CHAPTER II

REGIONAL GEOLOGY

by C. Roger Bristow and Bernard C. Worssam

The geology of south-west England is indicated in outline in Fig. 9 below; the succession of strata is shown in Table 1.

In the south-west of the district is the high ground formed by the Carboniferous Dartmoor Granite intruded into older Carboniferous deposits.

The Jurassic limestones, which provide most of the stones used in Anglo-Saxon sculptures, form prominent, mostly west-facing, escarpments. The Inferior Oolite is a persistent unit that extends in an approximate north-south line across the whole district. In the northern part of the district are the Cotswold Hills underlain by the limestones of the Great Oolite Group. These limestones only extend to just south of Bath, and are replaced southwards by clays. The outcrops of the Corallian and Portland groups are intermittent as they are overlain, in part, by the unconformable Cretaceous Gault and Upper Greensand formations.

The Upper Greensand gives rise to a prominent escarpment in the southern part of the district and forms the high ground of the Blackdown and Haldon Hills, respectively north-east and south-west of Exeter. The Chalk, which has a wide outcrop in the east of the district, gives rise to tracts of high ground with a generally open aspect.

The Palaeogene sands and clays occur in a downfold in the Cretaceous strata in the south-east of the district and occupy the western part of the Hampshire Basin.

In the centre of the district are the alluvial and peaty deposits forming the low-lying Somerset Levels.

Table 1 shows the relation between chrono-stratigraphical divisions based on geological age, and lithostratigraphical divisions (as in Fig. 9), represented in south-west England.

STONE TYPES USED FOR THE SCULPTURES

The various types of stone used for sculptures are described in stratigraphical order. Geological formations may contain other beds than those of building (or sculptural) stone quality: for example, not all the Chalfield Oolite Formation is made up of Bath stone.

Both sandstones and limestones were used, and most in each category were arenites, i.e. having sand-sized particles. Arenites lie within the total size-range 0.06–2 mm diameter. Fine-grained arenites have particles up to 0.2 mm diameter, medium-grained 0.2–0.6 mm, and coarse-grained from 0.6–2 mm. For identification, the stone of each sculpture was examined by hand lens with a built-in measuring grid, allowing the diameter of the grains above 0.1 mm to be measured with confidence.

The main type of stone used was Bath stone from the Chalfield Oolite Formation, which was widely exploited in the Bath area. In addition, some ten types of stone from localities in, and one (Taynton stone) from just outside, south-west England were used. A few carvings are of stone of uncertain provenance. See Fig. 8.

DARTMOOR GRANITE by R. C. Scrivener

Dartmoor is the largest of the granite bosses that trend west-south-west from Exeter to Land's End and covers an area of some 250 square kilometres. Characteristically, the granite gives rise to rugged tors overlooking areas of moorland or rough pasture. In general, the granite consists of quartz, perthitic orthoclase crystals up to 17 cm long, plagioclase and dark brown mica (biotite). Common accessory minerals are tourmaline, zircon and apatite.

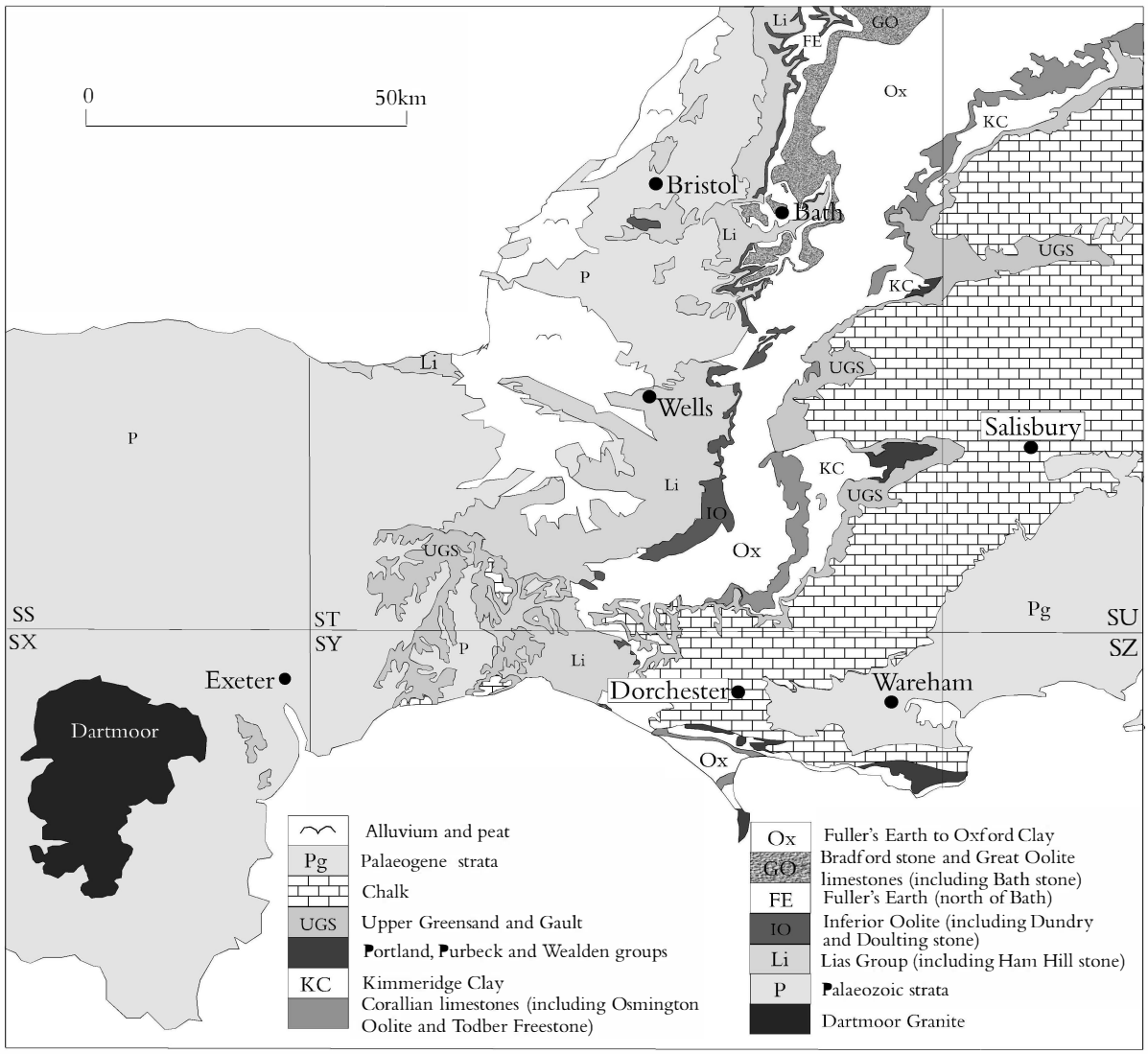

FIGURE 9

Geology of south-west England

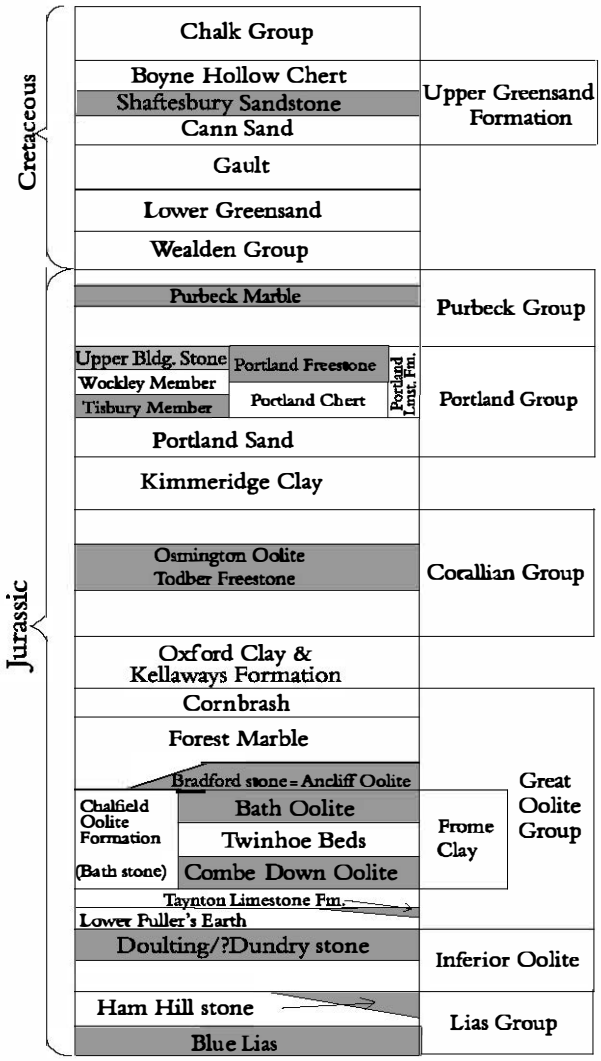

TABLE 1

Generalised vertical section (not to scale) of the Mesozoic strata in south-west England.
Stone used for Anglo-Saxon sculptures highlighted

In general, the granite can be divided into an upper (outer) one of 'giant' granite which forms most of the tors and is characterised by large rectangular feldspar crystals, and a lower (inner) one of 'blue' that contains fewer and smaller feldspar megacrysts. Muscovite (white mica) occurs as a secondary mineral resulting from post-crystallisation pneumatolytic or hydrothermal activity, and its presence commonly renders the granite more amenable to being carved or shaped (cf. the Copplestone 1 and Exeter 1 crosses).

The typical granite of most of northern Dartmoor, the nearest part of the outcrop for the four granite carvings in the present area, is a coarse biotite granite with variable abundance of K-feldspar megacrysts and does not appear to be the source of the stone for these carvings. The closest match for Copplestone 1 would be the granite of the Merrivale area near Princetown, where coarse-grained biotite-muscovite granite was worked at Merrivale Quarry until recently. The stone of Exeter 1 could be a 'contaminated' granite of the type formerly worked at Sweltor in southern Dartmoor. The Plymstock 1 cross is typical of granite on the south side of the batholith. The very fresh and hard biotite granite with sparse K-feldspar megacrysts of the Chulmleigh 2 stone (Appendix B) is very similar to that quarried in the Haytor 'blue' granite quarries in the nineteenth century, and extensively used for building and facing stone, also by monumental masons. Because of its relative intractabilty to the techniques used by the early masons, Chulmleigh 2 may be a late fake.

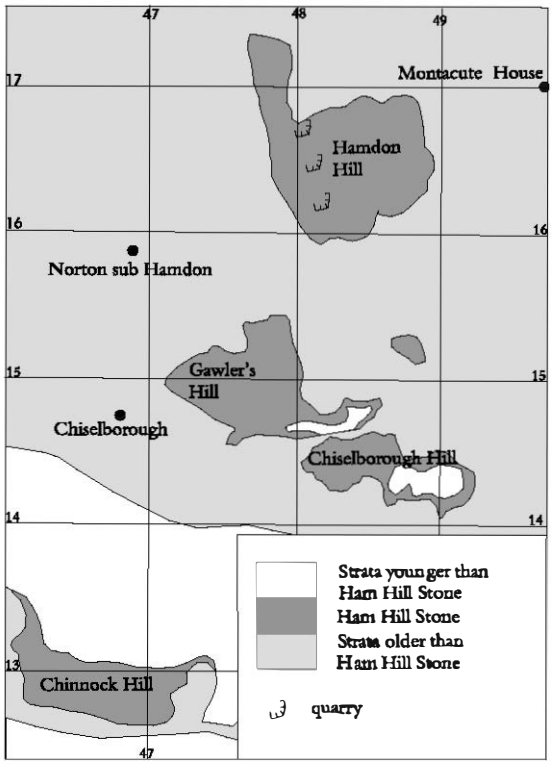

FIGURE 10

Outcrop of the Ham Hill Stone

LIAS GROUP, BLUE LIAS FORMATION

The Blue Lias Formation consists dominantly of an alternating sequence of hard, bluish grey, fine-grained, sparsely shelly limestones up to 0.25 m thick, alternating with grey mudstones of similar thickness. The formation, which is thick (up to 144 m) and widespread in Somerset, thins over the Mendips and is only about 5 m thick north of the Mendips in Gloucestershire.

In Somerset, the Blue Lias has been widely, and still is locally, quarried as a building and walling stone, but, because of its hardness, has rarely been used for sculptures. It has also been widely used for gravestones, but is not particularly long-lasting as weathering causes it to split and flake.

One carved stone (Muchelney 4) from Muchelney Abbey (much of which is built of Blue Lias limestone) is a pale grey, sparsely shelly micrite and resembles the limestones of the Blue Lias, except that it is fairly soft (it easily marks with a soft wire brush) and presumably is fairly easy to carve.

LIAS GROUP, BRIDPORT SAND FORMATION, HAM HILL STONE MEMBER

The Ham Hill stone, named from Hamdon Hill, south of Stoke-sub-Hamdon, Somerset, is an orange-brown, shelly, strongly cross-bedded (not obvious in small blocks) limestone developed at the top of the Bridport Sand Formation over a limited area in southern Somerset (Fig. 10). Because of superficial lithological similarity, the Ham Hill stone has sometimes been included as part of the Inferior Oolite. However, in lithological detail and age (as determined by ammonites) it can be distinguished from the Inferior Oolite. The stone on Chiselborough Hill about 2 km south of Hamdon Hill has also been called North Perrott stone (Green 1998). Although the Ham Hill stone is up to 27 m thick, only about 15 m of it is suitable for working as a high-class freestone. The stone has been worked from Roman times (Wilson *et al.* 1958, 63) and can be found in buildings over a wide area (Thomas 1990, 297; Robinson 1995, 163–4); Montacute House and Sherborne Abbey are good examples.

It continues to be worked as a building stone and stone for renovation at both the northern and southern end of Hamdon Hill.

Sculptured Ham Hill stone has only been identified at two localities (Muchelney, Somerset and Stinsford, Dorset). At Muchelney, two (Muchelney 2 and 3) of the four sculptured stones are of Ham Hill stone. One (Muchelney 2) is a very pale orange (10YR 8/2), very shelly limestone. Most shells (bivalves) are elongate and vary from 0.5 to 6.0 mm across and vary from sub-angular to sub-rounded and are clast supported. A crude alignment can be seen with a hand lens. The second stone (Muchelney 3) is a pale yellowish orange (10YR 8/6) shelly limestone. The shell clasts are in the range 0.5 to 5.0 mm, but most are about 2 mm across. The clasts are sub-rounded to elongate (most common) and clast-supported. The yellow, ferruginous, matrix is fairly soft. The Stinsford 1 angel is a greyish orange (10YR 7/4), coarsely shelly, matrix-supported limestone, with a matrix of crystalline calcite. A few scattered quartz grains and ooliths (or very well-rounded shell fragments) occur, together with a few, small scattered dark (?siderite) grains and with some larger (up to 3 mm) dark fragments. Some of the well-rounded clasts and larger patches are limonitised. Shell fragments (thin bivalves), up to 10 mm across, not aligned and generally pale grey in contrast to the matrix, occur.

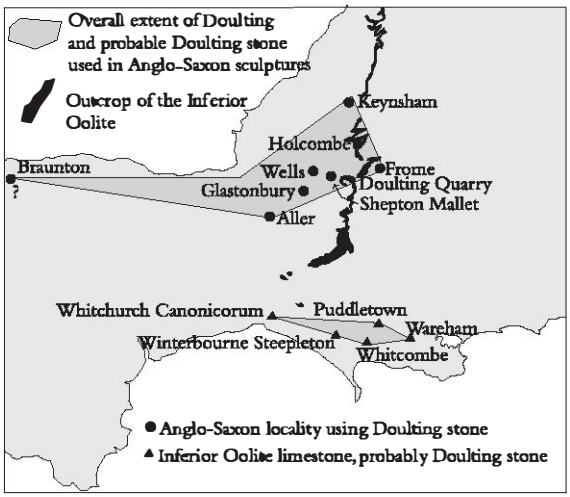

FIGURE 11

Distribution of Anglo-Saxon sculptures using Doulting stone

INFERIOR OOLITE GROUP, UPPER INFERIOR OOLITE 'FORMATION', DOULTING STONE MEMBER

The Inferior Oolite Group is a widespread and persistent limestone unit across the present district. North of the Mendips, the Inferior Oolite is up to 100 m thick and can be divided into mappable formations. From the Mendips southwards to the Dorset coast, the Inferior Oolite is generally a thinner (1–25 m), but nevertheless persistent, unit. Within this latter tract, however, the Inferior Oolite cannot be subdivided into mappable units and is regarded as a formation (see Bristow *et al.* 1995; id. 1999, 30). However, to conform with earlier Corpus volumes, in this account it is afforded group status. It appears that stone from the Mendip area, and also farther south in southern Dorset, has been used for Anglo-Saxon sculptures.

Where well developed, the Inferior Oolite can be divided into three 'formations' (Lower, Middle and Upper). For the most part, south of the Mendips, the Lower and Middle Inferior Oolite is thin or absent and it is the Upper Inferior Oolite which has been widely quarried for building stone and used for sculpting. In Dorset alone, Thomas (1990) records 138 quarries in 20 parishes; the last working quarry, near Beaminster, closed in about 1999. In north Dorset, a grey, fine-grained, sandy limestone (see Bristow *et al.* 1995, pls.1C and 1D), up to 15 m thick, the Sherborne Building stone, has been extensively quarried as a local building stone. It has been used in the exterior walls of Sherborne Abbey. Farther north, in south Somerset, the equivalent of the upper part of the Sherborne Building stone consists of massively bedded, somewhat nodular, ferruginous, brown, sparry, peloidal detrital, very fossiliferous limestone (see Bristow *et al.* 1999, pl. 2) and is known as Hadspen stone. It was used in the construction of Hadspen House. The best-known and most widely used Inferior Oolite stone in south-west England is Doulting stone from Doulting, about 4 km east of Shepton Mallet, Somerset. The stone has been worked from Roman times up to the present day. Doulting stone, up to 9 m thick, is a warm, yellowish orange (10YR 7/6) where freshly exposed (see Bristow *et al.* 1999, pl. 1), but weathers to a yellowish grey (5Y 7/2 or 5Y 8/1), cross-bedded, medium- to coarse-grained, bioclastic limestone formed largely of the fragmented remains of crinoids. It had been widely used for local buildings (e.g. Wells Cathedral and Glastonbury Abbey) and farther afield in Oxford, London and other cities. Similar, but paler, bioclastic limestones (with coral fragments) on Dundry Hill to the west are known as Dundry freestone.

Doulting stone is the only unit of the Inferior Oolite to be identified with certainty that has been used in Anglo-Saxon sculptures in south-west England. It has been recognised at Aller 1, Frome 2, Glastonbury 8, Holcombe 1, Keynsham 13, Shepton Mallet 1 and 2, and Wells 5 (all in Somerset) (Fig. 11). Although at most places yellowish grey (5Y 7/2), at Aller it is a pale yellowish brown (10YR 6/2), clast-supported, bioclastic limestone. Clasts vary from sub-angular to rounded and from 0.2 to 5.0 mm across, but most are in the range 0.3 to 2.0 mm.

Stones used for Puddletown 1 and 2, Wareham 1–9, Whitchurch Canonicorum 1, Whitcombe 1 and 2, and Winterbourne Steepleton 1 and 2 (all in Dorset) differ from typical Doulting stone by their better grading and the higher proportion of well-rounded clasts, some of which closely resemble ooliths. Stones from these last localities consist of yellowish grey (5Y 7/2) or pinkish grey (5YR 8/1), fairly well-graded, medium-grained, bioclastic limestone, with bioclasts sub- to well-rounded and clast supported; clasts range from 0.2 to 1.0 mm across, but most are in the range 0.3 to 0.6 mm. The source of these stones has not been determined. They are presumed to be Inferior Oolite as their lithology is typical of that formation and possibly these are the 'Top Beds' or 'Top Limestones' formerly exposed in many of the quarries in west Dorset (Wilson *et al.* 1958, 76) (one of the lithologies present in the last-worked pit near Beaminster is a medium-grained bioclastic oolite). As the Inferior Oolite has been so widely exploited in Dorset, a Dorset origin seems likely.

GREAT OOLITE GROUP, TAYNTON LIMESTONE FORMATION (TAYNTON STONE)

The Taynton Limestone Formation provides a good-quality building stone, Taynton stone, at its outcrop along the valley of the river Windrush, a tributary of the Thames, for some 10 km upstream from Burford, Oxfordshire (see Arkell 1947b; Worssam and Bisson 1961). Quarries at Taynton, 2 km west of Burford, were mentioned in the Domesday Book (Morris 1978, 13, 1). The formation, up to about 12 m thick, consists of massive, cross-bedded shelly oolitic limestones, that originated as underwater dunes in a shallow sea. On lithification, pore spaces between the constituent ooliths and shell fragments became infilled with calcite, a crystalline form of calcium carbonate. The calcite cement predominates in streaks with more abundant shell fragments that weather out as ribs or 'bars'. Stone from the Taynton quarries has typically a brownish yellow colour, while that from other localities, e.g. Sherborne, Windrush and Burford, is a paler, yellowish grey.

The formation is overlain by the clayey Hampen Formation, and that in turn by the White Limestone and the Forest Marble. It is underlain by a thin Fuller's Earth clay (Worssam and Bisson 1961). The work of Wyatt (1996) and others has shown that southwards along the Cotswolds the Taynton Limestone and overlying beds, up to near the top of the White Limestone, pass laterally into the upper part of the Fuller's Earth of the Bath district.

The Anglo-Saxon sculptures at three localities, Inglesham, Cricklade and Eysey (all in Wiltshire), are identified as of Taynton stone. At Inglesham is a large carved slab of pale brownish yellow (10YR 8/3–4) unevenly graded shelly oolite. Only one surface, probably a bedding plane, is exposed. However, the columns of the early thirteenth-century south nave arcade of Inglesham church match the lithology of the slab, and also, in cross-section, show the hard shelly streaks or 'bars' that typify Taynton stone. The locality is on the river Thames and less than 20 km from Taynton.

Both Cricklade 1 and 2, built into a wall in the north porch of St Sampson's church, also show only one face of the stone, which however in texture and colour resembles the stone at Inglesham. Like Inglesham and Eysey, the town has a Thames-side location.

GREAT OOLITE GROUP, CHALFIELD OOLITE FORMATION (BATH STONE)

Bath stone is a yellowish grey (10YR 8/2–3) cross-bedded oolitic limestone, consisting predominantly of ooliths of 0.3 to 0.6 mm diameter, together with ovoid pellets up to 0.9 mm in length and scattered shell fragments of 5 mm or so diameter, in a crystalline calcite matrix. On weathering, ooliths at the surface of the stone, being relatively soft, are eroded away to leave a hard pitted calcite surface. A feature of much Bath stone is the existence of calcite veinlets of about 2 mm width, cutting across the bedding; the veinlets are known to quarrymen as 'watermarks'.

Bath stone was the principal stone in use for Anglo-Saxon sculpture in Wiltshire, in Somerset and in the northern part of Dorset. It had been used by the Romans both in Bath and for large monumental works in London. Perkins *et al.* (1979) tentatively identified two areas of Roman quarrying: just south of Bath near the Fosse Way (on Odd Down); and east of Bath, near Box. Some Anglo-Saxon sculpture may be of re-used Roman stone from Bath, but Biddle and Kjølbye-Biddle (1995, 102–5) found

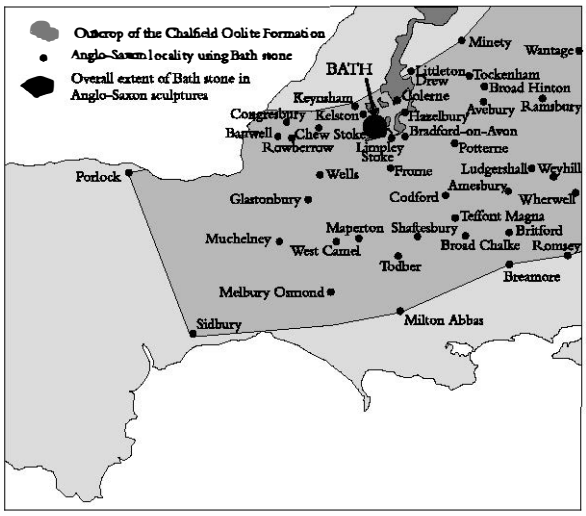

FIGURE 12
Distribution of Anglo-Saxon stone types using Bath stone

compelling evidence from their Winchester excavations that Bath stone had been freshly quarried at all Anglo-Saxon periods from the seventh century onwards.

At least from the twelfth to the sixteenth centuries quarrying seems to have been concentrated at Hazelbury, near Box. Old workings there are indicated by 'hills and hollows' in a wood (ST 832688) just below the crest of a steep escarpment on the east side of the Avon valley. Records have survived of grants of stone from Hazelbury to religious houses from *c.* 1189 to 1306, and in the fifteenth and sixteenth centuries for Great Chalfield Manor House and Longleat House (Saunders 1959); while the fabric accounts of Salisbury Cathedral record freestone 'brought from Haselbury' in 1479–81 (Tatton-Brown 1998). Early quarries at Hazelbury would have been rather better placed for the transport of the stone eastwards towards its main markets, by cart across a gently sloping terrain, than quarries at Odd Down or Combe Down, west of the deeply cut Avon valley.

In the early nineteenth century, the term Great Oolite, based on the Bath area, was introduced for oolitic limestones that occur as a group between the Fuller's Earth (mainly clays), below, and the Forest Marble (shelly limestones and clays), above. Green and Donovan (1969) defined the Great Oolite as a lithostratigraphical unit comprising four subdivisions: the lowest being the Combe Down Oolite; separated by rubbly and marly limestones named the Twinhoe Beds from the Bath Oolite, above; and that in turn overlain by a highest or 'Upper Rags' division. Penn and Wyatt (1979) transferred the Upper Rags to the Forest Marble. Wyatt and Cave (2002), in view of potential confusion arising from the use of Great Oolite as a formation name, as well as for the larger unit the Great Oolite Group, have proposed the term Chalfield Oolite Formation for Green and Donovan's Great Oolite exclusive of the Upper Rags (see also Sumbler *et al.* 2003).

Not all of the Chalfield Oolite Formation is of building-stone quality. The principal worked freestones occur in the upper part of the Combe Down Oolite and in the Bath Oolite in the Bath vicinity. On approaching an east–west line about 8 km south of Bath the whole Chalfield Formation passes laterally into a clay formation, the Frome Clay. This area is shown in Fig. 13 (which is based on fig. 3a of Green and Donovan (1969), with isopachytes from Penn and Wyatt (1979)). The Chalfield Oolite extends for some 15 km northwards from the area included in Fig. 13 (see Wyatt and Cave 2002, fig. 1). There is little evidence of freestone having been worked in that northern tract.

The resistance of Combe Down Oolite to weathering tends to be better than that of stone from the Bath Oolite, the matrix of which may include micrite (fine-grained calcite). While most Anglo-Saxon Bath stone shows good resistance to weathering and may well be from the Combe Down Oolite, the distinction between this division and the Bath Oolite at Hazelbury and at nearby Box Hill (Green and Donovan 1969, 22–3) is not clearly marked, since the Twinhoe Beds that separate them are there thin, approaching their northern limit. If, therefore, Hazelbury was a main source of Anglo-Saxon, as well as of later medieval stone, the possibility of some of it being

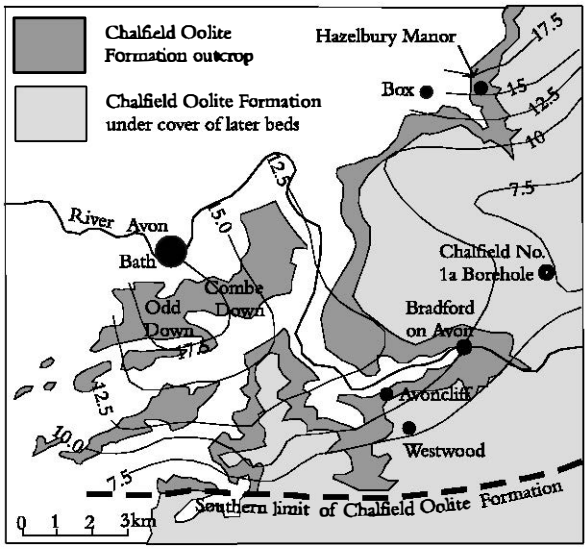

FIGURE 13
Isopachytes in metres of the Chalfield Oolite Formation in the vicinity of Bath

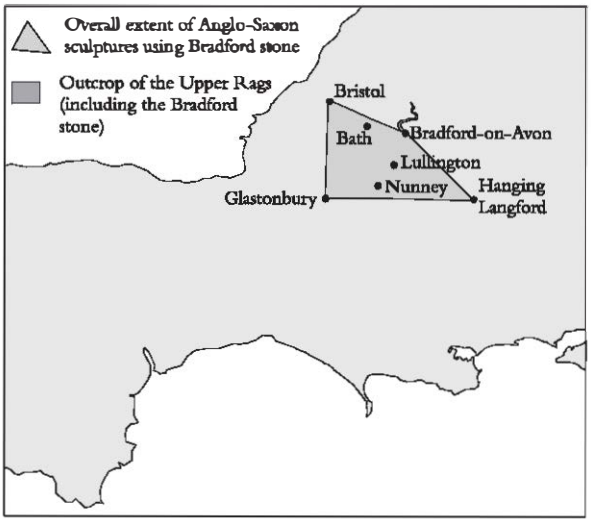

FIGURE 14.

Distribution of Anglo-Saxon carved stones utilising Bradford stone

Bath Oolite cannot be ruled out. Calcite veinlets are to be seen in many Anglo-Saxon Bath stone sculptures. They are known from the Combe Down Oolite, but whether they occur in the Bath Oolite also is uncertain. In this volume, therefore, the term Bath stone rather than Combe Down Oolite is used in description of Anglo-Saxon sculptures.

GREAT OOLITE GROUP, FOREST MARBLE FORMATION, ANCLIFF OOLITE MEMBER (BRADFORD STONE)

The Upper Rags division extends northwards from Bath as far as Cirencester and then eastwards to near Fairford (Penn and Wyatt 1979, 46; Wyatt 1996, 314). Over most of this tract it consists mainly of variably oolitic, coarsely shell-fragmental limestones. In the Bath area, Green and Donovan (1969, 19–22) recognised three subdivisions of the Upper Rags, comprising basal shelly beds 1 to 2 m thick and including the Corsham Coral Bed; overlain by the Ancliff Oolite, up to 8 m thick; capped by the Bradford Coral Bed up to 2.5 m thick. The Ancliff Oolite, named after Ancliff or Avoncliff, is described as consisting of detrital-shelly oolitic limestones becoming more purely oolitic southwards, so that south and east of Westwood (Fig. 13) they have been worked as a freestone. In this account, stone from the Ancliff Oolite is referred to as Bradford stone. Its shelly nature, often with layers of shell fragments along planes of crossbedding, distinguishes it from Bath stone. Among the shell debris, fragments of polyzoa (or bryozoa) are common.

Mr G. W. Green (pers. comm.) has kindly identified the stone used in the construction of St Laurence's Chapel in Bradford-on-Avon, and for the decorated slab (Bradford-on-Avon 5) in the chapel, as Bradford stone. Quarrying of the stone therefore undoubtedly took place in the Anglo-Saxon period. The Ancliff Oolite crops out on the slopes of the Avon valley at Bradford, dipping eastwards to river level within 1 km east of the town, and stone could have been transported downstream along the Avon from quarry workings to sites such as Bath Abbey (Bath 1 and 2) and Bristol. Additionally, Bradford stone has been recognised at Glastonbury, Nunney, Lullington and Hanging Langford (Fig. 14).

CORALLIAN GROUP, OSMINGTON OOLITE FORMATION/TODBER FREESTONE and CLAVELLATA FORMATION, ECCLIFFE MEMBER

There are two principal outcrops of limestones of the Corallian Group in south-west England: in south Dorset from Redcliff Point north-east of Weymouth to Abbotsbury, and from near Buckland Newton in mid-Dorset to just north-east of Wincanton in south Somerset. In Wiltshire, there are smaller outcrops near Trowbridge and Calne. Within these tracts, it is only the upper part of the Group which contains limestones and it is only some of the higher limestones (Calne Freestone, Osmington Oolite and Todber Freestone) which have been worked as freestones. A locally developed freestone unit, the Eccliffe Member, at the top of the Clavellata Beds, is present between East Stour and Bourton in north Dorset. In hand specimen, it is almost identical to the Todber Freestone. Other, more massive or flaggy, limestones (Cucklington Oolite, Clavellata Beds) have been used as building or walling stones.

Thomas (1990, 298–9) notes that Abbotsbury Abbey is built of Osmington Oolite which probably came from large quarries on Linton Hill to the east of the Abbey. These quarries fell into disuse in the nineteenth century. In the northern tract, both the Todber Freestone and Clavellata Beds were extensively worked for building stone (much of the villages of Hinton St Mary, Marnhull, Todber and Stour Provost are built of these stones). All are now disused, although the last one did not cease operations until about 1999.

No sample of Calne Freestone has been examined. Green (1998, 12) describes it as a 'white, cross-bedded, pellet limestone with much well-rolled fossil debris'.

Samples of the Todber Freestone from the type locality consist of yellowish grey (5Y 8/1), medium-grained, well-graded, matrix supported, variably shelly, cross-bedded

oolite. The ooliths, which vary from 0.3 to 0.6 mm diameter, mostly weather proud in hand specimen, but a few break across or weather out to leave small depressions. The ooliths are closely packed, but nevertheless occur 'floating' in a crystalline matrix (see Bristow *et al.* 1995, pl. 6B). Sparse, comminuted, thin, shell fragments (?bivalves), up to 5 mm across occur. The only whole fossil is the occasional burrowing echinoid *Nucleolites scutatus*.

Samples of Osmington Oolite from Linton Hill, Abbotsbury, vary from yellowish grey (5Y 7/2) to greyish orange (10YR 7/4), medium-grained, well-graded, matrix-supported, patchily shelly, oolite. The ooliths are mostly between 0.4 and 0.6 mm in diameter, although a few are up to 0.9 mm. The density of the ooliths varies from almost touching, to much more obviously 'floating' in a crystalline matrix. Thin platy (?bivalve) fragments, up to 6 mm across have abraded to well-rounded margins. A few larger shell fragments (up to 1.5 mm long by 2 mm thick) also occur.

It is the matrix-supported nature of the ooliths which distinguish the Corallian Group oolitic limestones from those in the Portland Group (see below). However, this distinction is not always clear cut in some of the poorly exposed and/or badly weathered Anglo-Saxon sculptures.

Sculptures at Banwell, Dolton, Colyton and Yetminster are attributed to the Corallian Group. The Toller Fratrum angel (Appendix B) is too heavily encrusted for certain identification and is only tentatively regarded as from the Corallian Group (it could equally well be from the Portland Group).

PORTLAND GROUP, PORTLAND STONE FORMATION, TISBURY and UPPER BUILDING STONE MEMBERS (Vale of Wardour) and PORTLAND FREESTONE MEMBER (Isle of Purbeck)

The Portland Group in south-west England crops out in four main areas: in Dorset on the Isle of Purbeck, on the Isle of Portland, and from near Osmington to Portesham in the west, and in Wiltshire in the Vale of Wardour. It has been worked, extensively in places, as a building stone wherever it occurs.

The Portland Group is divided into two formations: the Portland Sand below and the Portland Stone above. In Dorset, the Portland Stone is divided into two members: the Portland Chert below and the Portland Freestone above. It is stone from the latter member which has been widely used for building (e.g. St Paul's Cathedral) and, locally, for Anglo-Saxon sculptures. In Dorset, the Portland Freestone thins westwards from about 15 m at Portland to 4.5 m near Portesham. In this latter area, the unit is known as the Portesham Stone (Green 1998).

Thin sections of Portland Stone (Base Bed freestone, Whit Bed freestone, Fancy Beach Bed stone) from the Isle of Portland examined by Dr G. Lott of the British Geological Survey, are fine- to medium-grained, with the medium-grained ooliths mostly in the range 0.25 to 0.35 mm, but with a few larger ones. Fine-grained 'ooliths' appear to be peloidal, rather than oolitic. All the thin sections show good intergranular porosity with little or no spar cement; the ooliths are held together at point of contact. The bioclastic debris, which can be coarse-grained, varies from sparse to abundant.

In the Vale of Wardour, the Portland Stone has traditionally been divided into three units: in ascending sequence, the Lower Building Stones, a median unproductive unit, and the Upper Building Stones (Blake 1880; Woodward 1895). Wimbledon (1976) formalised the stratigraphical nomenclature and recognised four members. More recently (Bristow 1995; Bristow *et al.* 1999), modified Wimbledon's scheme to include only three members: in ascending sequence, the Tisbury (15–25 m thick), Wockley (0–15 m thick) and Chilmark (0–?10 m thick) members.

The Lower Building Stones are generally referred to as Tisbury stone or Tisbury freestone in the Tisbury area, and Chilmark stone in the Chilmark area. It is unfortunate that there is potential confusion between the terms Chilmark Member (Wimbledon 1976) and Chilmark stone. To avoid any ambiguity, in this account, we revert to the old name of Upper Building Stones for stone from the Chilmark Member

The Tisbury Member has a wide outcrop on either side of Tisbury, and occurs as a narrow inlier in the Chilmark valley (Fig. 15). It has been extensively used as a building stone (e.g. in Salisbury Cathedral (Tatton-Brown 1998), Wilton House, Old Wardour Castle). The medieval quarries just east of Tisbury that may have supplied the large amount of 'Chilmark stone' needed for the construction of Salisbury Cathedral (Tatton-Brown 1998, 41), may have also been in existence in Anglo-Saxon times. Some thirty-three quarries are known in the Tisbury and Chilmark areas; two (Chicksgrove and the Lower Quarry, Chilmark) are worked at the present day (Fig. 15).

The Tisbury Member has commonly been referred to as a calcareous sandstone, but in fact, thin sections of 50 samples studied under the microscope by Dr G. Lott from across the whole outcrop and from boreholes show that it is really a fine-grained, sandy, locally very sandy, bioclastic limestone. The quartz sand content varies from 4 to 42 per cent, but averages about 30 per cent (Bristow *et al.* 1999, 64). The sub-angular to sub-rounded quartz

grains vary from 0.06 to 0.18 mm across; the bioclastic debris varies from 0.25 to 0.35 mm. Tatton-Brown's (1998, 41) statement that Tisbury stone is less green (i.e. less glauconitic) than Chilmark stone appears to be true only for some of the currently worked stone. Across the whole outcrop of the Tisbury Member, the glauconite content in different parts of the sequence can vary from 0 to 6 per cent.

The Upper Building Stone, formerly thought to be restricted to the Chilmark Valley, is now known to extend westwards as far as just north of Tisbury (see 1:50,000 Wincanton Geological map, 1996). However, it appears to have been exploited only in the Chilmark Valley.

The one example of the Upper Building Stones from the Upper 'Teffont Evias' Quarry in the Chilmark Valley that Dr Lott examined consisted of well-graded, fine- to medium-grained, clast-supported oolite with a micritised matrix; most ooliths are in the range 0.1 to 0.3 mm diameter (see Bristow *et al.* 1999, pl. 3b).

Tisbury and Chilmark stone could have been transported eastwards along the river Nadder, a tributary of the Salisbury Avon.

Three examples of stone from the Tisbury Member have been identified (Amesbury 2, Shaftesbury 7, and the Knook 2 tympanum) and several examples of the Upper Building Stones (Knook 1, Britford, and possibly East Stour and Gillingham). All other sculptures attributed to the Portland Group (Batcombe Down, Buckland Newton, Cattistock?, Cranborne, Henstridge, Melcombe Horsey and Melbury Bubb) appear to be Portland Freestone.

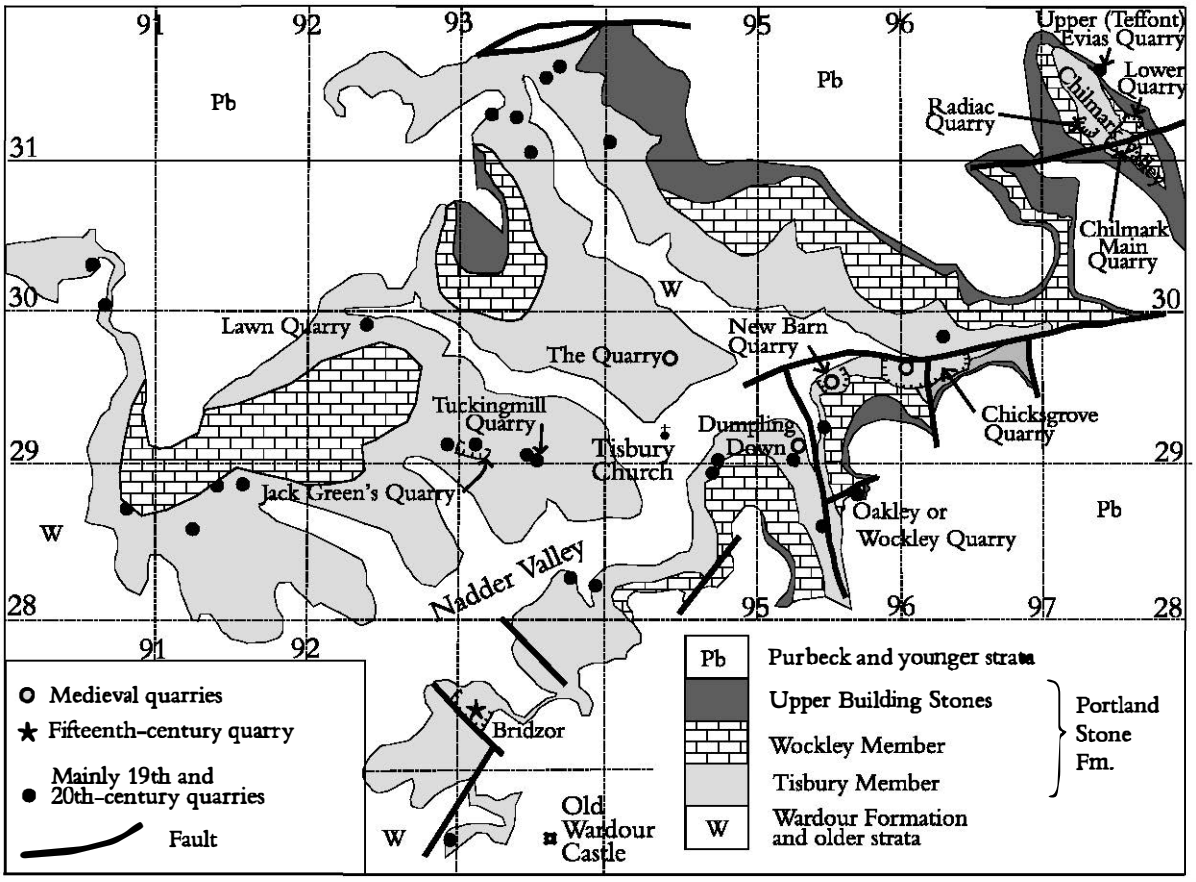

FIGURE 15

Geology of the Portland Formation in the Tisbury and Chilmark areas

PURBECK GROUP, DURLSTON FORMATION, PEVERIL POINT MEMBER, UNIO BEDS

The Purbeck Group has a similar distribution to the Portland Group, with the exception that on the Isle of Portland, only the lower, non-marble-bearing, part of the group, the Lulworth Formation, is present. Throughout its outcrop, the limestones of the group have been widely quarried for building and walling stones and tiles — Purbeck stone. However, only locally on the Isle of Purbeck are the marble-bearing beds in the uppermost member (Peveril Point Member) of the group present (see Haysom 1998, fig. 12). In the Vale of Wardour, Towlson (1991, 43) refers to 'Fovant Marble', named in 1862, and which has been speculated to have been used in Salisbury Cathedral, although Towlson believed it to have been a later working. Towlson also refers to a buff-coloured 'Cyrena' or 'Neomiodon Marble' that was exposed above the adit in the Upper (Teffont Evias) Quarry, Chilmark, but states that it was unlikely to have been of economic value.

On the Isle of Purbeck, the Marble occurs as thin units interbedded with shale. Different units have been recognised, named in ascending sequence 'Blue', 'Green' and 'Grey Marble (see Haysom 1998, figs. 11 and 13).

The coffin of King Æthelberht(?) in Sherborne Abbey (Appendix B) is made up of several slabs of Purbeck Marble. Mr Paul Enson of the Natural History Museum and Mr Treleven Haysom suggest (pers. commns.) that this limestone is from the Upper Cypris Clays and Shales at the top of the Peveril Point Member, and more specifically, possibly from the Green Marble.

UPPER GREENSAND FORMATION, SHAFTESBURY SANDSTONE MEMBER

The Upper Greensand has an extensive outcrop across south-west England. It forms a prominent escarpment from of the Chalk escarpment from the north-east of the area, just to the west of Wantage, to just west of Dorchester in the centre of the district. In the south-east, there is narrow, steeply dipping, partially faulted outcrop that extends from just south of Dorchester to just north of Swanage. There are large outliers on the Blackdown Hills and the Haldon Hill respectively to the north-east and south-west of Exeter.

Over much of south-west England (south of Westbury), the formation is divided into three members, in ascending sequence: the Cann Sand consisting of unconsolidated glauconitic sands, a median Shaftesbury Sandstone consisting of variably cemented, fine- to medium-grained, glauconitic sandstones with the highest, bioclastic, sandstone indurated and known as the 'Rag' or 'Ragstone', capped by the Boyne Hollow Chert which consists of glauconitic sands with common chert nodules. In south-west Dorset (south and eastwards from Crewkerne), a higher, fourth member, the Eggardon Grit, consisting of well-cemented, fine- to coarse-grained, bioclastic, calcareously cemented, fossiliferous sandstone, occurs.

The Shaftesbury Sandstone has been extensively used as a building stone — much of the old towns of Mere and Shaftesbury and Shaftesbury Abbey is built of this material — and as a roadstone (particularly the Rag). There are numerous quarries in and around Shaftesbury and also to the north and south-west. The grain size of the weakly cemented sandstones which occur between the better-cemented stones, varies from 0.14 to 0.26 mm (average of six samples, 0.2 mm). However, the harder, better-cemented, stones appear to be slightly coarser and with more bioclastic debris. Hurdcott stone, named from the village about 10 km east of Tisbury, is a local name for the Shaftesbury Sandstone; it was much used in south Wiltshire in the twelfth century (for example at Old Sarum) (Tatton-Brown 1998, 39). The Boyne Hollow Chert has been used in walling and as roadstone. The Eggardon Grit has been used as a building stone — Forde Abbey is built out of this stone (Thomas 1990). Around Potterne, where the Upper Greensand is not subdivided into mappable units, a soft, fine-grained malmstone known as the 'Potterne stone' has been worked.

Several Anglo-Saxon sculptures at Shaftesbury (Shaftesbury 2 and 3) are of Shaftesbury Sandstone. The two highly patinated sculptures at Batcombe are most likely Shaftesbury Sandstone, as is the large slab with cross at West Parley.

STONES OF UNCERTAIN PROVENANCE

In Devon, the roundel with a figure with outstretched hands (Chulmleigh 1) is very heavily coated with orange paint/plaster. There is a very small area on the south-west quadrant relatively free of coating which exposes a non-calcareous, fine-grained sandstone of unknown stone type.

In Somerset, the worn sundial on the south side of the tower of St Nicholas old church, Uphill, is a calcareous stone too lichen encrusted for identification. The Barton St David stone is a dark yellowish brown (10YR 4/2), weakly calcareous, fine-grained, finely laminated sandstone; the clasts are up to 0.2 mm across; the stone type has not determined, but is probably of Palaeozoic age.

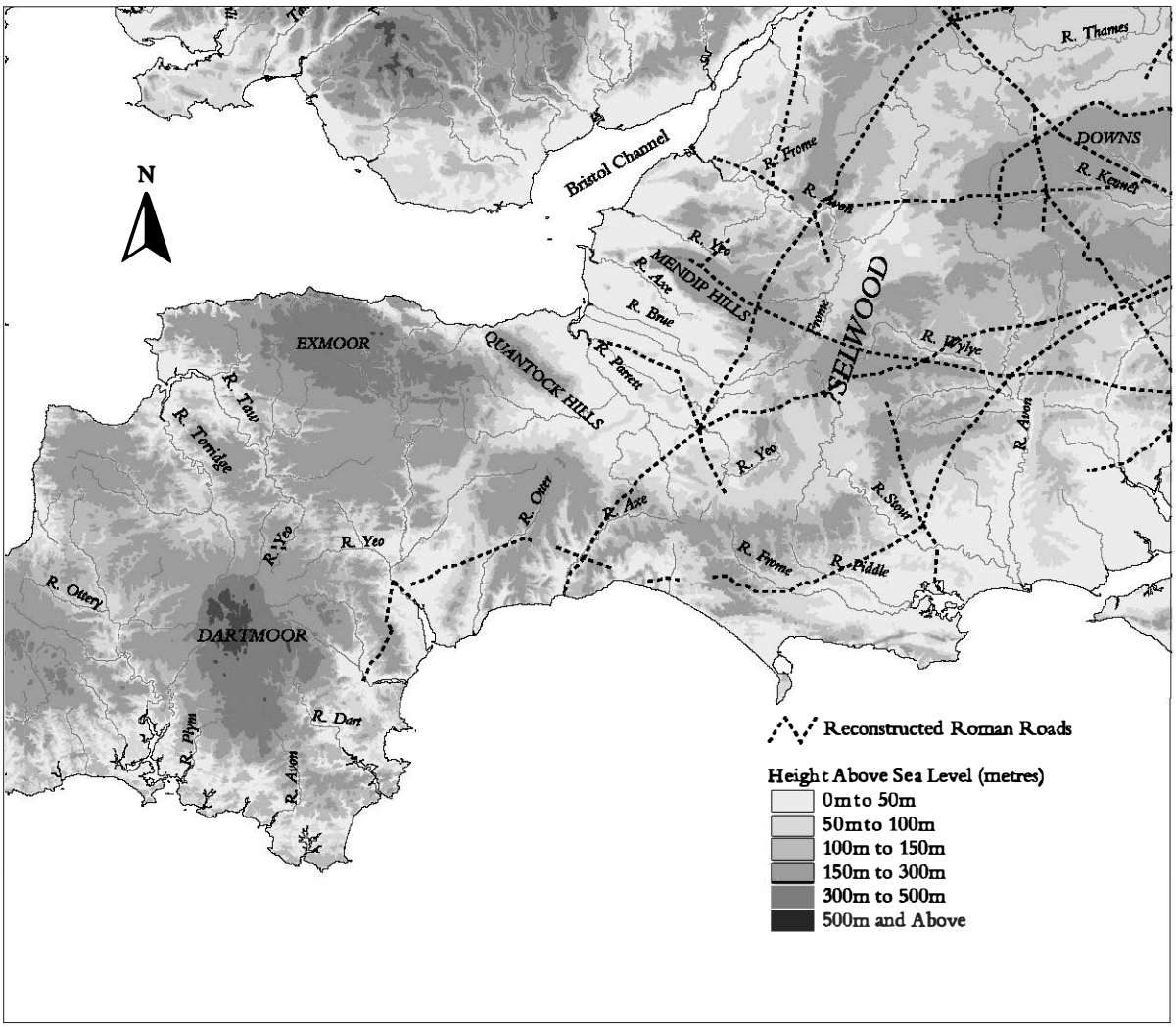

FIGURE 16

Topography of south-west England