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TECHNICAL REPORT WA/95/82
Geology of the Tisbury district (Wiltshire)

1:10 000 Sheet ST 92 NW (Tisbury) and the Jurassic of Sheet ST 93 SW
Part of 1:50 000 sheets 297 (Wincanton) and 298 (Salisbury).

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Geographical index
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Subject index
Geology, Jurassic, Portlandian, Cretaceous, Lower Greensand, Upper Greensand, Chalk

Bibliographical reference
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PREFACE

This account describes the geology depicted on 1:10 000 Sheet ST 92 NW (Tisbury) and the Jurassic strata of Sheet ST 93 SW, which forms part of the 1:50 000 Wincanton (297) and Salisbury (298) sheets. The district was first geologically surveyed on the one-inch scale by H W Bristow and published on Old Series Sheet 15 in 1856. The area was resurveyed on the 1:10 560 scale by C Reid in 1900. Mr B H Mottram partially resurveyed the area on either side of the River Nadder (principally the Lower Cretaceous strata) in 1950 and 1951; he later donated the maps to the BGS. The Salisbury (298) Sheet was published at the 1:63 360 scale in 1903. The map was reprinted, without revision, at the 1:50 000 scale in 1976. A provisional edition, at the 1:63 360 scale, of the Wincanton Sheet, largely based on Old Series Sheet 15, was published in 1969. The sheet was reprinted at the 1:50 000 scale without geological revision in 1972. A revised edition of the 1:50 000 Wincanton Sheet is currently in press. The BGS Tisbury Borehole was drilled in 1976-7 as part of the assessment of the oil-shale resources of the country. An outline log was given by Gallois (1979); slightly more detail appeared in Bristow et al. (1995). Further details of the Tisbury Borehole include: the palynology of the Portland Group and higher part of the Upper Kimmeridge Clay by Riding (1993a), the ostracods by Wilkinson (1978; 1995), and the petrography of the Portland Group by Lott (1994). Lott has also described (1993) thin sections of Portland Beds from brash and sections. Jurassic and Cretaceous microfossils have been identified by Dr I P Wilkinson. Dr B M Cox has identified the Jurassic macrofossils.

The 1:10 000-scale revision survey of the district was carried out by C R Bristow in 1989 and 1992 under the direction of R W Gallois.

Dyeline black and white copies of the geological maps can be ordered from the British Geological Survey, Keyworth.

CONTENTS

1. INTRODUCTION

The Tisbury district lies at the western end of the Vale of Wardour. The low-lying central part of the district along the the valleys of the rivers Sem and Nadder is underlain by the Kimmeridge Clay (Figure 1). The Nadder Valley is flanked by the Portland Group which, on the north side of the valley, forms long dip slopes rising to a maximum height of about 216 m OD at West Tisbury. Cretaceous strata include a thin Lower Greensand and a somewhat thicker Gault, both of which are poorly exposed. The latter formation is involved in extensive landslips in the south-west of the district. The Upper Greensand on both sides of the valley forms impressive escarpments, that on the south rising to over 200 m OD near Old Wardour, and that in the north rising to 230 m OD north of West Tisbury. The latter is the highest point in the district. A small area of Chalk crops out in the south-east.

The principal drainage is by the rivers Sem and Nadder in the south and central part of the district and by several north-bank tributaries, mostly unnamed, but including the Oddford Brook on the west side of Tisbury.

Soils developed on the Kimmeridge Clay and the Gault are heavy and poorly drained and are mostly under pasture. However, soils on the Portland Group and Upper Greensand, especially on the Boyne Hollow Chert, are light and well drained and given over to arable farmland. Woods, both deciduous and coniferous, occur principally on the steep scarp slope of the Shaftesbury Sandstone. Apart from a few light industrial units in Tisbury, agriculture is the only industry.

The solid formations and drift deposits on the 1:10 000 geological sheet ST92NW are shown in Table 1.

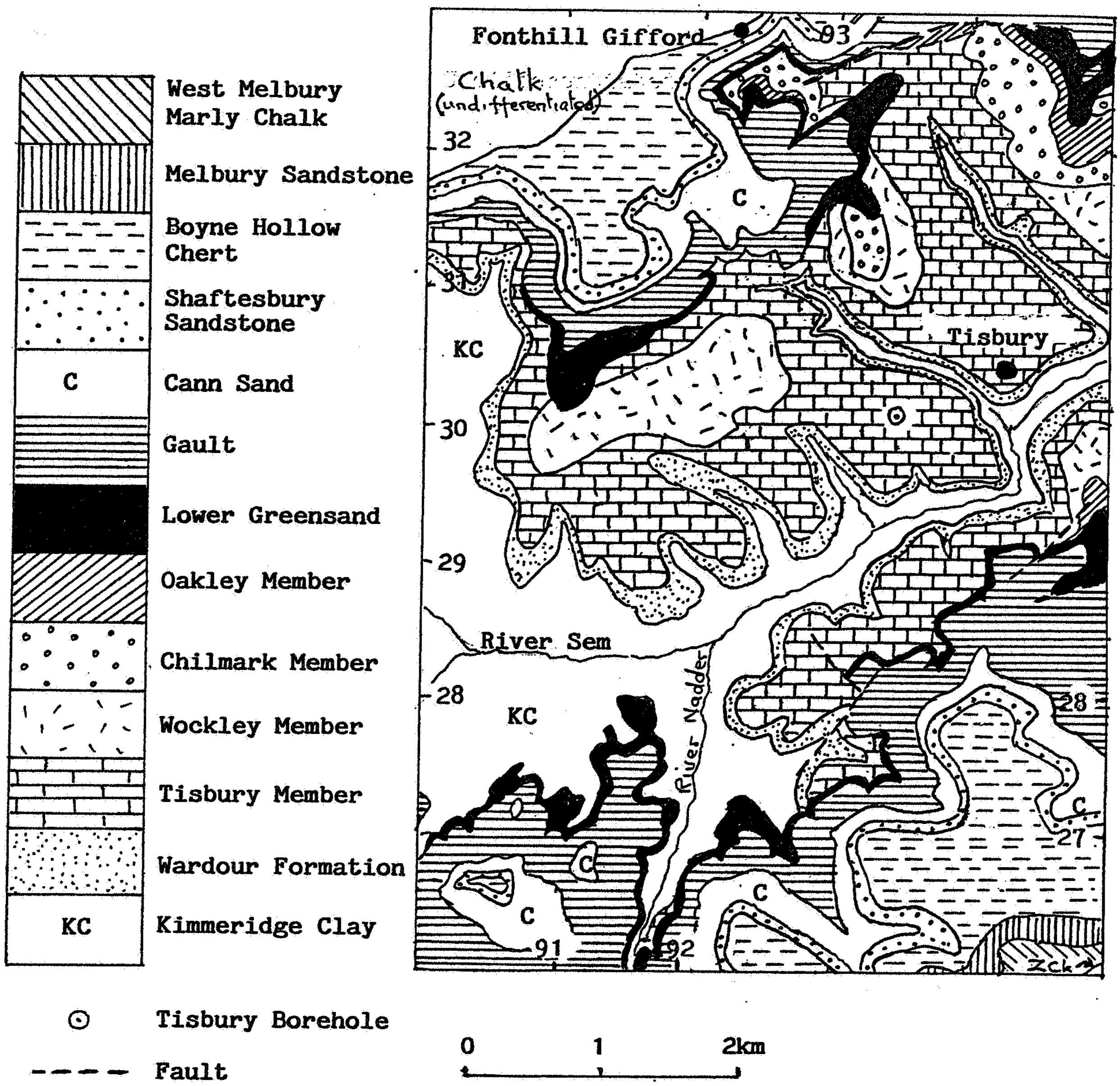

Figure 1. Sketch-map of the Solid geology of the Tisbury district

Table 1. Geological succession in the Tisbury district

Drift deposits

Landslip
Alluvium
River Terrace Deposits
Head
Older Head

Solid deposits

	Thickness (m)
Chalk	
Middle Chalk	
Holywell Nodular Chalk	10
Lower Chalk	
Zig Zag Chalk	25
West Melbury Marly Chalk	7
Upper Greensand	
Melbury Sandstone	2-10
Boyne Hollow Chert	20
Shaftesbury Sandstone	20-25
Cann Sand	5-20
Gault	25
Lower Greensand	0-5
Purbeck Formation	
Oakley Marl Member	0-5
Portland Group	
Portland Stone	
Chilmark Member	0-?10
Wockley Member	0-5
Tisbury Member	0-15
Wardour Formation	10-23
Kimmeridge Clay	>234

2. JURASSIC

Kimmeridge Clay

The Kimmeridge Clay forms low-lying ground in the west, and along the valleys of the rivers Sem and Nadder and their tributaries in the centre of the district. Within this tract, there is virtually no exposure. The cored BGS Tisbury Borehole [9359 2907] drilled in the bottom of the Tucking Mill Quarry, Tisbury, proved an incomplete c.234 m of Kimmeridge Clay (Gallois, 1979), consisting of a varying sequence of calcareous, kerogen-rich (bituminous mudstones and oil shales), and silty and sandy mudstones. These occur in a complex sequence of small-scale rhythms, and there are associated thin siltstones and cementstone beds. At its type locality on the Dorset coast, the Kimmeridge Clay is traditionally divided into Lower and Upper Kimmeridge Clay. Although these latter units have no formal lithostratigraphical status under modern rules of nomenclature, it is convenient to retain them for descriptive purposes; they can be readily distinguished on the basis of ammonite genera (Cox and Gallois, 1981). In the Tisbury Borehole, the Upper Kimmeridge Clay is 153 m thick; an incomplete 80.5 m of incomplete Lower Kimmeridge Clay was proved (Figure 2). As well as named marker beds from the Dorset coast, the sequence has been subdivided into a number of small-scale stratigraphical units (hereinafter referred to as KC 27, 28 etc.) originally established in cored boreholes sequences in eastern England (Cox and Gallois, 1979; Gallois and Cox, 1976). This scheme was developed by combining faunal markers and the rhythmic variation in lithology, within the framework of the ammonite zonation. It can be applied widely in sections and boreholes, including downhole geophysical logs, throughout southern Britain (Cox and Gallois, 1981; Penn et al., 1986), and is shown, together with the ammonite-based chronostratigraphy, in Figure 2.

The oil-shale-rich parts of the Kimmeridge Clay in the Tisbury Borehole are summarised in Figure 3. This figure, and the following account, is based on Gallois (1979). The five oil-shale rich bands widely recognisable in the Kimmeridge Clay are all present at Tisbury. Oil shales occur throughout the Eudoxus to Pectinatus zones inclusive. Some 3.6 m of of oil-shale was recorded in seams ranging from 2 to 34 cm in thickness. Some 82 per cent of the total of 34 seams were less than 20 cm thick, representing 60 per cent of the total oil-shale volume. The best concentrations of oil shales occur in the Wheatleyensis Zone and in the Upper Eudoxus Band. As elsewhere, the Upper Eudoxus seams are commonly the thickest, but are very shelly.

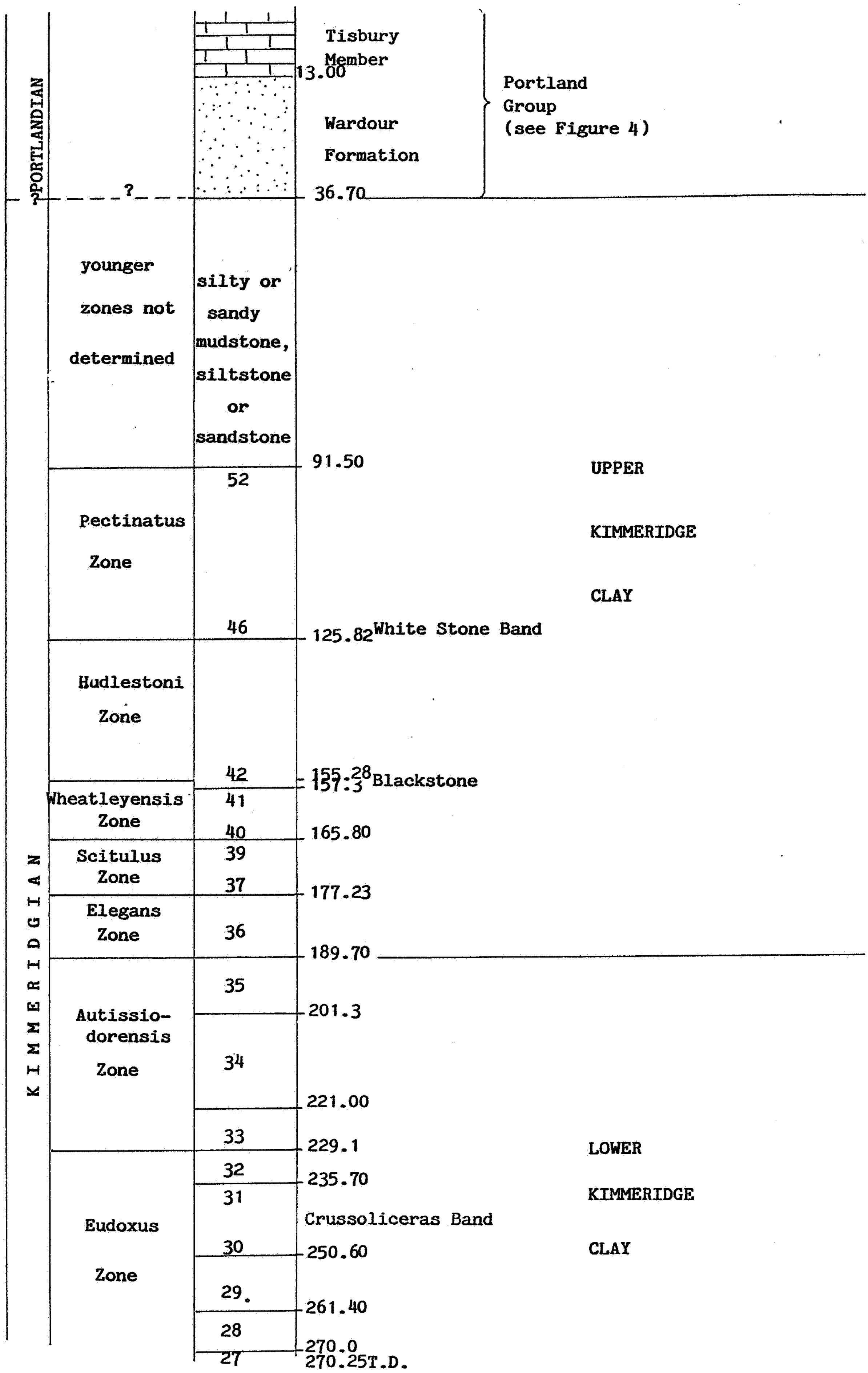

Figure 2. Outline stratigraphy of the Tisbury Borehole

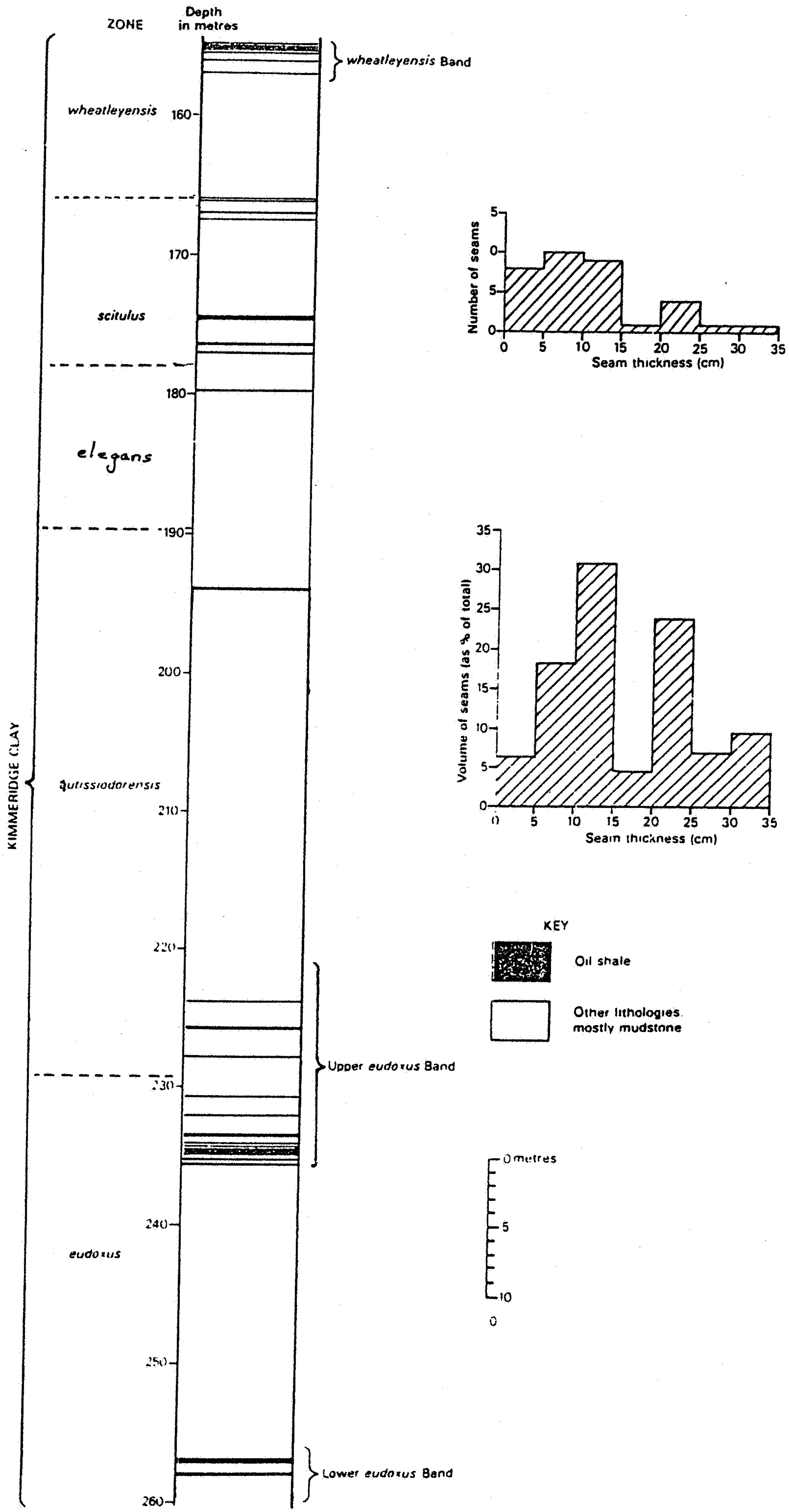

Figure 3. Distribution and thickness of oil-shale seams in the Tisbury Borehole

In the area to the west of the borehole site, cementstone beds within the interval KC 34 to KC 37 (i.e. close to the Lower/Upper Kimmeridge Clay boundary) appear to form mappable features at three levels (Bristow, 1995, figure 2).

Work on the biostratigraphy and macropalaeontology, particularly the uppermost part of the borehole sequence, is still ongoing, but there have been interim reports on the ostracods by Wilkinson (1978; 1995), and on the palynology (Riding, 1993). The following account of the ostracods in Tisbury Borehole is based on Wilkinson (1995):

Ostracoda have a patchy distribution throughout the borehole, very rare or absent in some intervals and common in others. It is assumed that this is a function of the environment of deposition and low oxygenated, bottom-water conditions (Wilkinson, 1983).

Although the lowest samples were barren, or yielded very rare specimens, an ostracod assemblage of ten species was found at a depth of 122.65 m. *Dicrorygma*, including *D. brotzeni*, and *Micrommatocythere* sp. nov. dominate the fauna, but rare specimens of *Mandelstamia tumida* are present and very rare *Paralesleya perforata* were also recorded. Comparison with the coastal sequence and boreholes in eastern England, which have excellent lithological and biostratigraphical control, indicates the inception of *D. brotzeni* is in the late Pectinatus Zone; *M. tumida* is restricted to the Pectinatus Zone. *Paralesleya perforata* has been recorded in the Rotunda/ Fittoni zonal boundary interval of Dorset, in the highest Argilles de Wimereux, and basal Assises de Croi of the Boulonnais (?latest Pectinatus to Pallasioides/Rotunda zones) and in the Late Kimmeridgian deposits off Denmark and Holland (WitteLissenberg, 1991). Its presence at 122.65 m, 48.2 m and 45.4 m, probably indicates the late Pectinatus to early Fittoni zones for this interval. It is surprising that the ostracod zonal index for the late Hudlestoni to early Fittoni zones, *Galliaecytheridea spinosa*, is not present (it does not occur below 76.30 m). This may be due to sample failure or palaeoenvironmental considerations.

The 119.9 m to 87.20 m interval yielded very sparse assemblages. Rare specimens of *Paranotacythere pustulata* were found in several samples above 115.85 m, *Paranotacythere caputmortuum* was present at 96.4 m and *Schuleridea moderata* was recorded in a number of samples above 96.4 m. It is not possible to date this interval with certainty. *Schuleridea moderata* is long-ranging throughout most of the Late Kimmeridgian, *P. pustulata* ranges from the

Pectinatus to the late Rotunda zones in Dorset (its inception is in the Hudlestoni Zone in eastern England) and *P. caputmortuum* extends throughout the Late Kimmeridgian (its inception on the continent is in the Autissiodorensis Zone, and offshore, in the Southern North Sea Basin, it ranges up into the earliest Portlandian). In Britain, the species has only been recorded in the Hudlestoni Zone of eastern England.

There is a sudden appearance of additional species at 84.25 and 81.00 m. *Schuleridea moderata* occurs in abundance, *Hechticythere serpentina* is common and *Aaleniella* (*A. inornata* and *A. gracilis*), *Macrodentina* sp. cf. *transiens*, *Klentnicella nealei* and *Dicrorygma maior* are also present. This is clearly an important biostratigraphical event, so far as the ostracods are concerned. Comparison with the stratotype sequence (Christensen and Kilenyi, 1970) suggests that it is in the younger part of the Rotunda Zone (in the "Lingula Shales"). However, ostracods from this part of the Kimmeridge Clay are not well known and reliance has to be placed on only a small data set.

As mentioned above, *Galliaecytheridea spinosa* appears at 76.30 m, and almost immediately dominates the faunas. It is consistently present between 76.30 and 52.3 m and is accompanied by less persistent *Aaliniella inornata, A. gracilis, Mandelstamia tumida, Dicrorygma maior, D. brotzeni, Micrommatocythere* sp. and *Hechticythere serpentina*. This assemblage is similar to that from the late Rotunda Zone of the Dorset Coast and the younger part of the Late Kimmeridgian in boreholes of the southern North Sea Basin.

Galliaecytheridea spinosa continues to dominate faunas between 48.20 and 38.19 m, in which interval *Hechticythere serpentina* is common. Other species, some of which are surprising, appear for the first time in this interval. *Procytheropteron brodei*, *Cytheropteron* cf. *prolongatum* and *Macrodentina* sp. appear at 48.20 m; the inception of *Procytheropton bicostata* is at 45.40 m, in the same sample as the last specimens of *Dicrorygma brotzeni*; *Paranotacythere* cf. *rimosa* was found at 40.50 m, and *Eocytheridea eusarca* at 38.19 m. Many of these species are more characteristic of the youngest Kimmeridgian (late Fittoni Zone) and Early Portlandian as recorded by Barker (1966) from the uppermost 3.05 m of the Kimmeridge Clay on the Dorset coast, just below the Massive Bed and Black Nore Sandstone, where the youngest ostracod zonal index, *Galliaecytheridea compressa*, has been found. However, no specimen of *Galliaecytheridea polita* or *G. compressa* (respectively the zonal indices equating with the 'mid' and 'late' Fittoni Zone of the coastal sequence) was encountered in the top of the Kimmeridge Clay at Tisbury. This may be due to sample failure (the highest samples examined (from 35.80 and 33.00 m) were barren of ostracods), patchy distribution of the key taxa (*G. polita* is particularly uncommon and stratigraphically restricted), or, more likely, only the lower part of the Fittoni Zone falls in the Kimmeridge Clay, the higher part of the zone falling in the basal part of the overlying Wardour Formation, as suggested by Riding (1993).

Details

North of West Hatch, an auger hole [9208 2855] proved 1.8 m of pebbly. sandy, glauconitic clay, above dark grey very sandy clay at the top of the Kimmeridge Clay.

In the floor of the stream [9229 2707] west of Wardour Castle, there is a 10-cm thick bed of sandy biosparite. The stratigraphical position of this bed is uncertain - it is not typical of the Kimmeridge Clay and no such lithology was proved in the Tisbury Borehole, but it falls within the outcrop of Kimmeridge Clay. It may be a man-made artifice, such as part of a ford. A thin section shows fine- to medium-grained, abraded bioclastic debris (bivalves and foraminifera)(26%), micritised peloidal (15%) and siliciclastic (15%) grains in a spar calcite cement. Partially replaced ?oolitic grains are moderately common; glauconite constitutes about 2% of the rock (Lott, 1993).

Portland Group

The Portland Group crops out principally in the northern part of the area. North of the River Nadder, the limestones form long south-east, or east-south-east, dipslopes.

Traditionally, the group is divided into a lower arenaceous unit, the Lower Portland Beds, overlain by a dominantly limestone sequence, the Upper Portland Beds (Woodward, 1895). The latter has been divided into four main lithological units, based largely on their building-stone potential; these have been further subdivided into a number of beds based on quarrymen's terminology. Wimbledon (1976) formalised the nomenclature, dividing the Portland Beds into two formations, a lower Portland Sand Formation, comprising three members, and an upper Portland Stone Formation consisting of two (one only locally developed) members. This formational grouping is biostratigraphical rather than lithostratigraphical. In the present account, to preserve continuity where possible, Wimbledon's (1976) local names are used, but slightly modified, and have been given different ranking (Table 2).

The Portland Group spans the Albani to ?basal Anguiformis zones of the Portlandian Stage (Cope et al., 1980b; Wimbledon, 1976), with the basal part of the Wardour Formation probably falling in the uppermost zones of the Kimmeridgian (Riding, 1993).

Wardour Formation

The Wardour Formation corresponds to the Lower Portland Beds of Hudleston (1881), Woodward (1895), Reid (1903) etc. The term Wardour Member was introduced by Wimbledon (1976) as the basal unit of the Portland Sand Formation. However, it is inappropriate to group on lithostratigraphical grounds, the Wardour Member and the succeeding limestones (Chicksgrove and Tisbury members) as the Portland Sand Formation [of the Dorset coast]. Accordingly, the basal, Wardour, member of Wimbledon's sequence is given formational status, and his higher two units are included in the succeeding Portland Stone Formation. The base of the formation is taken at the base of a fine-grained, glauconitic sandstone. From the gamma-ray log of the Tisbury Borehole [9399 2907], this glauconitic sandstone can be seen to be part of a fining-upward cycle (Figure 4). Springs issue from the base of the sand and enable the boundary to be traced with ease in the field. The bulk of the formation, 21 m thick in the Tisbury Borehole, consists of siltstones and bioturbated, friable, sparsely shelly sandstones. Small (3-4 mm) lydite

<table>
<tr><th rowspan="2">Blake (1881)</th><th colspan="3" rowspan="2">Woodward (1895)</th><th colspan="2">Wimbledon (1976)</th><th colspan="2" rowspan="2">Bristow
(this account)</th></tr>
<tr><th></th><th>Members</th></tr>
<tr><td>*
Building Stone Series</td><td rowspan="5">UPPER PORTLAND BEDS</td><td colspan="2">Upper Building Stones</td><td rowspan="3">PORTLAND STONE FORMATION</td><td>Chilmark</td><td rowspan="5">PORTLAND STONE FORMATION</td><td>Chilmark</td></tr>
<tr><td>Chalk of Chicksgrove</td><td colspan="2">Chalky Series</td><td rowspan="2">Wockley</td><td>Wockley</td></tr>
<tr><td>Upper beds of Swindon</td><td colspan="2">Ragstone</td><td rowspan="3">Tisbury
Sand</td></tr>
<tr><td rowspan="2">*
Tisbury Freestone</td><td rowspan="2">Lower Building Stones</td><td>Trough Bed</td><td rowspan="3">PORTLAND SAND FORMATION</td><td>Tisbury</td></tr>
<tr><td>$
Glauc-onitic & sandy lime-stones</td><td>Chicksgrove</td></tr>
<tr><td>Lower Sands</td><td colspan="3">Lower Portland Beds</td><td>Wardour</td><td colspan="2">Wardour Formation</td></tr>
</table>

* = Main building stones

$ = Divisible in descending sequence into Green Bed, Slant Bed, Pinney Bed, Cleaving or Hard Bed, Fretting Bed and Under Beds

Table 2. Stratigraphical nomenclature of the Portland Group of the Vale of Wardour

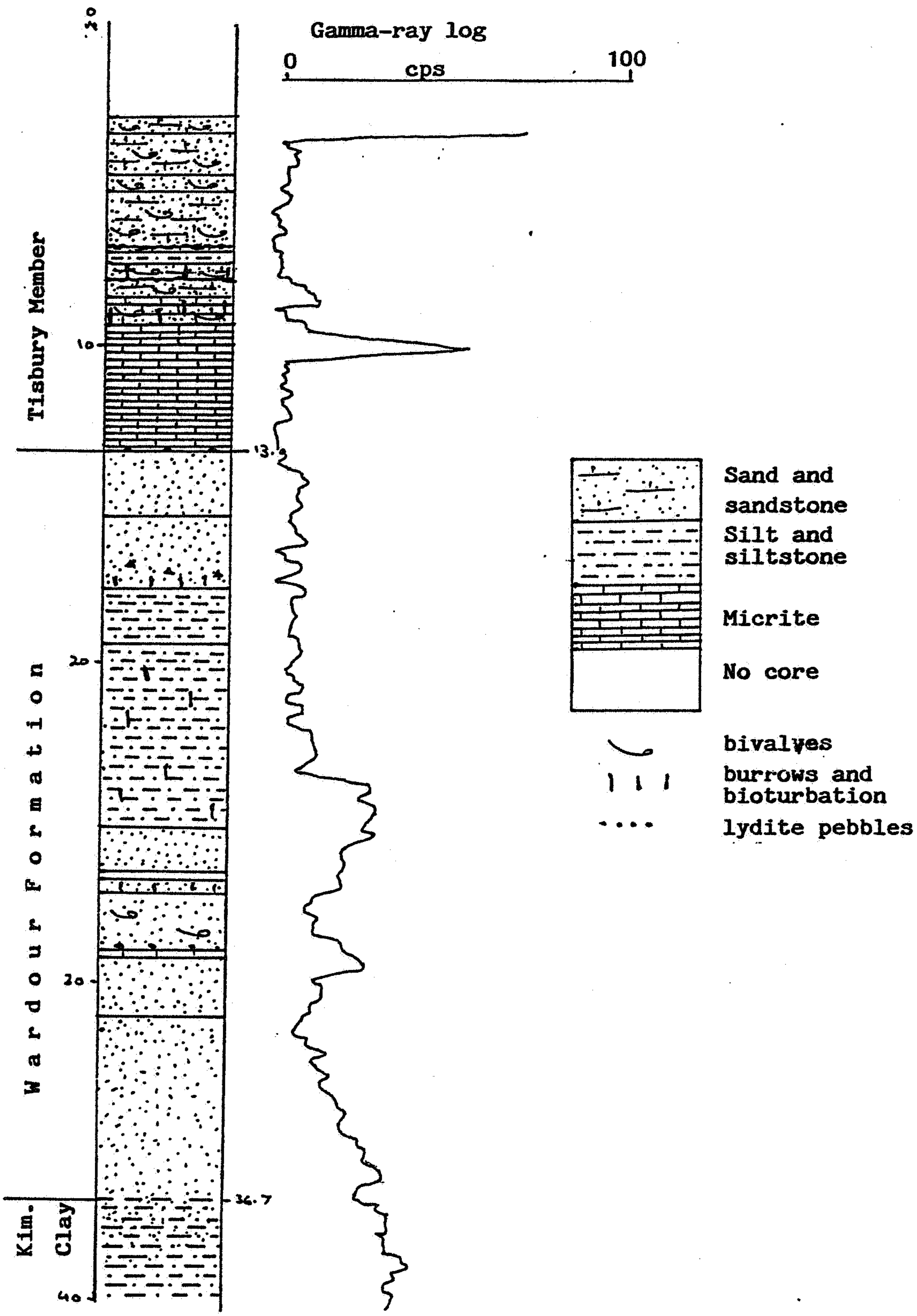

Figure 4. Lithostratigraphy of the Portland Group in the Tisbury Borehole

pebbles were noted 7.83 m above the base in the Tisbury Borehole. They have also been recorded in the Nadder Valley [9180 2528] in the south of the district. Wimbledon (1976) recorded a lydite bed 3.5 m from the top of the formation at Chicksgrove, just east of the district.

In the field, the thickness of the formation appears to vary from 10 to 15 m, but this apparent reduced thickness compared to that in the Tisbury Borehole (23.7 m) is thought to be due to cambering of the overlying limestones across the upper part of the outcrop of the Wardour Formation.

Dinoflagellates indicate that the basal 5 m of the Wardour Formation, corresponding to the fining-upwards, glauconitic sandstone, falls within the youngest zones of the Kimmeridgian Stage. The succeeding part spans the Albani and basal part of the Glaucolithus Zone (Cope et al., 1980b; Riding, 1993; Wilkinson, 1993).

Portland Stone

The Portland Stone Formation consists of siltstones, fine-grained calcareous sandstones, sandy limestones and micrites in the lower part (in part, the Chicksgrove Member of Wimbledon (1976)), passing up into a unit of fine-grained siliciclastic and bioclastic sandy, glauconitic, peloidal, biosparites (the Tisbury Member of Wimbledon (1976)), overlain by a peloidal, bioclastic micrite (the Ragstone), and capped by shelly, micritic limestones with little or no siliciclastic sand (the Wockley Member of Wimbledon (1976)). In this district, the youngest unit (the Chilmark Member), consisting of fine-grained oolites, occurs only in the area south of Fonthill Bishop. Chert occurs sparingly in the Tisbury Member, but is locally common in the Wockley Member. In mapping, it has not been possible to separate Wimbledon's Chicksgrove and Tisbury members. Accordingly, the use of the term Tisbury Member in this account has been extended downwards to embrace the Chicksgrove Member. Similarly, it was not practicable to map the Ragstone separately and it is here included as the upper unit of the Tisbury Member.

Tisbury Member

The base of the Tisbury Member is taken at the abrupt change from fine-grained, clayey sand of the Wardour Member to sandy limestones, and which coincides with a marked positive feature break. The member corresponds to the Lower Building Stones of the older literature, but as defined herein, also includes the Ragstone (Table 2). The lower part of the member consists of siliciclastic and bioclastic, peloidal, glauconitic biosparites. The glauconite content varies from 1 to 2 per cent, the bioclastic sand up to 31 per cent, but averaging about 8 per cent, the siliciclastic sand from 4 to 42 per cent, but averaging about 30 per cent, and the peloids from 5 to 26 per cent, but mostly about 10 per cent. There is a general gradual upward increase in bioclastic sand and a decrease in siliciclastic sand, and the beds pass into bioclastic biosparites. The Tisbury Freestone of Blake (1880), the principal source of building stone in the district, corresponds to this higher part of the Tisbury Member; it has a wide outcrop north of the River Nadder.

In places, a three-fold division of the Tisbury Member can be mapped, with a thin (up to 5 m), basal, shelly, generally micritic, limestone (possibly the Chicksgrove Member of Wimbledon (1976)), overlain by a fine-grained, glauconitic sand (up to 5 m thick), overlain by peloidal, sandy, bioclastic, sparry limestones. Where the median sand is absent, or cannot be recognised on pasture-covered ground and steep valley sides, no firm boundary can be drawn between the lower and the higher limestones. Lydite pebbles have been noted in the basal beds near Hazeldon Farm [c.9376 2816] (Hudleston, 1881).

Fossils, especially bivalves, including *Myophorella*, and ammonites, are common in the Tisbury Member. Ammonites from the lower part of the member at Chicksgrove and Chilmark, just east of the district, include common *Glaucolithites glaucolithus* and *G. polygyralis* indicative of the Glaucolithus Zone (Wimbledon, 1976). Ammonites in the upper part, where glaucolithitids are absent, include species of *Titanites (Titanites)*, *Titanites (Polymegalites)* and *Galbanites* indicative of the Okusensis Zone; (Wimbledon, 1976; 1980).

Wockley Member

Wimbledon (1976) drew the base of the Wockley Member at the base of the 'Ragstone', a unit, especially the basal shelly micrite, readily recognisable in quarry sections, but, in the absence of exposure, not easily identifiable from brash. At Chicksgrove, just east of the district, the basal bed of the Ragstone consists of 0.5 to 0.85 m of a very hard micrite with common large bivalves, and is succeeded by up to 2.5 m of micritised, peloidal limestone with common bivalves and scattered large ammonites; these peloidal limestones are, particularly where seen only as brash, lithologically more like the underlying Tisbury Member, than the overlying Wockley Member and have been mapped with the former. In the field, the base is taken at the incoming of dense, porcellanous, grey limestone with moulds of common small gastropods. This is probably the 'hard, white-cream lime mud with abundant minute gastropods' seen near the base of the Wockley Member in the Chicksgrove quarry (Wimbledon, 1976). Higher in the sequence, chalky, shelly micrites with common chert occur.

The ammonites *Galbanites (Kerberites) kerberus*, *Titanites giganteus*, *T. trophon* and *T.* cf. *anguiformis* have been found in the Wockley Member and indicate the Kerberus Zone and the lowest part of the Anguiformis Zone (Wimbledon, 1976; 1980).

Chilmark Member

The Chilmark Member, the Upper Building Stones of the older literature, was thought to be restricted to the Chilmark Ravine east of the district. However, the recent mapping shows that it extends westwards into the Tisbury area.

At the type locality, the Upper Quarry [9755 3137], Chilmark, the member is described by Woodward (1895, p.268) as 0.9 m of buff, oolitic stone 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. Wimbledon (1976) noted that the gastropod *Aptyxiella portlandica*, the Portland Screw, is common in this unit. He also observed that the junction with the overlying Purbeck Formation is not clear cut, with interbedded [presumed non-marine] stromatolitic tufas and [marine] oolitic sands forming a transitional zone between the two. In the field, the Chilmark Member is typified by flaggy, fine-grained oolite brash.

Although the Chilmark Member, more durable than the Lower Building Stones (Towlson, 1991, p.37), has been widely quarried as a building stone at Chilmark, it has not been worked in the present district.

No ammonite has been found in the Chilmark Member. Wimbledon (1976) and Cope et al. (1980b) regarded the Wockley and Chilmark members largely as lateral equivalents, with the latter falling in the upper part of the Kerberus Zone, and lowest part of the Anguiformis Zone.

Details

Wardour Formation

South-east of Ashleywood [9372 3073], very fine-grained orange sand is thrown out from badger setts. Down the valley from Ashleywood, the base of the Wardour Formation is readily traceable by springs.

From east of Summerleaze Farm to south of Hatch House [908 279], the base of the formation is marked by springs. An auger hole [9085 2790] in the basal beds near the last locality proved, beneath 1.5 m of head deposits, a glauconitic, grey sandy clay.

At West Hatch, the base is easily traced by the basal springs [9161 2758 to 9190 2793]. North-north-east of East Hatch, an auger hole [9282 2890] proved 1.6 m of mottled orange and grey clayey sand (Head deposits) on 0.3 m of glauconitic sand close to the base of the member.

From east of East Hatch towards Tisbury [932 285 to 9410 2856], from Tisbury north-westwards up the Oddford Brook [9409 2907 to 9262 3000 and 9287 3000 to 9408 2933], through Tisbury [9458 2943 to 9478 2952] and along the valley north of the town [9486 2978 to 9451 3000], the base of the Wardour Formation is nearly everywhere marked by springs. Mottram (Ms map, BGS) noted buff sand with a rubble of an '*Exogyra* band' in a temporary section [9352 2881] south of Tuckingmill.

Fine-grained glauconitic sand occurs at the bottom of the railway cutting [9482 2927] north-east of Tisbury station.

Near Wardour, glauconitic, clayey, fine-grained sand was proved at four points [9231 2707, 9236 2674, 9248 2671 and 9265 2663] close to the base of the member. A borehole [9295 2666] in Wardour Park proved 1.7 m of greyish brown mottled clayey silt, on 4.7 m of patchily green-mottled, orange-brown and grey, silty, fine- to medium-grained sand. Fine-grained, yellowish buff clayey sand was augered to the north [9294 2674] and south 9300 2658] of the borehole.

An inlier, beneath drift deposits, occurs in the valley of the River Nadder south-west of Park Gate Farm. Spoil from temporary sections [9175 2522 and 9171 2516] showed pale grey, fine-grained sandy mudstone; *Anisocardia* cf. *autissiodorensis* was found at the former locality. At the latter, the mudstone was associated with oolitic shelly limestone and fine-grained, non-calcareous, bioclastic sandstone with poorly preserved (as clay clasts) bivalves including *Modiolus* and *Myophorella*. Sandy mudstone from close by [9180 2530] included the foraminifera *Ammodiscus* sp., *Tritaxia* sp., *Lenticulina muensteri*, *Vaginulina legumeni*, *Arenobulima* sp. and *Trocholina* sp. and the ostracods *Macrodentina*, *M. rudis*, *Paracypris* sp. nov., *Procytheropteron* cf. *brodiei*, *Paraschuleridea* cf. *buglensis*, *Hechicythere serpentina*, *Paranotacythere rimosa*, *Darwinula* cf. *leguminella* and *Patelellacythere sp.* indicative of the Albani-Okusensis zones (Wilkinson, 1993).

To the south, just beyond the district, trench debris [9136 2461] included grey, fine-grained, non-calcareous sandstone with relatively poorly preserved bivalves, including *Entolium?* and *Myophorella*. Microfauna from this locality include *Citharina serratocostata*, *Lenticulina muensteri* and *Macrocypris retirugata* indicative of the Early Portlandian.

Portland Stone Member

Tisbury Member

South-west of Ruddlemoor Farm, flaggy, fine-grained, glauconitic, locally shelly, sandstone is common as brash [around 9035 3029]. The sandstone was worked in a quarry [9058 3032] at the eastern end of this outcrop. Around the margin of an old pit [9085 2965] south of Ruddlemoor Farm, there are blocks of shelly micrite and fine-grained sandy limestone.

Just above the track south-east of Pythouse [9074 2847], there is a cambered block of shelly micrite. Cambered limestone is also seen in the road cutting [9118 2813] east of Hatch House. South-east of the cutting, the Tisbury Member splits into a lower unit (?'Chicksgrove Member'), up to 0.5 to 1 m thick, of shelly micrite [9144 2788, 9148 2784, 9154 2781, 9198 2811 to 9224 2797 to 9240 2795 to 9236 2830], overlain by buff, silty, fine-grained sand and khaki silty clay, succeeded by shelly micrites and sandy limestones. Shelly micrite of the uppermost unit is common as brash in the fields [9119 2818, 9124 2814, 9135 2812 and 9137 2807] east of the cutting. Shelly, glauconitic, sandy limestone with common *Myophorella* and ammonites occurs as brash farther south-east [around 9143 2801].

On the higher part of the interfluve at West Tisbury [around 915 285] and West Hatch [around 925 287], glauconitic, sandy, oosparite is common as brash, and was formerly worked in several pits [9125 2849, 9130 2846, 9134 2826, 9138 2882 and 9158 2887]. In the last pit, C Reid (Ms map, BGS) noted 3.6 m of 'Lower Building Stone and chert'. Near Newtown, there are pits [around 9135 2915] dug to a depth of 2.4 m for sand, chert and Portland 'flint' (Jukes-Browne, Ms, BGS); these beds were regarded as decalcified ragstone by Reid (Ms, BGS).

'Greenish sandstone' was formerly worked in the quarry [9245 2990] at Lawn Quarry (Woodward, 1895). The artifical crags of fine-grained, patchily shelly, glauconitic sandstone around Bitham Lake in the grounds of Fonthill Abbey north of the district came from there.Quarry.

Tisbury Quarry [931 291] formerly exposed 1.8 m of 'chalk full of shells' on 3.6 m of 'freestone and chert' (Reid, Ms, BGS). The quarry has been extended eastwards since Reid's time and has only recently fallen into disuse. An illustrated account of the working of this pit is given by Manners (1971). A section [9320 2904] in the new pit exposes:

	Thickness m
Limestone rubble	0.7
Bioclastic (24%), fine-grained siliciclastic (22%), sparsely glauconitic (2%), peloidal (27%), sparry limestone	0.9
Biosparite, fine-grained sandy, peloidal, massive, passing laterally into a flaggy biosparite; at base, lenticular chert nodules up to 0.7 m long by 0.08 m thick	0.8
Bioclastic (32%), fine-grained siliciclastic (21%), peloidal (18%), sparsely glauconitic (4%), porous (22%), sparry limestone at top, passing down into less bioclastic (21%) and sandy (10%), peloidal (5%), glauconitic (2%), very porous (28%) sparry limestone in beds 0.3 to 1.5 m thick. Some bedding surfaces covered with large bivalves	3.2

% = area of thin section occupied by any one unit.

There are two dominant joint directions, one trending at 130° and the other between 190 and 205°.

North-east of Tisbury Quarry, an infilled pit [9297 2920] formerly exposed the 'Trigonia-bed' [basal Ragstone] at the top (C Reid, Ms, BGS).

A small infilled quarry [935 291] at Tuckingmill formerly exposed 1.8 m of rotten, shaly, cherty Lower Building Stones, on 2.4 m of similar, unweathered limestone. Just to the east is the large, fairly recently disused, Tuckingmill Quarry [936 290]. There are poor exposures of bioclastic (23%), fine-grained siliciclastic (10%), peloidal (9%), glauconitic (4%) sparry limestone (Lott, 1993). Similar lithologies were proved to a depth of 11 m, above sandstone and siltstone of the Wardour Member in the Tisbury Borehole [9399 2907] which was drilled in the base of the quarry (Figure 4).

Shelly micrite (?'Chicksgrove Member') with *Myophorella* is common at the base of the Member from just east of East Hatch to Tisbury [9328 2850 to 9345 2882, and 9357 2885 to 9374 2863 to 9405 2865], and up the Oddford Brook [9395 2925 to 9367 2942, and 9345 2965 to 9373 2966]. Large blocks of shelly, oomicrite dip 45° valleywards on the north side of Oddford Brook [9412 2930].

South of Fonthill Gifford, fine-grained, bioclastic oolite is common as brash [around 926 316]. A quarry [9327 3132] east of Fonthill Gifford church exposes a massive oosparite, 0.7 m thick, overlying a cross-bedded, oobiosparite, 0.7 m, on a flaggy oosparite, 1.2 m thick, in beds up to 0.3 m thick. Nearby, another pit [9336 3137] has a poor exposure in shelly sparite with chert nodules, in beds 0.3 m thick, at the top, and lower down, a 0.7 m thick bed of shelly micrite. Near the lake, ribs of shelly sparite, above a micrite, protrude through the turf [9348 3136].

A large, partially overgrown, pit [9351 3107] exposes a total of 5.4 m of the Tisbury Member:

	Thickness m
Sandstone, bioclastic, massive, weathering flaggy	0.70
As above, massive, but splitting irregularly; coarse-grained bioclastic sandstone, 0.15 m thick at base	0.85
'Roach' - hard, bioclastic shelly sandstone with fossils as hollow moulds	0.6-0.8
Sandstone, hard, glauconitic, bioclastic, in three principal beds	0.75
Chert, tabular, irregular	0.05
Sandstone, bioclastic, planar bedded at top	0.3-0.7
Chert, passing into dark brown, silicified, cross-bedded sandstone	0.25
Sandstone, friable, bioclastic, glauconitic	0.25
Sandstone, soft, bioclastic, glauconitic	0.10
Sandstone, siliceous, bioclastic, dark brown	0.10
Sandstone, hard, bioclastic, glauconitic	0.50
Chert, lenticular over a 4 m length	0.10
Sandstone, bioclastic, glauconitic	0.60

The steep valleyward dip of the beds, up to 40° at 80°, is presumably a cambering feature.

South of Ashleywood, sandy sparite, locally oolitic and glauconitic is common as brash [937 306 to 940 302]. According to local tradition, the coral *Isastraea oblonga*, the Tisbury Star coral, can be found on the fields west [935 310] and south [936 307] of Ashleywood. Reid (Ms, BGS) found this coral in the angle of Hindon Lane and a footpath [9376 3028].

The interfluve north of Tisbury [around 940 298] has much brash of fine-grained, sandy, peloidal biosparite. A cambered block of fine-grained, glauconitic sandy sparite was also seen on the north side of Tisbury [9449 2977].

In Quarry Wood, on the east side of the unnamed stream, old quarries and caves expose sections in the Tisbury Member. The most northern exposure [9353 3173] shows 1 m of hard, flaggy, shelly micrite, resting on a tabular chert. Nearby, a section [9356 3169] shows 5 m of sandy sparite, with massive (up to 0.3 m thick) beds of chert. Close to the lake, small exposures [9352 3159 and 9354 3156] are in shelly sparite with *Myophorella* and ammonites. One of the largest sections is a quarry [9370 3162] in the north-east of the wood, where 9 m of, largely inaccessible, strata are exposed. At the quarry top, 2 m of flaggy, cross-bedded oosparite can be examined. A cave [9366 3159] farther south reveals 5 m of well-bedded, sandy sparite with thin (up to 10cm) chert beds; an ammonite can be seen in the roof.

Opposite Ashleywood, large blocks of sandy sparite occur in tree roots [9386 3096] close to the base of the member. In the fields to the south-east, glauconitic, sandy, shelly sparite is common as brash [940 309 to 950 302].

A section [9455 2890] on the south side of the River Nadder at Tisbury Station, at the bottom of the escarpment, shows:

	Thickness m
Tisbury Member	
Biosparite, fine-grained sandy, crumbly, shelly, including *Myophorella*	0.75
Biosparite, shelly, with ammonite	0.30
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
Wardour Formation	
Sandstone, fine-grained, glauconitic	0.18
Sand and sandstone, fine-grained, glauconitic in eight alternating beds up to 0.25 m thick	0.90
Sandstone, fine-grained, soft	0.60

The base of a quarry [9465 2890] south of the station section, must have lain about 3 to 4 m higher than the top of the above section. It formerly exposed (Woodward, 1895):

	Thickness m
Rubbly stone and marl with seam of clay	1.22
Shelly limestone (Roach) with '*Trigonia incurva*') Impure shelly and tufaceous limestone)	1.22 to 1.52
Compact, but rotten chalky limestone much shattered, with gastropods	0.91 to 1.22
Greenish glauconitic sandy limestone with lenticular seams of oolitic chert: three layers seen	3.05 to 3.66

A third quarry [9469 2901] 100 m NNE exposes:

	Thickness m
Limestone, fine-grained sandy (24%), glauconitic (2%), bioclastic (20%), porous (20%), peloidal (6%), sparry (30%)	0.30
Limestone, fine-grained sandy (30%), glauconitic (3%), bioclastic (22%), porous (15%), peloidal (11%), sparry (18%)	0.20
Limestone, fine-grained sandy (18%), glauconitic (3%) bioclastic (31%), porous (20%), peloidal (8%), sparry (18%)	0.35
Limestone, fine-grained sandy (18%), glauconitic (6%), bioclastic (16%), peloidal (7%), sparry (43%), massive, with 10-cm thick chert bed at base	0.55

A trial pit [9455 2881] to the south-south-west appears to have proved the sequence intermediate to the above quarries. The pit started at the top of the escarpment and proved 1.3 m of topsoil, on 0.8 m of orange-buff, sandy silt, on 1.7m of buff, silty, fine-grained sand. The sand must crop out in the steep scarp face, but has not been proved elsewhere near the pit, although it has been mapped farther south-west between Hazeldon Farm and Wardour (see below).

A quarry [9400 2809] 500 m ENE of Hazeldon Farm exposes:

	Thickness m
Oobiosparite	1.10
Chert, tabular - not always present; where absent, a marked recess occurs in the face	0 to 0.07
Biosparite, fine-grained sandy, weakly glauconitic, lenticular chert nodules up to 5 by 45 cm	1.00
Biosparite as above; cross-bedded in lowest 20 cm	0.5 to 0.75
Biosparite, fine-grained sandy, weakly glauconitic, cross-bedded	0.85
Biosparite, fine-grained sandy	0.80
As above	0.80
As above	0.65

The outcrop of the Tisbury Member between Hazeldon Farm and Wardour Castle is tripartite with a median bed of fine-grained, glauconitic sand. A sample from the lower unit [9388 2785] consists of a fine-grained sandy (18%), bioclastic (8%), peloidal (10%), slightly glauconitic (2%), sparry (46%) limestone (Lott, 1993). Hudleston (1881) saw the following section [c.9376 2816] in the lower and median units in a lane near 'Hazleton':

	Thickness m
Loose sand with doggers	2.1
Greenish concretionary limestone grit, with occasional lydite; originally a Trigonia-bed	0.9
Wardour Member	
Loamy sands and clays	6.4

The grit yielded '*Trigoniae, Isognomon bouchardi, Chlamys lamellosa, Protocardia dissimilis, Exogyra nana*' etc (Arkell, 1933). The lower unit is unusually thin at this locality; a pit [c.9375 2820], now filled, just north of the road was opened for limestone. Massive limestone crops out in the roadbank [9342 2800] north-west of Hazledon Farm. There is much brash of shelly, peloidal micrite in the field [around 9338 2794] west of Hazledon Farm; brash of biosparite south [around 9342 2775] and south-east [9395 2775] of the farm suggests that the lower unit is at least 5 m thick in that area. At the latter locality, chert debris is associated with the biosparite.

The median sandy unit appears to vary in thickness from about 1 m to more than 5 m. Augering proves buff, only locally glauconitic, fine-grained sand. Glauconitic sandstone with an ammonite impression was noted at one point [9348 2778].

Brash from the higher unit [9370 2785] consists of flaggy, bioclastic (22%), sparsely sandy (3%) micrite with sparry patches (Lott, 1993). Other brash from this unit is peloidal and sparry.

The tripartite division of the Tisbury Member persists around Wardour Castle, but litle detail is available. Along the tract between Bridzor Farm [9335 2735] and north of Wardour Castle [925 271], the lower unit appears to be less than 1 m thick, but is probably the cause of the prominent feature break at the top of the scarp overlooking the River Nadder. Shelly sparite occurs as brash south-east of Wardour Castle [9333 2674, 9296 2654 to 9319 2654] and was worked in two pits [9325 2666 and 9295 2650] nearby. At the first pit, C Reid (Ms, BGS) noted 'rubbly shelly limestone' with 'Ammonites, *Trigonia* and *Ostrea*'. At the second pit, Reid noted 'rubbly limestone with *Trigonia*'. The outcrop of the Tisbury Member passes under the Lower Greensand less than 100 m south of the second pit. Debris from trenches south-west of Parkgate Farm, which included small lydite pebbles (p. 20), is probably part of this basal limestone.

The median sandy unit has a wide outcrop around Wardour Castle [928 269], although it is probable, because of lithological similarity, that the Lower Greensand has also been mapped with this unit. Augering proves ferruginous, buff and brown sand and sandstone.

Limestone of the upper unit was extensively worked in pits around Bridzor Farm [9310 2735], but all are now either infilled or overgrown, as they were when mapped by C Reid in 1900. They were, however, recently temporarily reopened to provide stone for repair work to Old Wardour Castle.

An inlier, beneath drift deposits, occurs in the valley of the River Nadder south-west of Park Gate Farm. Spoil from a trench [9171 2517] included fragments of shelly limestone with bivalves, including *Nanogyra* and *Plicatula*. Debris at a second locality [9180 2528] consisted of shelly limestone with impressions and fragments of the bivalves *Isognomon?*, *Myophorella* (including *?M. incurva*) and *Nanogyra*; rare, small (up to 4 mm) brown and black lydite pebbles were also present.

Wockley Member

The Wockley Member crops out on either side of the southward-flowing stream from Fonthill Bishop where it consists of porcellanous micrite with common moulds of small gastropods.

In a pit [9100 2945] north-west of Newtown, C Reid (Ms map, BGS) saw, presumably beneath head deposits, 0.6 m of chert beds, over 0.3 m of white horse [sic] and white limestone, on chert.

Brash of medium grey, porcellanous limestone with moulds of small gastropods is common south-east of Tisbury Station [around 948 288]. A thin section of a typical clast [9483 2862] shows poorly sorted, fine-to medium-grained, micritised non-ferroan calcite, aggregates of peloidal grains (75%), with rare bioclastic debris in a ferroan spar cement (Lott, 1993).

South of Wallmead Farm, the outcrop of the Wockley Member is difficult to trace across pasture-covered ground, but an overgrown pit [943 282] south-west of the farm formerly exposed 'Chalky Portlandian' (Mottram, Ms map, BGS).

Chilmark Member

The outcrops at Fonthill Gifford [925 315 and 932 305] consist dominantly of fine-grained oolite. The outcrop on the east side of Fonthill Lake includes beds of coarse-grained, oolitic, bioclastic sand, locally with small gastropods [e.g around 944 309]. Beds low in the succession consist of coarse-grained ostracod limestone [9491 3129 and 950 313]. The limestone forms a northward-dipping slope [949 313] south-south-east of Fonthill House.

Purbeck Formation

Oakley Marl Member

The Purbeck Formation, consisting of buff and dark grey marly clay, with thin beds of marly limestone, crops out south of Fonthill House [around 944 317], west of Fonthill in a fault-bounded crop [937 319], and south of Fonthill Gifford [9250 3145]; there is no exposure. For mapping purposes, the base of the formation is taken at the incoming of marl and marly limestone, above limestones of the Portland Group. This may exclude some thin beds of limestone which are classified with the Purbeck Formation in quarry sections, e.g. Woodward (1895). Only strata equivalent to the lower part of the Lower Purbeck Beds of the traditional classification (Woodward, 1895) crop out in the district. They are here named the Oakley Marl Member, with the type locality being the old Oakley (or Wockley or Shavers Bridge) Quarry [9555 2870] south-east of Tisbury (Andrews and Jukes-Browne, 1894). Much of the outcrop [948 311] south of Fonthill House is covered with up to 1.1 m of downwashed, fine-grained, clayey sand and sandy clay derived from the Lower Greensand which caps a small hill [9495 3110]. Mottram (1961, fig. 1) mapped much of this area as Lower Greensand.

3. CRETACEOUS

Lower Greensand

The Lower Greensand, consisting of some 3 to 7 m of fine-grained, buff, commonly glauconitic, slightly clayey sand, crops out as a narrow band beneath the Gault across the whole area. It probably corresponds to the Child Okeford Sands of the Shaftesbury district (Bristow et al., 1995). The overlying Bedchester Sands are either absent or, because of lithological similarity, have been included with the Gault (see below). Mottram (1961) recorded small rounded quartz pebbles in sand in a pit east of the district, and refers to the ease with which the formation can be mapped in the present area by the scatter of polished pebbles across the outcrop of the Lower Greensand. However, no pebble has been found in augering and it is more likely that these surface pebbles are derived from the basal bed of the Gault. Pinkish brown and greyish brown sandy clay within fine-grained glauconitic sand was proved by augering north-east of Totterdale Farm [around 9495 2815].

Reid (1903) found '*Pecten quinquecostatus*' and '*P. orbicularis*', but no diagnostic fauna, in the Lower Greensand of the area, and so its exact age is uncertain. It is presumed to be of Aptian age.

Details

An auger hole [9022 2605] west of East End Farm proved 0.5 m of stony sand, on 1.3 m of glauconitic fine-grained sand with scattered medium and coarse grains, on 0.2 m of glauconitic clayey sand, on 0.3 m of glauconitic, fine-grained, well-sorted sand. North-eastwards from this locality, springs [9041 2620, 9054 2639, 9074 2642 and 9091 2639 to 9088 2627] commonly mark the base of the formation.

An auger hole [9158 2545] west of Park Gate Farm, proved 0.4 m of stony clay, on 0.9 m sandy, glauconitic, micaceous clay, on 0.5 m of brown, clayey, micaceous sand, on sandstone. Another hole [9158 2530] to the south, encountered 0.5 m of stony clay, on 0.9 m of micaceous, very sandy clay, on 0.8 m of clayey, micaceous sand, on 0.1 m glauconitic, fine-grained sand.

Trench sections [9166 2501, 9167 2506 and 9170 2505] south-east of Beauchamp House, showed glauconitic fine-grained sand, beneath head deposits, at a depth of 2.5 m. The sparse microfauna from the first locality includes *Tritaxia* sp., *Arenobulimina* cf. *chapmani* and *A. macfadyeni* indicative of an Early to Mid-Albian age (Wilkinson, 1993).

The junction of the Gault and Lower Greensand was formerly exposed in a pit [9343 2673] north-west of Ark Farm, Wardour. There, beneath the pebbly base of the Gault, 0.9 m of white, well-bedded sands with carbonaceous layers was exposed (Mottram, 1957).

Near Totterdale Farm [around 950 280], the Lower Greensand, although dominantly a glauconitic, fine-grained sand, includes beds of glauconitic, very sandy clay. Near here [c.9485 2820], Reid (1903) recorded 'cherty sandstone with *Pecten quinquecostatus* and *P. orbicularis*'.

North-west of Newton, orange and buff, fine-grained, pebbly sand and sandstone occurs [around 913 296], although much of the outcrop is obscured by cherty clay head deposits.

Gault and ?Bedchester Sands

The Gault crops out in an arc across the southern and south-east part of the area, and in small tract in the north. The formation consists dominantly of a glauconitic, fine-grained sandy clay. The basal beds are usually the most glauconitic. In the east of the district, small, well-rounded pebbles are common in the basal bed, but have not been detected by augering west of Old Wardour.

In the Shaftesbury area, the Bedchester Sands at the top of the Lower Greensand consist of very clayey, very fine-grained sand. In the absence of the basal Gault pebble bed, or in areas where it has not been recognised, it is probable that the Bedchester Sands have been mapped with the Gault (Bristow et al., 1995). Such a situation may exist in the area around Bartholomew Hill [905 256] in the south-west of the district. Locally, as on Round Hill [915 260], there is a thin (up to 5 m) bed of clayey, glauconitic, fine-grained sand about 7 m above the mapped base of the 'Gault'. At one point [9157 2608] on this sand bed, an auger hole proved 1 m of orange-grey sandy clay, on 0.4 m of pebbly ferruginous clay, on glauconitic clayey fine-grained sand. The pebbly clay, together with a ferruginous pebbly clay at the surface to the north [9146 2644], may be the true base of the Gault. Support for this interpretation is provided by the spore *Polypodiaceoisporites foveolatus* from a clayey sand at a depth of 2 m (about 10 m above the base of the 'Gault') in an auger hole [9032 2590] near East End Farm. The spore, characteristic of a marginal marine depositional environment, falls within the range Early Aptian (*deshayesi* Zone) to Early Albian; it is characteristic of the Lower Greensand of southern England and has not been recorded from the Gault (Riding, 1994).

Owen (1971) reviewed the sparse literature on the Gault of the Vale of Wardour. The lower part of the Gault is of Middle Albian age.

Details

The basal beds of the Gault south-west of Broad Oak consist of very sandy, glauconitic clay and clayey sand [9010 2626]; springs issue from the base. On the opposite side of the valley, glauconitic fine-grained sand occurs within the lower part of the Gault. An auger hole [9032 2590] west of East End Farm, about 12 m above the base of the Gault, proved 1.3 m of orange-brown, very clayey sand, on 0.9 m of brown, clayey, fine-grained sand. The lowest sand, which may be the same as that mapped within the Gault on Round Hill, yielded a low-diverisity palynomorph assemblage which included *Clavifera triplex*, *Cyathidites* sp, *Gleicheniidites senonicus*, *?Microfoveolatosporis*, *Polypodiaceioisporites foveolatus*, cf. *Polypodiaceioisporites foveolatus*, *?Callialasporites* sp., *Classopolis* sp., *Botryococcus* sp., *Cymatiosphaera* sp. and *Pterospermella* sp. A nearby auger hole [9034 2597], about 5 m above the base of the Gault, proved 1.2 m of stony, glauconitic, sandy clay, on 0.9 m of soft, glauconitic, sandy, non-micaceous clay, on 0.2 m of firm, buff, glauconitic, non-micaceous sandy clay. From the lowest sample the long-ranging foraminifera *Lenticulina* ex gr. *muensteri* was obtained.

On the south and east side of Round Hill [9144 2615 to 9143 2562], a bed of fine-grained, glauconitic, clayey sand, up to 5 m thick, can be traced.

The old brickpit [9205 2555] south of Park Gate Farm used to work Gault and the lower part of the Cann Sand, but there is no recorded section.

The old pit [9343 2673] north-west of Ark Farm, used to expose 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, on Lower Greensand (Mottram, 1957).

An exposure [9475 2768] in the stream bank at Totterdale Farm showed about 0.5 m of glauconitic and ferruginous sandy clay; there are many lydite and quartz pebbles up to 15 mm across in the overlying soil.

Upper Greensand

Jukes-Browne and Hill (1900) made a five-fold subdivision of the Upper Greensand in the Shaftesbury-Warminster area and gave broad geographical distributions for the units. Their sequence and the terminology adopted in this account is given in Table 3.

Table 3. Classification of the Upper Greensand of the Tisbury district

Present survey	Thickness (m)	Jukes-Browne and Hill (1900)	Thickness (m)
Melbury Sandstone	0-4	Greensand, fossiliferous with nodules and layers of calcareous stone	c.1.2-3
Boyne Hollow Chert	10-14	Chert Beds and sands and sandstone	7.5
Shaftesbury Sandstone (Ragstone at top)	15-20	Green sands with layers of glauconitic limestone or greensand-rock	2.1-3.6
		Green, grey and buff sands, more or less micaceous, with *'Exogyra conica'* and passing down into soft micaceous sandstone with large 'burrstones'	21-30
Cann Sand	15-18	Pale grey malmstone	6

The lowest two units were grouped together as the Devizes Beds (or Zone of *Ammonites rostratus)*, and the three uppermost as the Warminster Beds (or Zone of *Pecten asper* and *Cardiaster fossarius*). The highest bed was locally subdivided into the Rye Hill Sands, overlying the Cornstones.

The thickness of the Upper Greensand in the Tisbury area is between 50 and 60 m. Only 30 m were proved near Berwick St John, south of the district (Bristow, 1991).

Cann Sand

The Cann Sand consisting of 5 to 20 m of very fine-grained, glauconitic, micaceous sand, forms a shelf, some 100 to 200 m wide, beneath the Shaftesbury Sandstone escarpment. Springs commonly issue from the its base. The member falls in the *inflatum* Zone, *varicosum* Subzone (Bristow et al., 1995).

Shaftesbury Sandstone

The Shaftesbury Sandstone consists of 20 to 25 m of mostly very fine- to fine-grained, glauconitic, micaceous sand and weakly cemented sandstone. At the top, there is a calcareously cemented shelly bed, the Ragstone, of sufficient hardness and thickness (1 to 2 m) to have been worked for building stone. The Shaftesbury Sandstone occupies a scarp face capped by the Boyne Hollow Chert and rises steeply from the platform of the Cann Sand. The only common fossils are *Pycnodonte (Phygraea?) vesiculosum, Merklinia* cf. *aspera* and *Neithea gibbosa*. *Pycnodonte* is especially characteristic of the Ragstone. The member probably falls in the top of the *varicosum* Subzone, possibly with the Ragstone occurring in the *auritus* Subzone (Bristow et al., 1995), as suggested by Drummond (1970) who regarded the Ragstone as the lateral equivalent of the Potterne Rock and placed them in the now defunct *aequatorialis* Subzone (= top *auritus* Subzone and lower part of the *dispar* Zone - see Owen (1976)).

Boyne Hollow Chert

The member consists of up to 20 m of fine-grained glauconitic sand with common layers of chert nodules. The chert nodules, generally between 10 and 15 cm thick, occur throughout, but are most common in the lower part. The member caps the escarpment formed by the Shaftesbury Sandstone and, south of the River Nadder, forms long south, or south-south-easterly, sloping dipslopes.

The fauna (Woods and Bristow, 1995) from the Boyne Hollow Chert is not zonally diagnostic, but may indicate the *dispar* Zone (Bristow et al., 1995).

Melbury Sandstone

The Melbury Sandstone consists of fine-grained, fossiliferous, calcareous sands and sandstone. The boundary between the Boyne Hollow Chert and the Melbury Sandstone is not always clear from published sections alone. Similarly, in the field it is not always possible to distinguish the pebbly basal bed from the underlying glauconitic sandstone, locally up to 1 m thick, at the top of the Boyne Hollow Chert. The upper boundary in the field is taken at the base of the incoming of marl, but as with the basal boundary, it is not always clear cut. Almost certainly, there is a complex internal stratigraphy with phosphatic nodules and pebble beds marking erosional events, and with a fauna composed of indigenous and derived specimens. From the published sections and faunal lists alone, combined with the available museum specimens (many poorly located stratigraphically), it is not always possible to disentangle the depositional history (Woods and Bristow, 1995).

Fossils, particularly brachiopods and echinoids, generally abound and indicate the Cenomanian *mantelli* Zone, and possibly the *dixoni* Zone (Woods and Bristow, 1995).

Details

Cann Sand

The lower part of the Cann Sand was worked for brickmaking in the pit [9205 2555] south of Park Gate Farm, but there is no section.

Shaftesbury Sandstone

An old pit [9232 2537] south-east of Park Gate Farm, formerly exposed 12 m of 'greensand', with a 0.6 to 0.9 m thick bed of sandstone at the top, beneath the Boyne Hollow Chert (Reid, Ms, BGS).

There are poor exposures of poorly sorted, dominantly silt in the track [9410 2630] up the scarp face near Old Wardour Castle.

Boyne Hollow Chert

The old pit [9232 2537] south-east of Park Gate Farm formerly exposed 4.5m of 'chert beds (Reid, Ms, BGS). The fields above the pit [around 926 253], and around Horwood Farm to the east [around 943 257], have much chert and silicified sandstone debris in the brash.

Melbury Sandstone

Glauconitic, fine-grained, chert-free sand occurs as brash in the fields south-east [around 943 253] and east [around 9475 2540] of Horwood Farm.

Chalk Group

The Chalk crops out in a small area in the south-east of the district. Throughout much of southern Britain, the Chalk is divided into Lower, Middle and Upper formations. By a combination of feature mapping, lithological variation, macro- and micropalaeontology, and aerial photography, the Chalk can be divided into nine mappable units, each of which is laterally persistent. Only the lowest three units occur in the present district.

Lower Chalk

The junction with the Upper Greensand is fairly sharp and is marked by a abrupt incoming of marl and a rapid decrease in sand content.

The Lower Chalk is divided into the West Melbury Marly Chalk, overlain by the Zig Zag Chalk (Bristow, 1989a). The boundary between the two members is usually marked by an abrupt negative feature break, with the West Melbury Marly Chalk forming a low shelf, and the Zig Zag Chalk rising steeply from it. There is a marked difference in gamma-ray signature between the two units (Bristow et al., 1995, fig. 49). The West Melbury Marly Chalk is equivalent of the lower part of the Chalk Marl of the South Downs succession, and the Zig Zag Chalk to the upper part of the Chalk Marl, together with the overlying Grey Chalk and Plenus Marls.

West Melbury Marly Chalk

The member has an outcrop between 200 and 500 m wide in the south-east of the district. It consists of soft, off-white, creamy and buff marly chalk, which is glauconitic and sandy in the basal part; there are a few thin harder beds of chalk. The base may be transitional with the Upper Greensand over a metre or so. The top of the member is taken at the top of the Tenuis Limestone (Bristow et al., 1995; 1996). This limestone marks the entry of *Acanthoceras*, contains large *Inoceramus tenuis*, and is associated with *Turrilites costatus*. The thickness varies from about 2 to 10 m, but probably averages 2 to 3 m.

Zig Zag Chalk

The term Zig Zag Chalk was introduced by Bristow (1989a) for the 10 to 30 m of firm white chalk that overlies the West Melbury Marly Chalk. The member has a narrow outcrop at the foot of the Chalk escarpment; its base is taken at a marked negative feature break, which appears to correspond to the incoming of thick beds of firm to hard chalk above the gently sloping ground developed on the more marly West Melbury Marly Chalk.

The Plenus Marls are included in the top of the Zig Zag Chalk, because it is not possible to map them separately; they are rarely well exposed. The Plenus Marls give a good gamma-ray signal and are readily recognisable in geophysical logs.

Middle Chalk

The Middle Chalk is defined in East Anglia as the beds between the base of the Melbourn Rock and the base of the Chalk Rock. The Melbourn Rock forms a marked lithological contrast to the underlying Plenus Marls, and is one of the easiest of the Chalk boundaries to map and to pick on wireline logs of wells and boreholes.

The Middle Chalk is divisible into two members, of which only the lower, the Holywell Nodular Chalk, crops out in the district.

Holywell Nodular Chalk

The Holywell Nodular Chalk consists dominantly of nodular chalk, with some weak chalkstones, thin marl seams and, in the higher parts, smooth-textured chalk. It is characteristically rich in *Mytiloides* species, either fragmented or entire. The member has a narrow outcrop in the face of the main escarpment.

Details

Lower Chalk

West Melbury Chalk

The base of the West Melbury Chalk south-east of Horwood Farm, consists of sandy, shelly chalk [9424 2510]. To the south-east, brash from a pit [9435 2507] consisted of soft, white chalk with *Inoceramus* fragments.

4. STRUCTURE

Over most of the district, the structure is very simple with a regional dip of 1 to 2° to the south-east. In the north-west, there is an anticlinal axis of low amplitude, with the strata on the northern border of the district having a gentle north or north-easterly dip.

Small-scale faulting, affecting both the Upper Jurassic and Lower Cretaceous strata, with east-west, north-east, and south-easterly trends, occur in the east and south of the district.

5. DRIFT DEPOSITS

Older Head

In the north-west of the area, there is an extensive spread [906 287 to 928 298] of cherty clay similar to Clay-with-flints. The deposit mostly overlies Portland limestones, but they also partially overlie ?Lower Greensand and Gault. Most of the chert is presumably derived from the Portland limestones, but some may be from the Upper Greensand. The maximum thickness of the deposits is not known, but probably does not exceed 2 m.

Head

Head deposits flank the valley sides and bottoms of most of the valleys in the area. For the most part, they consist of pebbly clayey sand and sandy clay, locally organic; the deposits are commonly glauconitic. The maximum thickness proved is 2.3 m [9200 2560].

Details

In the north-west, an auger hole [9036 2973] proved 1.1 m of clayey sand on 0.1 m of gravel.

In the valley west of East Hatch, an auger hole [9208 2855] sited close to the springline at the base of the Wardour Member, proved 1.8 m of pebbly, glauconitic, sandy clay above Kimmeridge Clay.

On Semley Common, auger holes [9009 2708 and 9013 2722] proved up to 1.2 m of glauconitic sandy clay above Kimmeridge Clay.

On the north side of Hook Copse, an auger hole [9112 2675] encountered 1.7 m of glauconitic, stony clay, on stiff, grey, shelly clay. Farther down this valley, 1.6 m of sandy clay was proved above gravel [9121 2691].

In the Nadder valley, an auger hole [9170 2565] passed through 1.3 m of brown sand, 0.5 m of sandy, clayey, stony gravel, above Lower Greensand. A trial pit [9200 2560] on the opposite side of the valley proved 0.9 m of orange-brown, mottled grey, sandy, silty clay with some gravel, on 1 m of bluish grey, sandy, clayey, silt with much gravel, on 0.4 m of gravel in a sandy, clayey, silt matrix, above Kimmeridge Clay. At Park Gate Farm, an auger hole [9204 2572] encountered 2.3 m laminated, sandy clay. Behind a barn at the farm, a section and auger hole [9209 2582] proved 2.2 m of stony clay. North of the farm, 1.2 m of sandy clay, overlying more than 0.5 m of gravel was proved [9212 2610].

In the broad valley south-west of Wardour Castle, an auger hole [9256 2656] proved 1.4 m of sandy clay, on 0.4 m of gravel, on 0.3 m of very glauconitic, wet, clayey sand. Farther down this same valley, 1.3 m of very glauconitic, sandy clay, overlay 0.8 m of pebbly clayey sand [9228 2671].

West of Hazledon Farm, augering [9314 2799] proved 1.5 m of pebbly, sandy clay. North-east of the farm, an auger hole 9398 2839] encountered 1.6 m of brown sandy clay and clayey sand, on 0.4 m of glauconitic, clayey sand, on 0.1 m of gravel.

In the east of the area, an auger hole [9485 2693] proved 1.2 m of pebbly, glauconitic, sandy clay, above gravel.

River Terrace Deposits

Low-lying deposits of clayey gravel occur principally along the valley of the River Sem and part of the River Nadder in the west of the area. They occur at two levels, the higher, more pebbly, deposits lie about 5 to 6 m above the floodplain, and the lower, more extensive and clayey, spread, about 1 to 2 m above the floodplain.

Details

First River Terrace Deposits along the River Sem consist of sandy clay or clayey sand, 0.7 to 1 m thick, over gravel [905 274 to 9140 2725].

Brash above Second River Terrace Deposits on the north side of the River Sem north-west of Wardour Castle is very pebbly, with clasts dominantly of subrounded chert. An auger hole [9211 2744] proved 2 m of sandy pebbly clay above gravel.

Alluvium

Alluvium occurs along the valleys of the rivers Sem and Nadder, and along the Oddford Brook. There is no permanent exposure, but small sections in the river banks show an upper unit of brown, sandy, commonly organic clay, 1 to 2 m thick, above gravel, 0.3 to 1 m thick.

Landslip

Landslips are developed extensively at the junction of the Upper Greensand and Gault around Bartholomew Hill in the south-west of the area and, to a lesser extent on the Kimmeridge Clay west of West Tisbury.

Detailed investigations have been carried out by Dr T P Gostelow on the slips around Shaftesbury, and the results are published elsewhere (Gostelow, 1991). The present account by Dr Gostelow is a summary of his conclusions of the slips in the Shaftesbury area. They appear to be equally relevant to the Bartholomew Hill area.

Three distinct elements or landforms can be recognised:

i) the Shaftesbury Scarp

ii) the Shaftesbury Platform

iii) the Shaftesbury Undercliff.

Shaftesbury Scarp

The escarpment, about 15-25 m high, with average slope angles of between 30-35°, is a distinct landform which occurs all round the outlier of Bartholomew Hill, and continuosuly along the main escarpment from south-west of Nower's Copse to Ansty Coombe. The scarp face, consisting of Shaftesbury Sandstone capped by the Boyne Hollow Chert, is smooth and vegetated.

Shaftesbury Platform

The platform, underlain by the uncemented or only poorly cemented sands of the Cann Sand, ranges from 50 m to 300 m in width, and slopes from the base of the escarpment at between 3° and 7°. The inner edge, corresponding with the base of the Shaftesbury Sandstone, can be traced as a continuous feature. The outer edge is irregular, but is usually marked by a distinct break of slope and accompanied by springlines.

The platform topography varies from smooth, to gently undulating, to hummocky, with each type passing imperceptibly into another. Hummocky surfaces are more noticeable towards the outer edge where the slope angle steepens slightly. In this part of the platform, a series of crescentic steps of about 1 to 2 m height, separated by 10 to 15 m of intervening flat ground, may occur locally (Bristow, 1989a), but they have not been recognised in the present district. The platform is usually well drained, with little evidence of active springs at the inner edge. Springs are, however, a common feature of the outer margin. In places [9075 2620], there are smooth spurs underlain by Cann Sand that extend beyond and topographically below the main platform. The lowered stratigraphic contact levels suggest that the slopes are cambered.

Shaftesbury Undercliff

The outer edge of the platform is marked by a feature break and prominent spring line, and coincides approximately with the boundary between the Gault and Upper Greensand. The surface of the landslipped Gault lies at an overall angle of between 9° and 12°. There are few signs of active movements, although the presence of fresh back scarps, tilted trees and toe features indicates historically recent activity. At most localities, the undercliff can be divided into an upper steeper portion (9 to 12°) degrading zone, and a lower accumulation zone, which has a lower slope angle (7 to 10°). The slides in the erosional zone are of shallow, successive rotational, type, and up to four separate slipped blocks, usually between 10 m and 20 m across, occur. Depth of slipping is perhaps up to 6 m in places, and small ponds have developed in the upper part of the undercliff.

The extensively landslipped slopes of the undercliff are close to limiting equilibrium. Reactivation could easily be caused by rising groundwater levels in the overlying sand platform, or by cut and fill on the undercliff.

Three principal processes have acted individually, or in combination, to form the scarp, platform and undercliff. These are landslipping, seepage erosion, and periglacial processes such as freeze-tham (cryoturbation). The steep scarp slopes at Shaftesbury are arcuate in plan and resemble deep-seated landslip backscarps. The initial development may have included some small-scale slipping of the Upper Greensand, but there is no evidence of large-scale slipped blocks or relict slip surfaces which pass across the Gault. The limited borehole evidence from the Shaftesbury area suggests that the Gault/Upper Greensand contact below Shaftesbury is continuous and not displaced by slip surfaces.

The long-term development of the Shaftesbury Scarp and Shaftesbury Platform has been controlled by the river system and the rates of lateral erosion, both of which were affected by Quaternary climatic changes. A combination of seepage erosion and periglacial processes was probably responsible for platform development. Hutchinson (1981) has reviewed the processes of seepage erosion, and listed occurrences in the United Kingdom. The process is related to 'piping' failure in loose sands, in which individual grains are dislodged and removed by subsurface groundwater under a high hydraulic gradient. Closely spaced pipes in a sandy stratigraphical unit can cause the overlying strata to collapse or slide onto a shelf formed at the level of erosion. The sand and other debris moves across the shelf either by fluvial erosion or solifluction in a zone of high piezometric water pressures. The scarp face retreats by a combination of backsapping and removal of debris across the platform, the process being most effective where a loose, permeable sand overlies an impermeable clay and is overlain by stronger strata; such conditions are present at Bartholomew Hill. The Cann Sand is uniformly graded, loose and fine grained, and is of the type quoted by Hutchinson (1981) as particularly susceptible to this process.

The common occurrence of a layer of clayey gravel on the platform, and the lack of large sandstone blocks, suggests that cemented Upper Greensand rocks have been broken up by freeze-thaw processes. The movement of this head deposit across the gently sloping platform will have been promoted by solifluction. Head deposits presumably originally continued down to a slope base which has now largely been removed by more recent downcutting and landslipping on the undercliff.

The later phases of the development of the scarp, platform and undercliff took place in four stages.

Stage 1 assumes an initial erosional slope of Gault and Upper Greensand which was formed by fluvial downcutting and erosion during the early Pleistocene. The water table is assumed to have been high and to have provided a hydraulic gradient sufficient to cause piping or back sapping in the lower portions of the Upper Greensand.

In Stage 2, the scarp collapsed and the debris was removed by fluvial and solifluction processes, possibly with the formation of secondary steps. It is assumed that the point of erosion at the base of the scarp moved back across the platform, because the debris on the shelf probably arrested the seepage-erosion process.

This migration of the erosion point led to Stage 3 in which the platform widened, and the escarpment decreased in height.

In Stage 4, the present situation, the water table has fallen and, for the most part, there is now no spring at the escarpment base; thus, further backsapping is prevented. Renewed toe erosion and oversteepening has caused landslipping on the Gault, and the main seepage is now at the outer edge of the Platform, leaving the Shaftesbury Scarp as an abandoned erosional slope.

Future stability may depend on variations in the water table and also on changes in hydraulic properties at seepage faces, especially close to spring lines near the platform edge. Alterations, by cut and fill or building construction, may lead to a build up of water pressure in sand layers causing instability tens or hundreds of metres away. Piezometric instrumentation is recommended before any development takes place in the Bartholomew Hill area.

Cambering

Cambering probably developed under conditions of perennially frozen ground associated with a periglacial climate; it is commonly associated with overconsolidated clays with high lateral stresses. Outward flow of clay from beneath the cambers towards the valley bottom and its removal by stream erosion appears to be an essential part of the cambering process. Small-scale faulting is usually developed in the overlying strata.

Details

In the field, the thickness of the Wardour Formation appears to vary from 10 to 15 m, but this apparent reduced thickness compared to that in the Tisbury Borehole is thought to be due to cambering of the overlying limestones across the upper part of the outcrop of the Wardour Formation. Examples of cambered outcrops of the Tisbury Member include shelly micrite just above the track south-east of Pythouse [9074 2847]; limestone in the road cutting [9118 2813] east of Hatch House; large blocks of shelly, oomicrite dipping 45° valleywards on the north side of Oddford Brook [9412 2930]; steeply (up to 40° at 80°), valleyward-dipping beds, in a quarry [9351 3107] near Ashleywood, and a steeply dipping block of fine-grained, glauconitic sandy sparite on the north side of Tisbury [9449 2977].

The base of the Upper Greensand on some smooth-surfaced spurs in the landslipped ground falls steadily away from the scarp. In places [9075 2620], there are spurs underlain by Cann Sand that extend beyond, and topographically below, the main outcrop. The lowered stratigraphic contact levels suggest that the slopes are cambered.

Swallow holes

Swallow holes are developed over limestones of the Tisbury Member south of Ruddlemmor Farm [9060 3046, 9072 3038, 9077 3033, 9077 3032 and 9076 3028], on Gault over Lower Greensand and the ?Tisbury [9282 3077, 9288 3076, 9285 3071, 9285 3069 and 9279 3059] and ?Chilmark members south [9262 3109] and south-west [9210 3136] of Fonthill Gifford.

ECONOMIC DEPOSITS

Building Stone

The Tisbury Member has been extensively quarried as a source of building stone: near Ruddlemoor Farm [9058 3032, 9085 2965], at West Tisbury and West Hatch [9125 2849, 9130 2846, 9134 2826, 9138 2882 and 9158 2887], north-west of Newtown [9100 2945], at Lawn Quarry [9245 2990] (the artifical crags of fine-grained, patchily shelly, glauconitic sandstone around Bitham Lake in the grounds of Fonthill Abbey came from Lawn Quarry), Tisbury Quarry [931 291] and nearby [9297 2920], at Tuckingmill [935 291 and 936 290], Fonthill Gifford [9327 3132, 9336 3137 and 9351 3107], Quarry Wood, Fonthill Gifford [9353 3173, 9356 3169 and 9370 3162], Tisbury [9465 2890, 9469 2901], near Hazeldon [9400 2809 and c.9375 2820], south-east of Wardour Castle [9325 2666 and 9295 2650] and Bridzor Farm [9310 2735]. The last quarry was reopened briefly to supply stone for the repair of Old Wardour Castle.

There is now no working quarry in the Tisbury area, the last, Tisbury Quarry [931 291], having closed in 1977. An account of the working of this pit is given by Manners (1971).

Building Sand

Lower Greensand was dug, presumably for building sand from a pit [9346 2676] north-west of Old Wardour Castle.

Brick Clay

A pit [9205 2555] at Donhead St Andrew, sited on Gault, was probably worked for brick clay.

Marl

A pit [9493 2504] in Zig Zag Chalk south-east of Old Wardour was probably opened for lime.

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