are significant minor aquifers outside the district and indeed the Portland Limestone is a major aquifer in Dorset.

In this district the Purbeck Group (Lulworth and Durlston Formations) is a poor aquifer because of its generally more argillaceous nature with interbedded shales, limestones, sandstones and evaporitic beds. The limestones are fissured and their water resources are limited, not least because of their small outcrop area. To the east, at the closure of the Vale of Wardour, the Purbeck Group (and underlying Portland Group) is probably in hydraulic continuity with the thin Wealden and Lower Greensand strata (both of which are poor aquifers providing poor quality water) and can be regarded here as a single low yield concealed aquifer. Boreholes have not tested the extension of this group of strata towards the east, beneath the Gault Clay Formation.

The principal water bearing lithology in the Portland Group is limestone with minor calcareous sands in the Wardour Formation at the base. The limestones tend to be cemented and intergranular permeabilities are low. Water movement is through fractures that have been enlarged by solution. High yields can be obtained where these openings are closely interconnected. In this district their limited surface outcrop and highly fissured and fractured nature (compartmentalising the aquifer) make the aquifer vulnerable to fluctuations in water table and contamination. In general the deeply incised valleys mean that unless wells penetrate the whole thickness of the limestones down to the Kimmeridge Clay Formation they are prone to seasonal drying. Because of their fissure flow characteristics the limestones tend to have high transmissivities (particularly where the aquifer is karstic) but low storage coefficients and excessive abstraction can affect surface water flows. The yields from springs issuing from the group are highly variable. Water quality information is sparse for this aquifer throughout southern England but is generally hard to very hard with high concentrations of $CaCO_3$.

Details

ST93SE

The stream which issues in the Chalk at Chilmark and sinks into the streambed soon after resurges through the alluvium and at a spring [ST 9695 3185] emanating from the Purbeck Group at the northern end of the 'Chilmark Ravine'. The stream is seasonal reflecting the fluctuation in the water table.

9.2.2. Wealden Group and Lower Greensand Group

Wealden and Lower Greensand strata (both of which are poor aquifers providing poor quality water) and can be regarded here as a single low yield concealed aquifer. There are numerous small springs and sinks associated with the Gault/ Lower Greensand and Lower Greensand, Wealden/ Purbeck contacts around the Vale of Wardour. The most notable are listed below.

ST93SE

A sink [ST 9550 3179] into Lower Greensand in the valley near Ridge terminates a small stream that starts in land drains 200 m to the west. Further east north of Teffont Evias two stream sinks [ST 9927 3178 and 9943 3158] in the top of the Lower Greensand Group take the water from very small surface water streams running over the Gault Formation.

ST92NE

There are numerous stream sinks into the Lower Greensand Group at [ST 9504 2778, 9575 2833, 9633 2899 and 9657 2900] these all terminate small catchment streams on the Gault Formation to the south.

Elsewhere springs at the base of the Gault Formation sink into the top of the Purbeck Group after travelling over a narrow outcrop of the Lower Greensand. An issue at [ST 9675 2891] sinks at [ST 9678 2904] and a spring at [ST 9723 2905] sinks at [ST 9726 2919].

A spring at [ST 9764 2964] rises at the Lower Greensand/Purbeck contact and sinks at [ST 9774 2957] within the Durlston Formation of the Purbeck Group. A small dry valley northeastward from this sink, contains a small doline at [ST 9783 2964] and leads to a resurgence at [ST 9796 2964] close to the main Nadder stream.

SU03SW

There is a small sink [SU 0005 3113] in the top of the Purbeck Group for a stream that traverses the Lower Greensand and Wealden strata. A similar short stream sinks at [SU 0052 3092].

9.2.3 Upper Greensand

The Upper Greensand Formation is an important minor aquifer in southern England. In this district the formation comprises three members all sandy in nature. It is often found in hydraulic continuity with the overlying Chalk aquifer and when this occurs they are usually considered together as a single aquifer unit. However where the formation is at outcrop, such as in the Vale of Wardour (and just outside the district in the upper Wylye valley) the formation is an aquifer in its own right. The Gault Clay Formation below acts as an aquiclude.

The formation is highly permeable (intergranular flow predominates), consisting of alternating sands and sandstone with a little chert usually concentrated in this district in the Boyne Hollow Chert Member. Where the degree of cementation is high fracture flow can become important. Towards the west in the Shaftesbury district the formation is the principal aquifer. One of the seven major public water supply wells is in Berwick St. John [ST 9415 2182] just to the southwest of the district. Springs are commonly used for abstraction and issue from various horizons within the formation, depending on local topography and hydrogeology, and at the junction with the underlying Gault Clay Formation. Yields of up to 85 m^3 per day are common for small springs and wells and they characteristically continue to flow even during extended dry periods. This perhaps the result of tapping into the larger resources within the overlying Chalk.

ST93SE

A very hummocky field near Ridge [ST 9551 3193] has a number of springs or seepages at the base of the Cann Sand Member of the Upper Greensand.

ST92NE

Several major springs occur at the base of and within the Upper Greensand Formation. This contact is often marked with many springs and flushes and can be used a reliable mapping guide. Groundwater discharge seems to be concentrated in three places; Swallowcliffe, Ansty and Sutton Mandeville. At Ansty water emerges from springs in the pond just north of Ansty Church [ST 9565 2636]. A spring further up valley just south of the A30 at [ST 9572 2585] was dry at the time of survey (September 2003).

At Swallowcliffe, three springs occur close to the base of the Cann Sand at [ST 9655 2713], which give rise to a moderate stream.

Around Sutton Mandeville, the largest spring is just north west of the village at [ST 9840 2895]. Here a small stream emerges from several points at the base of a two-metre section of Upper Greensand (Plate 43). Another group of springs occur in a ravine 200 m to the east at Hardings Corner [ST 9861 2892] with another small spring occurring [ST 9898 2900].

Spring at the base of the Upper Greensand, Sutton Mandeville. [ST 9840 2895]

Photo A R Farrant.

Plate: 43

SU03SE

Major springs occur at the Heath Farm Mobile Home Park [SU 0554 3025] with a total flow of about 1 l/s in August 2003. There is also a related small spring (c 0.1 l/s) [SU 0568 3051] further down the spring stream to the northeast. These springs are coming from the Upper Greensand Formation/West Melbury Marly Chalk Formation contact. This site is unusual in the context of the expected hydrogeology of the area and is probably related to the northward dip and proximity to the Mere Fault Zone with Upper Greensand waters coming against the impermeable West Melbury Marly Chalk as they flow down-dip to the north.

SU02NW

Springs [SU 0063 2817] emanating from the Boyne Hollow Chert Member of the Upper Greensand Formation feed a lake near West Farm, Fovant. The stream flows weakly through Fovant to the top of the Gault Formation where it has its flow enhance by two further springs at [SU 0022 2897 and 0013 2902].

9.2.3 Palaeogene

SU12NE

A strong spring emanates from the base of the Wittering Formation southwest of Alderbury at [SU1828 2717]. A pond overflow [SU1819 2781] at Hole Farm north of Alderbury, fed by a spring emanating from the base of the Wittering Formation, maintains a small stream flowing over the London Clay Formation.

SU22NW

Springs and spring-fed ponds at the base of the Reading Formation at [SU 2115 2932, 2073 2923, 2052 2891 and 2025 2798] feed the headwaters of the River Dun.

9.2.4 Quaternary

Shallow wells intercept the water table along most of the river valleys. They take water from the sub alluvial gravels that for the greater part are in hydraulic continuity with the underlying bedrock (principally Chalk in this district). Yields normally reflect those of the underlying bedrock but the shallow wells are prone to surface contamination and the majority are no longer used for supply.

9.3 Karstic solution features

Solution features are widespread within the Chalk of the Hampshire Basin. Densities of over 100 per km^2 have been reported in parts of Dorset (Sperling et al., 1977), but more typically densities of between 10 and 50 per km^2 occur across Hampshire. Their location is unpredictable, but by assessing the geology and geomorphic setting, it is possible to highlight areas with greater potential for solution features.

A wide variety of solution features occur but only two, ‘buried’ and ‘subsidence’ sinkholes are common on the Chalk. The term sinkhole is interchangeable with the term doline, and can also be applied to surface features where a stream wholly or partially disappears underground. Buried sinkholes (as defined by Culshaw and Waltham, 1987) are typified by ‘pipe’ or cone-like cavities within the chalk (Plates 44 and 45), infilled by the overlying deposits that have subsided into the cavity as a result of dissolution. Most are circular or oval in plan and can be many metres deep, often bifurcating into several smaller ‘pipes’ at depth. They often have *no surface expression* and are commonly infilled with flinty gravelly clay derived from the superficial cover, usually clay-with-flints.

Subsidence sinkholes are closed surface depressions, usually either bowl, pipe or cone-like in shape. They can occur as isolated examples or as groups, often coalescing into large composite dolines. They can form rapidly as a dropout failure following the washing out of pre-existing infilled pipes. Most occur in covers of unconsolidated sediment between 1-10 m thick, such as the clay-with-flints and older head.

The presence of these solution features is dependent on several variables including rock lithology, fracture style, geomorphic setting, geological structure and even anthropomorphic factors. The wide variety in chalk lithology (discussed above), fracture style, geological structure, flint content, porosity and fissure permeability significantly affects the style and degree of karst weathering, both at surface and underground.

Plate 44. Typical solution feature shown in cross-section within the Quidhampton Quarry [SU 1140 3151. Photo P 598768

Plate 45. Sediment-filled solution feature, Britford Quarry, [SU 15113 28054]. Photo P 584721.

However, the main control on near surface solution features is the geomorphic setting and the presence/absence of an impermeable cover. An area of impermeable strata either adjacent or overlying the Chalk serves to concentrate recharge and hence dissolution at the contact between the two rock types. The highest density of sinkholes occurs around the margin of the overlying Palaeogene strata or around the clay-with-flints outcrop. Topography and drainage patterns affect the distribution of solution features. Dissolution is enhanced where underground drainage routes are concentrated such as along valley floors and at spring lines. Typically the chalk is far more weathered under valley floors than under interfluves. Topography also influences whether drainage from the Palaeogene outcrop flows onto or away from the chalk and thus influences the location of water recharge via stream sinks.

An understanding of the geomorphic evolution of an area is vital to identify potential areas of karst development that have little no surface expression today. This is especially the case for karst features formed under differing climatic conditions or relict karst formed prior to present topography. Where the present land surface is close to the sub-Palaeogene peneplane, solution features inherited from the former Palaeogene cover may still exist. For example, solution pipes may still exist below ground level in areas where a former clay-with flint or Palaeogene cover has now been eroded. Elsewhere, erosion and dissection has removed these relict solution features.

Karstic features are also known in the Purbeck strata in the Vale of Wardour, both in the Salisbury district and to the west on the Wincanton sheet. Many stream sinks have been noted around Tisbury and Sutton Mandeville, (Sparrow, 1975, 1976; and Clark and Waters, 2002), as well as a few small phreatic caves and resurgences. None of these have been traced to any resurgence (see above for details of sinks and resurgences observed during the survey).

9.4 Distribution of Solution Features

The distribution of *observed* solution features is shown on the 1:10 000 scale geological maps and on a small scale Figure 78 below. Many sinkholes have been ploughed in or landscaped so the distribution of solution features marked on the updated geological maps is certain to be an underestimate of the true density. Others have been worked as chalk pits and some ‘dolines’ may simply be small, degraded marl pits. Furthermore, many solution features such as the infilled ‘pipes’ often have no surface expression and cannot be identified by surface mapping.

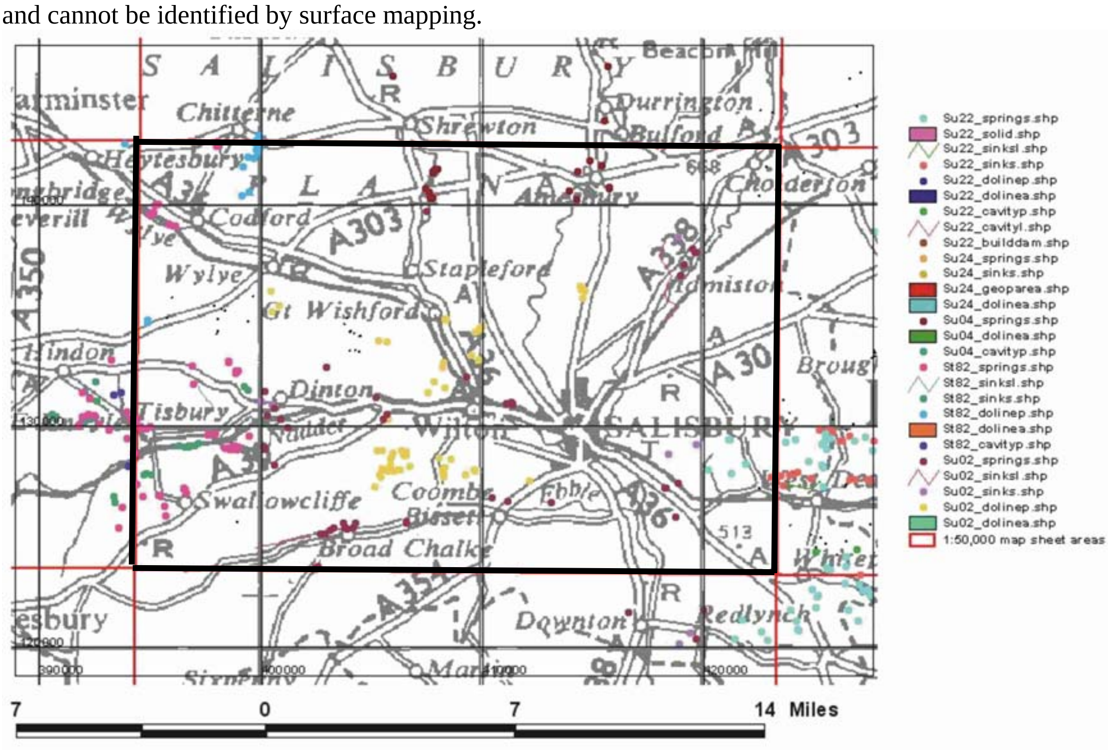


Figure 77 Distribution of solution features, Dolines and sinks on the Salisbury and adjacent areas

The Chalk outcrop with the highest density of solution features is in the extreme south of the district, close to the Palaeogene outcrop, and through the central part of the district around the extensive clay-with-flints cover of the Great Ridge. Many of the dolines here have been landscaped or worked as pits. Some minor stream sinks occur along the margin of the overlying Palaeogene strata, but these are only intermittently active during wet weather. Areas of clay-with-flints exhibit high densities of solution features, notably the crest of Great Ridge, on the interfluve between the Lower Avon and the River Wylye, north of the Palaeogene outcrop east of Salisbury and on the interfluves to the north and south of the River Ebble. Here the present land surface is close to the sub-Palaeogene peneplane and both recent active and relict solution hollows derived from a former Palaeogene cover occur. Other outcrops of clay-with-flints are associated with dolines but elsewhere, the land surface has undergone greater dissection and these relict solution hollows have been eroded.

Minor solution features occur widely throughout the area, especially where there is a thin superficial cover, although many of these are likely to have been ploughed in and obliterated or worked as pits.
Solution features ('bourne holes') can be expected to occur along the middle and upper reaches of the Bourne, Till and Chitterne Brook where significant recharge into the aquifer occurs. These may act as either sinks or springs depending on relative groundwater levels.

Details

ST92NW

Several stream sinks are developed at the contact between the Gault or Lower Greensand and the Durlston Formation (Upper Purbeck Beds) around Totterdale Farm. Three sinks occur, one on sheet SU92NE and two at [ST 9484 2780] and [ST 9476 2778]. The resurgence for these is unknown, but probably lies in the Nadder valley to the north.

ST 92NE

Several stream sinks are developed at the contact between the Lower Greensand and the Durlston Formation (Upper Purbeck Beds). Five well-developed stream sinks can be seen west of Upper Chicksgrove at [ST 9715 2918, 9677 2903, 9658 2900, 9635 2903]. The latter in particular is a very well developed blind valley 6m deep and 40m wide. The resurgence for these is not known, but a small spring emerges from the Durlston Formation on the banks of the River Nadder a kilometre to the northeast at [ST 9796 2963]. Although it is unlikely a major cave system exists here, groundwater flow is likely to be karstic. Another set of stream sinks occurs around Totterdale Farm. Three sinks occur, again at the contact between the Lower Greensand and the Durlston Formation at [ST 9504 2727], and two on the adjacent sheet ST92NW.

ST93SE

Two stream sinks are developed at the contact between the Lower Greensand and the Durlston Formation (Upper Purbeck Beds) in The Park, just east of Teffont Evias, at [ST 9942 3156, 9927 3173]. Both were dry at the time of survey, but probably take a significant amount of water in winter. The resurgence is unknown but is probably a small spring 1.5 km to the southeast at [SU 0058 3075].

SU03SW

Many shallow closed depressions were noted on the clay-with-flints covered ridge around Grovely Lodge [SU 0450 3400], and 0.5 km further south around Grovely Farm. Most are between 20 and 50 m across and 1-2 m deep, and either within the clay-with-flints or in areas with much clay-with-flints type soil. However, it is not clear whether these are true dolines or marling pits for liming field or old brick clay pits, although there is no evidence for old brickworks.

Two stream sinks are developed at the contact between the Wealden Group and the Durlston Formation (Upper Purbeck Beds) southwest of Dinton at [SU 0005 3111] and [SU 0051 3092]. Both were dry at the time of survey (September 2003). The resurgence is unknown but is probably a small spring on the banks of the River Nadder to the southeast at [SU 0058 3075].

SU02NE

A series of hollows thought to be associated with solution features in the Chalk are present in the head gravel and to a lesser extent the clay-with-flints. These features mostly for in the edge of the deposit, but they also occur in the adjoining Seaford Chalk.

SU22NW

Stream sink within London Clay Formation at [SU 2140 2800] in a minor valley bottom perhaps indicates continuity with the underlying Reading Formation.

10 REVIEW OF SOIL TYPES

This review is based on the 1:250 000 scale Soils of England and Wales Sheet 5 (South West England) published by the Soil Survey of England and Wales and the compendium volume, Bulletin No. 14 'Soils and their use in South West England', (Findley, Colborne, Cope, Harrod, Hogan and Staines, 1984). The soils of 1:25 000 scale sheet SU03 (Wilton) are dealt with in more detail in the explanatory booklet, Soil Survey Record No. 32, Soils in Wiltshire 1 Sheet SU03 (Wilton), (Cope, 1976).

Within the district there are 22 Soil Associations whose major constituents and geological derivation are described below. Each Soil Association is closely associated with a number of ancillary subgroups and soil series. Full descriptions and representative soil profiles, which define each of the soil series, are published in numerous publications of the Soil Survey. The reference is given in brackets after each entry.

10.1 341 Icknield Association (full description in Cope, 1976, p. 61)

Shallow, mostly humose, well drained, calcareous soils over chalk on steep slopes and hill tops. Deeper flinty, calcareous, silty soils exist within small coombes and valleys. Predominantly found on broad spur tops and dip slopes underlain by the White Chalk Subgroup around Porton, in the southeast, and over the highest ground on Great Ridge, north of the Wylye and on the interfluves of the Ebble. There is a close association with Andover, Upton, Coombe and Millington soils.

10.2 342a Upton 1 Association (full description in Cope, 1976, p.76)

Shallow, well drained, calcareous, silty soils over chalk. Mainly on moderately steep, sometimes very steep land. Deeper fine silty calcareous soils exist within coombes and dry valleys. Most commonly found on valley sides within the major streams Avon, Wylye, Nadder and Ebble and on the crest and slope around Figsbury ring south of Porton. Predominantly on the lower part of the White Chalk Subgroup but also found on the limestones of the Portland and Purbeck groups. Close association with Andover, Icknield, Panholes and Coombe soils.

10.3 342b Upton 2 Association (see above)

Shallow well drained calcareous, silty soils over argillaceous chalk. In places the association comprises deeper well-drained, calcareous, clayey soils. Confined to the extreme southwest of the district on steep valley slopes at the head of the Ebble Valley on the lower part of the White Chalk Subgroup and the Grey Chalk Subgroup. Close association with Wantage and Blewbury soils.

10.4 343h Andover 1 Association (full description in Cope, 1976, p. 68)

Shallow, well drained, calcareous, silty soils over chalk, on slopes and crests. Deep calcareous and non-calcareous, fine, silty soils also occur in valley bottoms. Rainfall readily absorbed with little run-off and can suffer from drought particularly on the harder Holywell Nodular Chalk and Lewes Nodular Chalk formations. Striped soils patterns locally. Thin soils, generally developed on bedded chalks with flints. Association covers much of the dip slopes of the White Chalk Subgroup. Close associations with Panhole, Coombe, Upton and Charity soils.

10.5 343i Andover 2 Association (see above)

Shallow, well drained, calcareous, silty soils over chalk. Associated with deeper non-calcareous, variably flinty, well drained, fine silty, and fine silty over clayey soils. Rainfall readily absorbed. Generally associated with the White Chalk Subgroup and particularly the flinty Lewes Nodular Chalk and Seaford Chalk Formations. Often contains little chalk debris and very flinty on the Seaford Chalk. Close associations with Garston, Carstens and Charity soils.

10.6 411a Evesham 1 Association (full description by Findley et al., 1984 and Palmer, 1982 p. 138)

Variably thick and wet depending on the nature of the underlying Jurassic clays and shales with limestone seams, calcareous clay with minor limestone clasts. Soils slowly permeable and seasonally waterlogged. Generally associated with the Lower Cretaceous and Purbeck Group strata in the Vale of Wardour. Close association with the Haselor, Moreton, Sherbourne and Wickham soils

Plate 46. Mill Farm, South Newton, Salisbury. Typical soils on Seaford Chalk. Gradual increase in soil depth and flint content down slope. [SU0900 3420].

10.7 511d Blewbury Association (full description in Findley et al., 1984, p. 382)

Shallow, well drained, calcareous, clayey, and fine silty over clayey soils, over argillaceous chalk. Some fine silty over clayey soils with slowly permeable subsoils and slight seasonal waterlogging. Shallow soils closely associated with the West Melbury Marly Chalk and the more argillaceous basal part of the Zig Zag Chalk formations. Close association with Winterbourne, Yatesbury and Wantage soils.

10.8 511f Coombe 1 Association (full description in Findley et al., 1984, p. 385)

Shallow to deep, well drained, calcareous, fine silty soils, deep in valley bottoms. The soil is shallow on chalk on valley sides in places. Slight risk of water erosion on steeper slopes. Can suffer occasional damaging floods and prolonged waterlogging by groundwater. Developed on gravelly head and head within the upper reaches of the Bourne and Nine Mile river valleys, and flanking the alluvium on terrace and gravel-rich head in the Wylye, Till, Lower Bourne and Avon river valleys. Close association with Panhole, Millington, Andover and Charity soils.

10.9 541B Bearsted 2 Association (full description in Fordham and Green, 1980, p. 69)

Deep, well-drained, coarse loamy and sandy soils over sand or sandstone, in places ferruginous. Some permeable coarse and fine loamy soils affected by groundwater. There is a distinct risk of water erosion and gullying during heavy rainfall. Deep soils closely associated with the lower part of the Upper Greensand Formation around the Vale of Wardour. Close associations with Lupitt and Shirrell Heath soils.

10.10 571g Fyfield 4 Association (full description in Jarvis et al., 1984 p. 379)

Deep, well-drained, coarse loamy, typical argillic brown earths that pass down into sand or sandstone. In this district closely associated with the sandy Reading Formation in the southeast of the district Close associations with Standhill, Burseldon and Frilford soils.

10.11 571h Ardington Association (full description in Findley et al., 1984, p. 380)

Deep, well-drained, fine and coarse loamy, glauconitic soils. Generally permeable and naturally well drained. Some valley bottom soils can be affected by groundwater. Locally perennially wet. Closely associated with the valley bottom around Bower Chalke in the headwaters of the Ebble valley. Close associations with Urchfont and Coate soils.

10.11 571j Frilsham Association (full description in Jarvis et al., 1984 p. 378)

Deep, permeable and well-drained, slightly stony sandy clay loam or clay loam soils over blocky stony clay loam. Found in the extreme southeast associated with the thin sandy Reading Formation above a chalk substrate. Close association with Rudham, Soham, Andover and Weasenham soils.

10.13 571m Charity 2 Association (see above)

Deep, well-drained, flinty, fine silty soils in valley bottoms. Calcareous fine silty soils over chalk or chalk rubble on valley sides, sometimes shallow. Derived from chalky head and gravel-rich head in the narrow valleys of the Dun and Ebble. Close association with Garston, Coombe, Panholes and Andover soils.

10.14 571w Hucklesbrook Association (full description in Jarvis et al., 1984, p. 382)

Mainly well-drained, non-calcareous, moderately stony, coarse loamy and sandy soils on river terraces adjacent to and slightly above floodplains. In this district mainly associated with the terraces of the Lower Nadder and River Avon below the confluence. Closely associated with Maplestead soils.

10.15 572h Oxpasture Association (full description in Palmer, 1982, p. 145)

Dark brown slightly mottled and stony clay loam and silty clay loam soils over stoneless yellow clay. In this district found on the steep valley sides of the Avon to the west of Alderbury and founded on the lower part of the London Clay Formation and the Reading Formation. The soils have a slow permeability and can become seasonally waterlogged. Closely associated with the Burlesdon, Wickham and Holdenby soils.

10.16 572j Bursledon Association (full description Jarvis et al., 1984, p. 374)

Soils generally dark greyish brown, very slightly stony clay loam or sandy loam soils. They are slowly permeable and liable to seasonal waterlogging. Found in the Alderbury area where they are associated with the London Clay and Wittering formations, Closely associated with the Curdridge, Kings Newton and Oxpasture soils.

10.17 581d Carstens Association (full description in Jarvis et al., 1979, p. 215)

Deep, well-drained, fine silty over clayey, clayey and fine silty soils, often very flinty. Generally with reddish clayey subsoils and with good vertical drainage into the underlying chalk. Relatively deep soils closely associated with the clay-with-flints, and the older head and gravelly head derived from it. In the extreme southeast of the district outside the catchment it is associated with thin Tertiary cover and the derived drifts from it. In these circumstances the soils contain significant well-rounded, chatter marked 'Tertiary' flints. Close association with Givendale, Winchester, Porton, Garston and Wallop soils.

10.18 641b Sollom 2 Association (full description in Findley et al., 1984)

These soils have a close correlation to the Wittering Formation within the Alderbury – Mottisfont Syncline around Alderbury itself. They are deep, acidic sandy gley-podzols soils. They are frequently waterlogged but can dry severely during extended dry periods, making these soils of limited value and hence they are often wooded. Closely associated with Leziate, Shirrel Heath and Isleham soils.

10.19 711f Wickham 2 Association (full description in Jarvis et al., 1984, p. 297)

These soils have a close association with the Gault and Kimmeridge Clay formations in the Vale of Wardour. Here they are heavy fine loamy soils over clayey subsoils and are typically stagnogleys. The shallow slopes typical of these deposits and the slowly permeable subsoils give rise to seasonal waterlogging. Closely associated with Denchworth, Oxpasture and Evesham soils.

10.20 711h Wickham 4 Association (full description in Jarvis et al., 1984, p 297)

These soils are based on Palaeogene clays with a thin cover of superficial material such that they are mapped as bedrock at outcrop. In this district the soil forms on the extensive London Clay Formation at outcrop within the Alderbury – Mottisfont Syncline. It comprises fine loamy or fine silty soils over colour mottled clay subsoil and is seasonally waterlogged because of the low permeability of the substrate. Closely associated with Denchworth and Windsor soils.

10.21 812a Frome Association (full description in Findley et al., 1984, p. 391)

Shallow, calcareous and non-calcareous, loamy soils over flint gravel affected by groundwater. The association includes small areas of peat. Seasonal flooding is common. These are essentially the alluvial soils associated with the lower reaches of all of the major rivers (with the exception of the upper part of the River Nadder, see Fladbury association below) where perennial flow is evident and in the seasonally wet stretches above the perennial springs. Close association with the Racton, Wylye and Gade soils.

10.22 813b Fladbury 1 Association (full description in Jarvis et al., 1984, p 157)

These are deep clayey alluvial soils commonly associated with rivers that drain Jurassic areas. The soils tend to be dark greyish brown, stoneless clay soils over prominently mottled pelo-alluvial gley subsoils. Soils are slowly permeable and there is seasonal flooding from both groundwater and runoff sources. Closely associated with Thame and Wyre soils.

11 ECONOMIC GEOLOGY

11.1 Building Stone

11.1.1. Jurassic Strata

Many buildings use stone imported from the Upper Jurassic succession in the Vale of Wardour, west of Salisbury. Here the Wardour or Tisbury Stone and the Chilmark Stone have been quarried widely around Tisbury, Wockley, Chicksgrove, Chilmark and Teffont and mined in extensive galleries, chiefly from quarries in the Chilmark Ravine. Traditionally the lower part of the Portland Group, the Wardour Formation herein, is the major source of freestone that comprise generally variably glauconitic and calcareous sandstones and sandy limestones. The principal beds quarried have the local workman names of the Trough Bed, the Green Bed, the Pinney Bed and the Fretting Bed. The freestone has been used locally and exported for the construction of many buildings including the cathedrals at Salisbury, Rochester and Chichester and in other notable buildings such as “Wardour Castle, Longford Castle, Fonthill Abbey, Wilton Abbey, Romsey Abbey, Westminster Abbey (the Chapter House), Christchurch Priory, Balliol College Oxford” (Reid, 1903), and many more. The upper part of the group, the Chilmark Formation provides oolitic freestone (the Chilmark Stone) that has been used in the construction of the west front of Salisbury Cathedral.

In the early 1990s the Dean and Chapter of Salisbury Cathedral requested a geological survey and descriptions of the Portland Group in the Vale of Wardour specifically to identify stone for the restoration project on the cathedral. These reports Bristow and Lott (1994, 1995, 1996) and Bristow (1995) contain detail of the thickness and distribution of the beds (see Jurassic section) and their mineralogy, grain-size, cementation and porosity/permeability that greatly affect the durability of the stone.

11.1.2 Upper Greensand

Reid (1903) states “ the stone has been quarried in many places for building material and was formerly in much request”. Evidence of degraded workings are frequently found throughout the outcrop of the Shaftesbury Sandstone and Boyne Hollow Chert members of the formation but little now remains of this former industry other than the many houses built from the stone locally. It was much prized, as it was not susceptible to frost once ‘hardened’ (weathered) and withstood immersion making it a valuable stone for the building of foundations and copings.

The UGS pit at Upper Hurdcott Farm [SU 0503 2997] is still active producing a small amount of soft sandstone for the restoration of local buildings.

11.1.3 Chalk

Extensive use is made of the flints from the Chalk for building, particularly in churches and the larger houses and farms. The flint is used both as knapped squared blocks and as single-faced trimmed nodules. Flint shards derived from the knapping of dressed flint are often seen pressed into the wet mortar for decoration, a process known a ‘galletting’. Flint, as a 'waste' product of chalk extraction and from 'field picking', has also been used to maintain farm tracks.

The harder chalks from the Melbourn Rock Member and the Lewes Nodular Chalk Formation are incorporated into buildings to a small extent in this area. Their source is unknown but both dressed blocks (suggesting some form of quarrying) and ‘field picked’ clasts are seen in older buildings.

A loosely bound mixture of chalk rubble, mud and straw has been used traditionally in the construction of the older cottages and garden walls in villages in the district (Osborne White, 1912, p. 81). Such walls (cob walls) are very susceptible to damage by the weather and so have to be sheltered by thatch or tile roofs and a surface rendering.

11.2 Bulk Minerals

Bulk mineral extraction is confined to three deposits in this district: the Chalk and limestone, sand and gravel, and brick clay. Extraction of all three is now limited with the only major extraction site being for chalk at Quidhampton (other major quarries e.g. at Harnham, closed in the 1980s with the industries move into larger scale cement manufacture).

11.2.1 Chalk and Limestone

Apart from the uses of the freestone derived from the Portland Group the limestones and calcareous shales of the Jurassic strata in the Vale of Wardour (Portland and predominantly the Purbeck groups) were used locally for the production of lime mortars and cements. There are numerous sites where kilns are noted on both historical and current Ordnance Survey maps but the industry has long been abandoned and the sites are degraded and in many cases the original kilns removed.

The cement industry was based around the three major pits at East and West Harnham and Quidhampton. Only the latter is still working and here the high purity chalk from the middle and upper parts of the Seaford Chalk Formation are now extracted for the production of fillers, whiting and for refractory end uses. Flints are a by-product of the extraction and are used locally to restore buildings or to add architectural features to new buildings.

Many small, disused chalk pits are found throughout the district but are particularly common in the east, where within local living memory the chalk was used to ‘marl’ the heavier clay soils. Most are close to or in areas of clay-with-flints or with Palaeogene cover. Many of these small pits were probably originally small dolines. The majority have now been infilled with domestic waste, overgrown or ploughed in.

Elsewhere in the district the chalk is only won on a local and ‘at need’ basis as hardcore.

Flint mines are known in an area of Porton Down that perhaps attest to the winning of flints by our ancient cousins, but there is also evidence that these same areas were a centre for the production of gunflints.

11.2.2 Sand and Gravel

There is no large-scale extraction of aggregate from any of the deposits within the district. Resources exist within the Upper Greensand (sand), Reading Formation (sand), Wittering Formation (sand) and within the various Quaternary deposits (sand and gravel) but they are either not exploited or only on a local scale to support farms. Their grade and potential as a source of aggregate has not been tested.

Several small gravel pits occur in the Avon valley to the west of Amesbury, but none are active. There are former workings for sand and gravel (won from gravelly sub-alluvial and terrace deposits) within the Wylye valley near Langford [SU 040 370] (now a nature reserve) and at Croucheston [SU 066 256] in the river Ebble. There are numerous small sites elsewhere within the floodplains of the principal river valleys.

11.2.3 Brick Clays

The London Clay and Reading formations in the southeast of the district and the Gault Clay in the Vale of Wardour were used for brick making and further afield outside the district the Kimmeridge Clay Formation is still used as a resource.

Reid (1903) describes a brickyard in the Gault Formation at Ridge [ST 9526 3173] and the formation was formerly used for the production of tiles and bricks at Dinton [SU 018 318].

There are numerous old clay pits within the Palaeogene strata in the Alderbury – Mottisfont Syncline to the southeast of the district. Here the clayey units in the Reading and London Clay formations were exploited for the manufacture of both brick and tile. Old clay pits within the London Clay occur near Brick Kiln Copse [SU 186 288] on the Clarendon Estate.

Within the Quaternary the clay-with-flints, and alluvial clays have been worked on a small scale but the largest industry locally was based on the 'brickearth' around Fisherton. This industry effectively finished in 1900 but was declining before that as reserves became exhausted and the expansion of Salisbury encroached over the remaining deposits.

11.3 Geological Hazards

The following statements should be taken only as a guide to likely or possible problems and should not replace site-specific studies.

The Chalk is locally affected by solution phenomena and as a consequence, fractures naturally occurring in the Chalk are enlarged and a very irregular rockhead is created. Solution can result in the formation of small surface depressions (dolines) that range in size up to some 50 m across, and up to 4 m to 6 m deep. These generally overlie pipes filled with Palaeogene materials, clay-with-flints, or in some places, head. Such depressions continue to act as sumps for surface drainage, and may be liable to further subsidence. Differential compaction under load can occur across such structures. Either phenomenon can create difficulties during or following construction. Dissolution phenomena are also present in the Purbeck strata in the Vale of Wardour. Stream sinks and dolines may be locally present.

Map users should be aware that thin deposits of head are much more widespread than indicated by the geological map. In particular, large parts of the White Chalk outcrop, which are shown with no overlying superficial deposit, do actually carry a thin and extensive, but discontinuous, blanket of head. Head, especially where clay-rich, can contain gently dipping shear planes that can fail when loaded.

Planning for future construction should allow for the possible existence of small areas of Made, Infilled or Landscaped Ground. Such areas might be liable to differential settlement.

Peat is a compressible material and will compact when loaded or give rise to differential settlement when partially built over. Care should be taken to identify peat units within the major floodplains where they have not been delimited by surface mapping.

Excavations within units comprising sand are liable to failure if unsupported particularly where groundwater is present.

Areas of landfill or in older areas of made ground may be subject to differential compaction. Frequently the nature of the fill is unknown. In the case of landfill sites the presence of gas derived from the breakdown of the buried wastes may form a problem.

Areas of landslipped ground are not common on the Salisbury sheet. Minor areas (not shown on the published map, but identified on the larger scale survey maps) exist on the Palaeogene deposits around the Alderbury – Mottisfont syncline and associated with the steep scarp slopes adjacent to the major valleys, for example along the face of the Upper Greensand Formation scarp associated with the Mere Fault. In most cases the area of slip is obvious from the disruption of the surface sediments.

Plate 47. Landslipped terrain of Lambeth Group and London Clay, near Alderbury, [SU 18110 27060]. PhotoP584728.

12 SOURCES OF INFORMATION

1:10 000 field slips:

1:10K tile	Name	Geologist	Date	1:10K tile	Name	Geologist	Date
ST94SW	Heytesbury	CRB/ ARF	1993/ 2004	SU02NE	Bishopstone	RJM	2003
ST93NW	Great Ridge	CRB/ PMH	1993/ 2003	SU02SE	Faulston Down	CMB/ PMH	1998/ 2003
ST93SW	Hindon	CRB/ PMH	1993/ 2003	SU14SW	Stonehenge	ARF	1999/ 2003
ST92NW	Tisbury	CRB/ PMH	1989/ 1992/ 2003	SU13NW	Woodford	ARF	1999/ 2003
ST92SW	Berwick St John	CRB	1988	SU13SW	Old Sarum	ARF/ PMH	1999/ 2003
ST94SE	Codford St Peter	PMH	2003/ 2004	SU12NW	Harnham	AJN	2003
ST93NE	Stockton	PMH	2003	SU12SW	Whitsbury Down	CMB/ PMH	1998/ 2003
ST93SE	Chilmark	PMH/ CRB	1994/ 2003	SU14SE	Amesbury	ARF	1999
ST92NE	Swallowcliffe	ARF/ CRB	1994/ 2003	SU13NE	Porton	ARF	1999
ST92SE	Alvediston	KRR/ PMH	1999/ 2003	SU13SE	Laverstock	ARF	1999
SU04SW	Yarnbury	ARF	2003/ 2004	SU12NE	Alderbury	ARF/ AJN	1999/ 2003
SU03NW	Steeple Langford	AJN	2003	SU12SE	Downton	CMB/ PMH	1997/ 1998/ 2003
SU03SW	Dinton	ARF	2003	SU24SW	Cholderton	DTA/ ARF	1999
SU02NW	Broad Chalke	KAB	2003	SU23NW	Porton Down	ARF/ PMH	1999
SU02SW	Bowerchalke	KRR/ PMH	1999/ 2003	SU23SW	Pitton	KAB/ ARF	1999
SU04SE	Winterborne Stoke	ARF	2003/ 2004	SU22NW	East Grimstead	KAB	1999
SU03NE	Stapleford	RJM	2003	SU22SW	Redlynch	CMB	1997/ 1998
SU03SE	Wilton	RJM	2003				

* indicates part mapped sheet; see also Figure 3.
Geologists: AJN – A J Newell, ARF - A R Farrant, CMB – C M Barton, CRB – C R Bristow, DTA - D.T. Aldiss, KAB - K A Booth, KRR – K R Royse, PMH – P M Hopson, RJM – R J Marks.

1:10 560 field slips: The original 1:10 560 field slips for the 1903 primary survey are archived in the BGS collections.

BGS Technical Reports:

WH/99/57R	Woods, 1999b	WA/00/11	Aldiss, 2000
WH/99/138R	Woods, 1999a	WA/00/18	Booth, 2000
WH/00/42C	Woods, 2000	WA/00/23	Hopson, 2000
WH/00/36R	Wilkinson, 2000a	WA/00/24	Farrant, 2000
WH/00/43R	Wilkinson, 2000b		

Borehole Records: The registered borehole records for the sheets indicated above may be consulted through the National Geosciences Information Service, BGS Keyworth and are filed according to 1:10 000 quarter sheet.

Aerial photographs: NRSC (National Remote Sensing Centre) nominal scales 1:25 000 (1993) and 1:10 000 (1991).

Other reports and publications are listed under References. These can be consulted at the BGS Library, Keyworth.

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This document has drawn heavily, and quoted extensively from the individual technical reports for the Bourne and Nine Mile River catchment areas and on an unpublished Chalk criteria document by D T Aldiss, C R Bristow, P M Hopson, M D A Samuel, C J Wood and M R Woods. Additional notes and observations are included from the authors stated on the title page. The landowners, farm managers and land agents of the district area are thanked for their co-operation in providing access to private land for the purposes of this survey.

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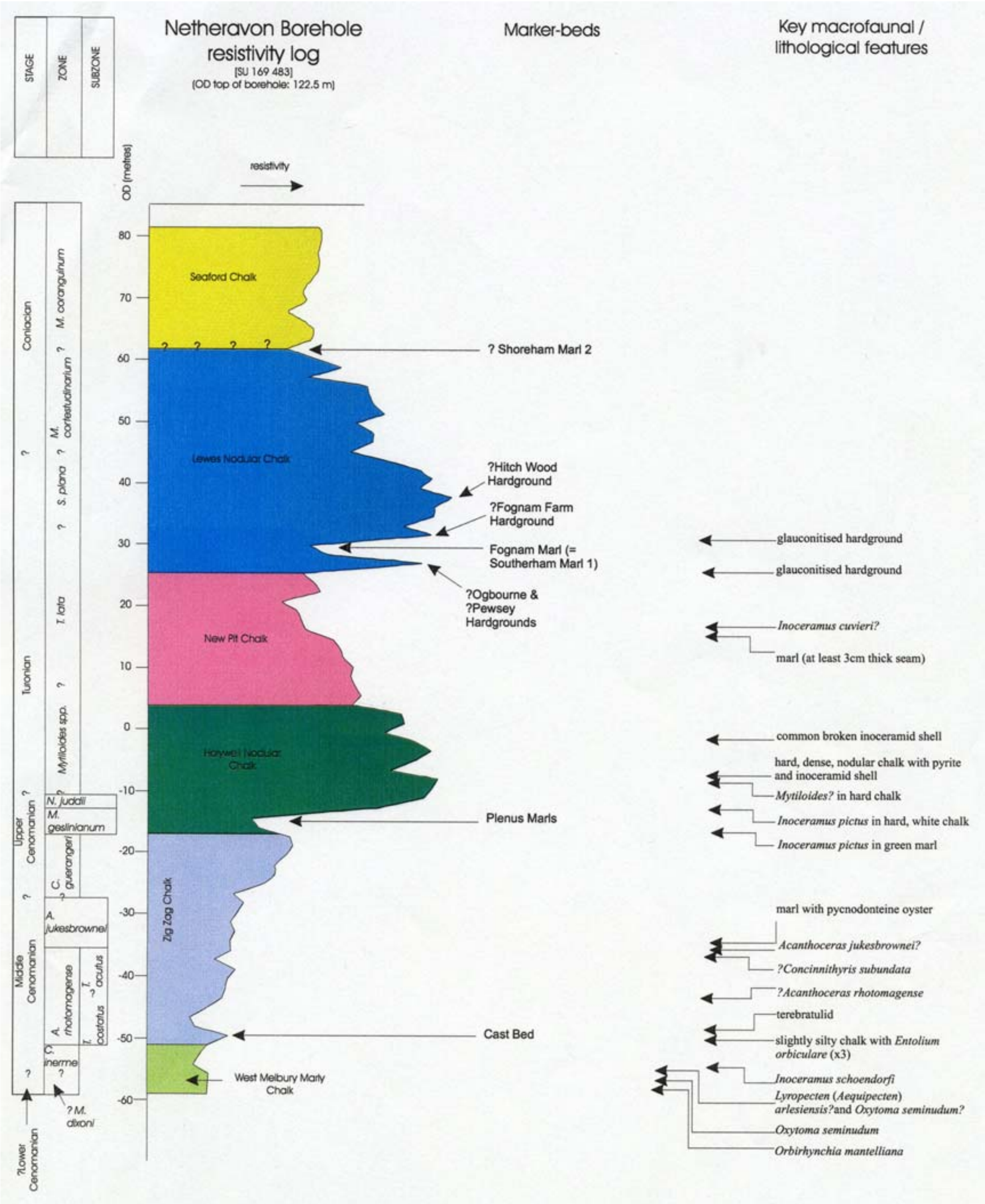
APPENDIX A. LOCATION OF MAJOR CHALK GROUP SECTIONS BY FORMATION.
The table below shows the location of all the major sections seen in the district.

Lithology	Location	NGR
West Melbury Chalk	Footpath from East Farm, near Fovant	SU 0142 2828
Zig Zag Chalk Fm	Disused quarry adjacent to the main Fovant to Fifield Bavant road	SU 0055 2735 to SU 0044 2723
	Old pit southeast of Compton Chamberlayne	SU 0396 2894
	A small trackside section	SU 0326 2830
	Degraded and disused pit south of Four Winds	SU 0574 3072
	Thorpe Bottom Cottage pit	SU 0850 2501
Holywell Chalk Fm	Track crossroads north of Manor Farm, Codford.	ST 9718 4162
	Southwest of Manor Farm, Codford	ST 9623 4109 to ST 9640 4139
	Old chalk pit NNE from Great Bathampton Farm.	SU 0180 3834
	A small, disused pit	SU 05016 26253
	Pit at Flamstone Farm Grain Plant	SU 0646 2635
	The Plenus Marls were seen beneath three metres of shelly chalk and in a track south of Homington	SU 1109 2613 SU 1239 2594
New Pit Chalk Fm	Manor Farm	ST 96970 41669 & ST 98197 41936
	Cuckoo Pit, Great Bathampton Farm, near Wylye	SU 0180 3834
	A small chalk pit east of Deptford Field Barn	SU 0212 3922
	East Clyffe Farm Steeple Langford	SU 04530 37406
	A pit 1 km north of Dinton	SU 0167 3265
	A pit 1 km to the east of Baverstock	SU 0377 3224
	Disused Chalk pit in Barford St Martin	SU 0579 3145
Lewes Chalk Fm	Old pit at Chalk Pyt Farm, Broad Chalke	SU 0360 2600
	Old chalk pit on Fifield Down	SU 0070 2560
	North of the district around Chitterne	ST 9904 4434 & ST 9820 4381
	The Wylye valley, adjacent to a track	ST 98088 36894
	Adjacent to a track that divides the Short Shrub from the Long Shrub	ST 99234 37522

	Steeple Langford	SU 0397 3755
	Quarry east of the cross roads at Stapleford	SU 0729 3701
	Baverstock	SU 0376 3223
	Roadside pit at Upper Woodford	SU 1235 3700
	Roadside pit at Middle Woodford	SU 1204 3572
Seaford Chalk Fm	Roakham Bottom.	ST 98187 36088
	Chalk pit by a track near Newton Tony	SU 2193 4056
	A small pit near Coronation Plantation	ST 9608 3597
	Stoford in a disused chalk pit	SU 0860 3561
	New building, Down Barn, Cholderton	SU 2212 4324
	Old chalk pit near Baverstock Manor, Baverstock	SU 0313 3288
	Windwhistle Farm pit	SU 0729 2815
	Ragland disused Chalk pit	SU 0835 2631
	Excavations on Netheravon Airfield	SU 1575 4891
	Excavations on Netheravon Airfield	SU 1624 4924
	Excavations on Netheravon Airfield	SU 1633 4939
	Excavations on Netheravon Airfield	SU 1690 4962
	Westfield Farm	SU 1174 3866
	Old pit by river, Great Durnford	SU 1333 3746
	Old Pit, by Stratford Bridge, Old Sarum	SU 1297 3332
	Pit on the A345 just south of Amesbury	SU 1585 4068
	Old pit by West Gomeldon Farm	SU 1749 3614
	Quidhampton Quarry	SU 11473 31446
Newhaven Chalk Fm	East Grimstead Quarry	SU 227 271
	1kilometre southwest of Figsbury Ring	SU 1802 3306
	West Harnham Chalk Pit	SU 1280 2880
	Brickworth Down Landfill quarry	SU 216 243
	Pit by road south-east of Figsbury Ring	SU 1802 3306
	Old railway cutting, Boscombe Down	SU 1820 4092
Culver Chalk Fm	Track exposure near Clarendon Palace	SU 1782 2998
	Road cutting southeast of Pitton	SU 2130 3118 to SU 2128 3098
	Britford at the site of a dairy	SU 1516 2808
	Abandoned railway cutting south of Whaddon	SU 1942 2562 to SU 1940 2530
	Brick Kiln Copse	SU 1822 2860
	Small quarry at West Grimstead	SU 2172 2648

APPENDIX B. STRATIGRAPHY OF THE NETHERAVON BOREHOLE.

The Netheravon Borehole provides a key stratigraphical section through most of the White Chalk subgroup and part of the Grey Chalk subgroup. The resistivity log is correlated with macro-faunas to give the stratigraphical interpretation shown overleaf in Figure 79 (taken from Woods, 2000). The microfauna is documented in Wilkinson, 2000b.



Lithostratigraphical units interpreted from resistivity log response and borehole samples for the Netheravon Borehole