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On retirement he trained to be a Cathedral guide.
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>3</td>
</tr>
<tr>
<td>Geological background</td>
<td>5</td>
</tr>
<tr>
<td>Summary of the stratigraphic succession</td>
<td>8</td>
</tr>
<tr>
<td>Building in Winchester</td>
<td></td>
</tr>
<tr>
<td>Romano-British and Anglo-Saxon periods</td>
<td>11</td>
</tr>
<tr>
<td>Early medieval period (1066-1350)</td>
<td>12</td>
</tr>
<tr>
<td>Later medieval period (1350-1525)</td>
<td>18</td>
</tr>
<tr>
<td>16th to 18th century</td>
<td>23</td>
</tr>
<tr>
<td>19th to 21st century</td>
<td>24</td>
</tr>
<tr>
<td>Principal stone types</td>
<td>28</td>
</tr>
<tr>
<td>Chalk, clunch and flint</td>
<td>29</td>
</tr>
<tr>
<td>Oolite</td>
<td>30</td>
</tr>
<tr>
<td>Quarr</td>
<td>31</td>
</tr>
<tr>
<td>Caen</td>
<td>33</td>
</tr>
<tr>
<td>Purbeck</td>
<td>34</td>
</tr>
<tr>
<td>Beer</td>
<td>35</td>
</tr>
<tr>
<td>Upper Greensand</td>
<td>36</td>
</tr>
<tr>
<td>Portland</td>
<td>38</td>
</tr>
<tr>
<td>Other stones</td>
<td>40</td>
</tr>
<tr>
<td>Weldon</td>
<td>40</td>
</tr>
<tr>
<td>Chilmark</td>
<td>41</td>
</tr>
<tr>
<td>Doultmg</td>
<td>41</td>
</tr>
<tr>
<td>French limestones</td>
<td>42</td>
</tr>
<tr>
<td>Coade Stone</td>
<td>42</td>
</tr>
<tr>
<td>Decorative stones, paving and monuments</td>
<td>43</td>
</tr>
<tr>
<td>Tournai Marble</td>
<td>43</td>
</tr>
<tr>
<td>Ledger stones and paving</td>
<td>44</td>
</tr>
<tr>
<td>Alabaster</td>
<td>45</td>
</tr>
<tr>
<td>Jerusalem stone</td>
<td>45</td>
</tr>
<tr>
<td>Choice of stone</td>
<td>46</td>
</tr>
<tr>
<td>Quarries</td>
<td>47</td>
</tr>
<tr>
<td>A personal postscript</td>
<td>48</td>
</tr>
<tr>
<td>Bibliography and References</td>
<td>50</td>
</tr>
</tbody>
</table>

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Photographs and diagrams are by the author, unless otherwise indicated
Introduction

Winchester lies in an area virtually devoid of building stone. The city is on the southern edge of the South Downs, a pronounced upland area extending from Salisbury Plain in the west to Beachy Head in the east (Figs. 1 & 2). The bedrock of the Downs is the Upper Cretaceous Chalk (Fig. 3), a soft friable limestone unsuited for major building work, despite forming impressive cliffs along the Sussex coast to the east of Brighton. To the south of Winchester lies the Hampshire Basin where the underlying strata are unconsolidated sands and clays of younger, Tertiary, age (Fig. 4).

The vernacular buildings reflect this. On the Chalk outcrop, the principal building material is flint, irregular lumps of silica, very hard, which have weathered out from the Chalk, together with occasional use of "clunch", harder streaks within the soft Chalk limestone (Fig 5). To the south, bricks, fired from clays found within the Tertiary sediments, predominate (Fig 6.).

Unlike, for example, the cathedral cities of Durham or Wells, where a local source of good building stone lay close by, no such source existed for Winchester. This account describes the variety of stone used in Winchester, principally in the construction of the Cathedral, and the provenance of this stone. While not always specifically referenced, three invaluable sources of information have been Andrew Rutter’s “Winchester: Heart of a City” (2009), Tim Tatton-Brown’s “Building Stones of Winchester Cathedral” (1993) and Pevsner’s “The Buildings of England” (Bullen et al 2010).
Fig 3: Geological map of the Channel area, showing location of the sources of Bath, Quarr, Caen, Purbeck, Beer, Portland and Weldon stone. Contains British Geological Survey materials © NERC 2002.

Fig 4: Hampshire Basin sediments - Hordle Cliff, Milton-on-Sea

Fig 5: Flint building – St Cross, Winchester
Geological background

There are three types of rocks making up the Earth’s crust: igneous, sedimentary and metamorphic (Fig. 7). Building stones are found among all three types, though this account deals almost exclusively with sedimentary rocks.

Igneous rocks (from the Latin for fire) are formed by the solidification of initially molten material from the interior of the Earth. Slow cooling deep in the Earth’s crust results in coarsely crystalline rocks, such as granite (e.g. at Lands End, Fig. 8), whereas more rapid cooling close to or on the
Earth’s surface results in a much finer grained rock, such as basalt (e.g. the Giant’s Causeway, Staffa, Fig. 9). Such rocks are difficult to work, though many ancient civilizations were able to, with great skill (for example the Egyptians). In this country they only came into their own for major construction when mechanical aids became available, for example, at Truro Cathedral. Few medieval monastic churches or cathedrals are built of granite, a notable exception being Mont St Michel in Normandy.

Fig. 8: Granite – Lands End
Fig. 9: Basalt: Staffa

Sedimentary rocks are derived from previously existing rocks, from organisms and from vegetation. A fundamental characteristic is that they are layered (also termed bedding or stratification) as a result of having been deposited in parallel layers, usually in water (Fig. 10). There are two main families of sedimentary rocks: clastics and carbonates.

Fig. 10: Stratification – Burton Bradstock

Clastics are the result of the breakdown, weathering and erosion of pre-existing rocks: for example, sandstones are formed from rounded quartz (silica) crystals derived from igneous rocks (Fig. 11), and shales from other minerals also derived from igneous rocks which weather to mud (Fig. 12).
Sandstones are very important as building stones - Durham, Lichfield, Chester, Hereford - but are not able, as a rule, to take intricate carving.

Carbonates, which are principally limestones (calcium carbonate), are formed by the accumulation of shells or the calcareous hard parts of marine organisms (Fig. 13). Oolitic limestone (for example, Bath Stone) is a distinctive type of limestone, formed in shallow wave-disturbed seas by chemical precipitation accreting around nuclei such as minute shell fragments (Fig. 14); the rock looks like fish roes (ooid = egg). Limestones were preferred over sandstones as building stone because of the ease of working and the ability to take intricate carving. However, in pre-Industrial Age times, transport was a major expense and hence local stone of whatever type - or that easily transported by water - was preferred.

Chalk is a special form of limestone, very pure, being formed from the microscopic skeletons of plankton, and very soft, though harder streaks are found (Fig. 15).

Flint (a form of silica) is a chemical precipitate, found as nodules within the Chalk (Fig. 16) and redeposited from the siliceous skeletons of sponges and radiolaria (plankton with silica skeletons).
Another chemical precipitate is *alabaster*, a form of gypsum (calcium sulphate), a soft rock used for interior decoration and monuments.

*Fig. 15: Chalk: coccolith debris and micrite - Burdale, North Yorkshire*  
Scale: 3µm (microns) = 0.003 millimetres  
Courtesy Eric Condliffe, Leeds University

*Fig. 16: Flint layers - Paulsgrove quarry, Portsmouth*

*Metamorphic* rocks ("changed rocks") are igneous and sedimentary rocks that have been subject to intense pressure and/or heat and have become recrystallised. *Slate* is shale or volcanic ash which has been subjected to great pressure, aligning the platy minerals so that the rock splits easily, and *marble* is recrystallised limestone, now devoid of any signs of bedding or fossil content. However, the term marble is somewhat loosely used and can refer to a dense limestone which is capable of taking a polish; for example, *Purbeck marble* and *Tournai marble*, neither of which are true marbles.

**A summary of the Jurassic, Cretaceous and Tertiary succession of Southern England**

As the majority of the building stones described in this account are found in the Jurassic, Cretaceous and Tertiary parts of the geological succession (Fig. 17), a brief summary is perhaps appropriate at this point (Green 1998, Lott 2013, Lott [no date]). The stratigraphy and associated geological ages follow the British Geological Survey Stratigraphical Chart of Southern Britain (2008).

The Jurassic period, lasting from 200 to 145 million years ago, has a three-fold division. The Lower Jurassic, also known as the Lias, consists mainly of grey mudstones but with thin alternations of limestone; although no longer a primary source of building stone, these limestones were widely used for local buildings in the past. The blocky grey limestones, particularly well developed in the basal part of the succession (Blue Lias), are commonly seen in the walls of older houses along the whole of the outcrop from the Dorset coast to Yorkshire. Higher in the succession are the Middle Lias ironstones, which are best developed in Oxfordshire (Hornton Stone), Northamptonshire and Lincolnshire (Marlstone Rock Formation). Within the Upper Lias only the orange-brown, Ham Hill Stone from Somerset, a locally developed ferruginous, sandy and shelly limestone, has been widely used as a building stone and is still actively quarried.
The principal source of building limestones is the Middle Jurassic succession of southern and eastern England, many of the limestones having been quarried for building stones since Roman times. The Middle Jurassic comprises the Inferior and Great Oolite Limestone groups, a mixed succession of calcareous mudstones and coarsely oolitic and shelly limestones (the term “Inferior” has nothing at all to do with quality but simply to describe its position beneath the Great Oolite). Most of the limestone beds have been worked for freestone (that is, a stone that can be cut freely in any direction and is relatively easy to tool) for building, at least on a local scale but some have reached a pre-eminent position as building stones. The limestones of the Inferior Oolite Group crop out extensively from Dorset to Lincoln. Some of the best known freestones include the Guiting, Doulting, Whittington and Painswick stones of Gloucestershire and Somerset and the Lincolnshire Limestones from Ketton, Clipsham, Weldon, Stamford, Ancaster and Lincoln in Northamptonshire, Rutland and Lincolnshire.
The limestones of the overlying Great Oolite Group include the important Bath stones (such as Box Ground, Stoke Ground, Westwood Ground, Combe Down, Monk's Park) and the Cotswold and Oxfordshire stones (such as Taynton, Windrush, Barrington). Within the Middle Jurassic succession some other limestone units were exploited because of their well developed thinly bedded and fissile nature and could be split into thin sheets and dressed to provide stone slates for roofing local buildings, as at Stonesfield (Oxfordshire) and Colleyweston (Rutland).

The Upper Jurassic succession of southern Britain is dominated again by mudstones with subordinate limestones (such as the Corallian), sandstones and ironstones. However, possibly the best known of all of Britain's building stones, the white oolitic and shelly Portland Stone, is quarried from the top of the Jurassic succession. In the Vale of Wardour in Wiltshire equivalent beds of the Portland Stone include the sandy limestones mined at Chilmark that were used to build Salisbury Cathedral.

The Cretaceous period, lasting from 145 to 65 million years ago, has a two-fold division. In sharp contrast to the marine limestone successions of the Jurassic, the Lower Cretaceous of southern England is initially dominated by a succession of freshwater clays, with thin fresh- and brackishwater limestone and sandstone beds developed which were suitable for building purposes. Limestones from the Isle of Purbeck area of Dorset were worked along their coastal outcrop but perhaps more famous is the darker so-called Purbeck 'Marble', a thin, hard fossiliferous freshwater limestone which when cut and polished was widely used to make decorative columns and fonts in churches and cathedrals throughout southern England. Also of note is the slightly younger Paludina 'Marble', a hard, fossiliferous freshwater limestone containing numerous freshwater gastropods that give it its characteristic coarsely mottled appearance when polished (the so-called “Sussex Marble”). Eventually the sea broke through and a major transgression spread across the British Isles. The tidally influenced shoreline deposits of the Lower Greensand comprise calcareous and variably glauconitic sandstones which include the Bargate stone from the Guildford/Godalming areas and Kentish Ragstone, a hybrid mix of quartz sand and limestone which, despite its fairly intractable nature, once formed the basis of a major quarrying industry in the Maidstone area of Kent. The succeeding Gault Clay was deposited in deeper water but there was a later westerly-derived influx of sand that forms the Upper Greensand Formation. This reaches its maximum thickness in the vicinity of Selborne and was an important building stone in East Hampshire and West Sussex (Malmstone) and on the Isle of Wight (Green Ventnor). Further east, the Reigate Stone, also known as firestone (from its alleged refractory properties) and hearthstone, was much quarried in medieval times as a building stone. The presence of the mineral glauconite can impart a distinctive green coloration to some of the sandstones, hence the term “Greensand”.

The Upper Cretaceous succession in Britain is dominated by the Chalk. In general these fine, white to pale grey chalky limestones (commonly known as Clunch) are relatively soft and needed to be protected from the weather. They were principally used for interior carved stone decoration. However, a harder Chalk suitable for external use is found: at Totternhoe in Bedfordshire, at Burwell in Cambridgeshire, at Beer in Devon and at Lavant in West Sussex.

The Upper Cretaceous chalk successions are also the principal source of another important building stone of past times, the extremely hard and durable, siliceous black, white or grey flints. They provided the basic walling material for many buildings of southern England where freestones are generally in short supply. Flints are found as irregularly shaped nodular bands throughout the Middle and Upper Chalk successions of eastern England. They were widely used from Roman
times as rubble walling, embedded in thick lime mortars. In later periods the flints were precisely dressed or squared to form intricately patterned block-work within wall fabrics.

Tertiary sedimentary outcrops are restricted to the Hampshire and London basins in the south of England. They would appear at first sight to be unlikely candidates for providing building stone because of the generally poorly consolidated nature of the successions. However, there is one stone of note in the Tertiary succession of the Hampshire Basin, a fossiliferous freshwater limestone commonly known as Quarr Stone that was quarried from below the Bembridge Limestone Formation on the Isle of Wight. This limestone was an important medieval building material both locally on the Isle of Wight and in Hampshire but was also occasionally imported into London.

**Building in Winchester**

**Romano-British and Anglo-Saxon periods**

Winchester was an important Roman town, *Venta Belgarum*, and much is known of the layout of the town (the present High Street still follows the alignment of the central axis of the Roman street pattern linking the Roman east and west gates), the extent of defensive earthen banks and ditches, and the engineering works associated with the diversion of the River Itchen into a new channel to the east of the town (Whinney, 2009, Bullen et al 2010). However, very little is known of the building techniques used but they are likely to have combined flint with bonding courses of tile, brick and stone, with chalk infill (Anderson 1990). There is a small sector of wall exposed behind a grating in the wall running parallel to the River Itchen, south of the city bridge, which appears to be of flint. Apart from this, excavations have suggested that sandstone and limestone (both oolitic and shelly) were used (Worssam in Biddle, forthcoming). The provenance is not known but is likely to be local Greensand, Bath stone and Purbeck slabs, the latter probably used for roofing. In addition, fragments of marble originating in France have been found, probably used as inlay or wall veneer (Shaffrey, 2011). It has also been suggested that the fragments of Portland Stone and the two column fragments of the Tertiary (Eocene) age Calcaire Grossier from the Paris Basin, found during the excavation of the Anglo-Saxon Old Minster, were re-used from Roman buildings (Worssam in Tweddle et al, 1995, Worssam 1998). The nearest known use of the Calcaire Grossier is in the first-century Fishbourne Palace, near Chichester.

From the early 5th century urban life gradually decayed in *Venta* but revived from the mid 7th century with the introduction of Christianity and the creation of the Kingdom of Wessex. In c.648 King Cenwalh established a church, later known as Old Minster, in Winchester and in 662 the bishopric of the West Saxons was transferred from Dorchester-on-Thames to Winchester (Whinney, 2009).

There is no surviving Anglo-Saxon building left in Winchester as both the Old Minister and the later New Minster and Nunnaminster were demolished when the present Norman cathedral was built (Fig. 18). However, the extensive archaeological investigations undertaken in the 1980s have given much information about the materials and techniques employed (Tweddle et al 1995, Biddle and Kjolbye-Biddle in press).
The majority of the building material used for the foundations, footings and walls of the Old Minster was of local origin (some 85%: Martin Biddle, personal communication, 2014): flint, chalk and greensand, including tile, brick, concrete, flint, limestone and sandstone blocks recovered from Roman buildings. However, all the carved details (both architectural and decorative) are of freshly obtained quarried stones, the bulk of which is Combe Down Bath stone. Of the carved pieces from Old Minster, some 86% are identified as Combe Down, all of the pieces from New Minster, and 27% of the grave markers. There appears to have been some 7th century use of Portland Stone but Quarr stone only makes an appearance in Winchester in the 10th century, initially as gravemarkers. Saxon masons’ tools appear to have been rather coarse, dressing being done usually with axe and adze, although there is sporadic evidence for the use of fine chisels for carved stonework, a technique which only became more usual in England in the 12th century (Jope 1964).

Although in Anglo-Saxon times some of the larger religious buildings were in stone, such as the Old and New Minsters in Winchester, royal domestic buildings seem to have had their rigid construction carried out entirely in timber, although later the building of isolated sections of stone walling was used an anchoring for the timber construction.

**Early Medieval period (1066 – 1350)**

For the construction of the immense new Norman cathedral (Fig. 19) - “with the cathedral of St Peter at Winchester, William’s kingdom takes a step into a different league, and it is possible to talk of imperial pretensions” (Fernie 2000) - a new and accessible source of stone had to be sought and this was achieved by a considerable expansion of the quarries on the Isle of Wight in the area around Quarr and Binstead (between Fishbourne and Ryde): the so-called Quarr and Binstead limestones. Such stone would have been brought across the Solent to Southampton and then up the River Itchen, probably as far as Bishopstoke, where in 960 there is a record of a staith, and then by cart to Winchester. A number of weirs on the river above Bishopstoke would probably have precluded further transport by boat (Anderson 1990). Improvements to facilitate navigation in the higher reaches of the river were only made at the end of the 12th century by Bishop de Lucy and the
Itchen Navigation proper only commenced operation at the beginning of the 18th century (Southampton Canal Society website).

Bath stone (Oolite), most probably recycled from Old Minster (or other sources) rather than newly quarried, was also used (Biddle 1990). It is difficult to be sure, but there is a suggestion that an increase in the use of Oolite towards the west end of the Cathedral reflects the availability of a "new" source of stone following the demolition of Old Minster, although as mentioned above, there was probably not a great amount of stone in the actual fabric of Old Minster. Newly imported stone would have required transport over land for a distance of at least 50 miles.

Because of the scarcity of good building stone, such stone was only used for the external and internal facing of the walls and piers, the interiors being an infill of firmly compacted and mortared rubble, principally flint and clunch. This can be seen, for example, in the crypt of the Cathedral where a passage was cut through the end wall of the Norman construction to link with the later crypt under the Lady Chapel (Fig. 20).

The North Transept gives the best impression of the original Norman Cathedral (Fig. 21). The quality of the workmanship is very crude with courses of almost square blocks of Quarr limestone, trimmed and dressed with an axe, with rough diagonal tooling and thick mortar courses, reflecting the methods and techniques of what was probably a large workforce of mainly unskilled labourers (Fig. 22). The quality of the workmanship had considerably improved by the time the tower was reconstructed after its collapse in 1107. Over the years, the size of stones employed increased, probably due to the improvement of the devices employed for hoisting up to scaffolds (Braun 1968), progressing from the almost square blocks used by the Normans to stones two or three times their depth in length by the fourteenth century (Fig. 23).
In the middle of the 12th century, another type of stone made its appearance in the Cathedral: Caen stone. This was extensively imported into southern England from Normandy during the Middle Ages, as it was a stone with which the Norman and later builders were very familiar. Being a fine grained rock, it was capable of taking delicate carving and hence became preferred over the coarser Quarr stone. At Winchester Caen stone was used in the construction of the Holy Sepulchre Chapel.
(c.1160) and when the tower was raised by a few courses (c.1200). The famous black Tournai Marble font also dates from this time.

From the 1200s onwards Caen stone was used for the construction of the Retrochoir, this probably reflecting both the difficulty in being able to procure good quality Quarr stone and the ease of working Caen stone, especially as decoration was becoming more elaborate. Although most of the outer wall faces are still Quarr, the moulded plinth and much of the internal walling is of Caen.

![Fig. 24: Retrochoir, showing use of Caen stone and Purbeck marble](image)

It was also in the Retrochoir that Purbeck marble was first used on a large scale, as slender polished columns in contrast to other lighter coloured stones (Fig. 24). Purbeck marble was also used in the rebuilding of the presbytery in the early 14th century; here the compound columns used drums, not monoliths, and the Purbeck is not polished.

Other significant early medieval buildings in Winchester are:

St Andrew, Chilcomb (Figs. 25 and 26) - dated to around 1060; flint construction but with original stonework (such as the chancel arch) using Quarr stone.

![Fig 25: St Andrew, Chilcomb](image)  ![Fig 26: Chancel arch, St Andrew, Chilcomb](image)
St Mary’s Abbey formerly Nunnaminster – excavated remains of the late 11th century nave can be seen in Abbey Passage, to the east of Guildhall. The site was excavated in 1973 and 1981-83 (Scobie and Qualmann 1993). These investigations revealed that the first church (901-964) had only very shallow mortared flint foundations unable to bear the weight of substantial masonry walls and it is assumed that the church was built entirely of timber. The second church (964-1107) was built from Greensand ashlar blocks and flint and re-used Roman brick and tile. The third church (St Mary’s Abbey, 1108-1539) was built of limestone ashlar supported on massive rammed chalk and flint foundations (Fig. 27). The ashlar blocks show diagonal toolmarks and were bonded together by wide bands of mortar, typical of early Norman building traditions. In appearance it would have resembled the north and south Quarr stone transepts of the present Cathedral. After the Dissolution of the Greater Monasteries in 1559, the ruins of the Abbey were dismantled and sold; some of the building material was bought by Winchester College and incorporated into the College’s boundary walls.

![Fig. 27: Remains of St Mary’s Abbey](image)

St Peter Chesil (Fig. 28) - nave and chancel early 12th century, with a south aisle and tower of c. 1200-30; flint with Quarr stone and interior malmstone pillars.

![Fig 28: St Peter, Chesil](image)

![Fig 29: Wolvesey Castle, Quarr stone facing](image)

![Fig 30: Wolvesey Castle: remains of Purbeck marble blind arcading at north end of East Hall](image)
Wolvesey Castle (Old Bishop’s Palace) - built from the mid 1130s onwards; in the early stages of construction the walls were faced with Quarr stone (Fig. 29) but after around 1150 the walls were flint faced. The porch is of Caen stone and the blind arcading at the north end of the East Hall is of Purbeck marble (Fig. 30). Fragments of four octagonal shafts of Tournai marble were recovered during excavations.

St John, Winnall (Fig. 31) - a church is mentioned just before 1142, with the north and south aisles added c.1179-89; flint with Quarr stone externally; interior piers and arches of Caen stone.

St Cross Church - built between c. 1160 and 1250; Exterior: Caen stone with rubble/flint walls (Fig. 32). Interior: Caen stone with some Purbeck marble (Fig. 33).
Winchester Castle - The Great Hall is the only extant part of the formerly very extensive Winchester Castle, which was slighted by Oliver Cromwell following the Civil War. Between 1222 and 1235, Henry III (who was born at Winchester Castle) added the Great Hall, built to a "double cube" design, measuring 110 ft by 55 ft by 55 ft (approx. 33.5m by 16.8m by 16.8m). The Great Hall is built of flint with Bath and Quarr stone dressings; the buttresses are mainly Quarr and the walls are of flint with blocks of Quarr, Caen and Malmstone (Fig. 34). Inside, the piers of the arcade are of Purbeck marble (Fig. 35). Originally the hall had lower walls and a roof with dormer windows but in their place were added the tall two-light windows with early plate tracery. Extensions to the castle were made by Edward II. In 1873 the roof of the Great Hall was completely replaced. Later renovations have used Bath and Portland stone.

Later Medieval period (1350-1525)

When the reconstruction of the Nave began under Bishop Edington in the 1340s, the west front and the new porch appear to have been built with Caen stone, though they have been much restored since. When William of Wykeham resumed the rebuilding of the nave, Caen stone was again used and Beer stone for the internal refacing and the vaults (Fig. 36). Despite the general unsuitability of Chalk as a building stone, Beer stone is an exception, being a hard form of Chalk, with shell fragments rather the pure soft planktonic fossils of the normal Chalk.

The remodelling of the Nave is described by, among others, Robert Willis in his famous "Architectural History of Winchester Cathedral" (1846). Here the scheme was to avoid pulling down the old nave, as had been done at Canterbury, but to leave as much of the Norman masonry in situ, cutting new profiles where necessary. This procedure was followed for the first eight piers on the south side of the nave (Figs. 37 and 37a), but thereafter abandoned: either this was found to be more troublesome than casing the piers with new Beer stone ashlar, or the contrast between the small Norman stones and thick mortar beds, compared with the large close-jointed stones of the new work, was found to be aesthetically unattractive (Figs. 38 and 38a).
Fig. 36: Remodelling of the Nave, showing Beer stone vaulting
For the extension of the Lady Chapel by Bishop Courtney, the principal stone used was Caen stone but it also contains many sandstone blocks (Fig. 39). The Upper Greensand was quarried on the south coast of the Isle of Wight ("Green Ventnor" or "Bonchurch") and at Selborne; it derives its name from the presence of the green mineral glauconite. It is possible that some of the stone used at Winchester came from Selborne, as transport costs would not have been excessive, and land in that area was in the gift of the Bishops of Winchester. (The manor at Selborne was gifted to Magdalen College, Oxford by Bishop Waynflete in 1484).
The Great Screen, the feretory screen of the 1480s, separating the presbytery from the retrochoir, is of Caen stone, as are the Wykeham, Waynflete, Fox and Gardiner chantries. The Beaufort chantry is largely Purbeck marble, with Caen stone for the vaulting.

Other significant later medieval buildings in Winchester are:

Winchester College - building commenced in 1387; flint with Green Ventnor dressings (Upper Greensand from the Isle of Wight: Fig. 40). The chapel, consecrated 1395, and Fromond’s Chantry of 1435 also use Green Ventnor. Thurber’s Chantry Chapel, completed in 1485, was rebuilt by Butterfield in 1862-3 using Bath stone. Meads Wall, built in 1544 (Fig. 41), uses Green Ventnor and Malmstone, purchased after the demolition of the College of St Elizabeth of Hungary (founded 1302).
St Cross Hospital - refounded in the 1440s. Gate Tower of Green Ventnor with Caen stone at higher levels (Fig. 42); other buildings principally flint.

![St Cross Hospital: Beaufort Tower](image)

Fig. 42: St Cross Hospital: Beaufort Tower

St John’s House, The Broadway - “rebuilt” 1409-17; greensand plinth and quoins, with Caen stone windows.

Buttercross (Fig. 43)– early 15th Century but severely restored by George Gilbert Scott in 1865; various Jurassic limestones.

![Buttercross](image)

Fig: 43: Buttercross
16th to 18th century

The Dissolution of the Monasteries in the 1530s resulted in a significant “new” source of stone and buildings from this time onwards are often constructed from a mix of stone types obtained from the demolition of now redundant monastic buildings.

One of the most famous English building stones is Portland Stone; it is an Upper Jurassic limestone, deposited around 145 million years ago (slightly older than the Purbeck marbles). Before the 17th century Portland stone was little used except locally and its fame dates principally from the time of its selection by Sir Christopher Wren for the rebuilding of St Paul's Cathedral in London; by then, no further significant building work would be carried out at Winchester Cathedral though there is some use of Portland stone from that time onwards (for example, Curle's Passage: Fig. 44). However, Portland stone was more widely used in a number of public buildings in Winchester, frequently in combination with brick.

Significant buildings of this period are:

Wolvesey Palace (Fig. 45) - begun for Bishop Morley (1662-84) to replace the ruined medieval palace; designed by the London master bricklayer Sir Thomas Fitch; reused ashlar.

Fig 44: Curle’s passage

Fig. 45: Wolvesey Palace

23
The former Guildhall of 1713, now Lloyds Bank (Fig. 46): Portland stone.

![Fig. 46: former Guildhall](image1)

City Bridge (Fig. 47) - rebuilt in 1813 in Portland stone.

![Fig. 47: City Bridge](image2)

**19th to 21st century**

The construction of the canal network from 1760 onwards provided a national transportation system for moving bulky goods across the country and thus enabling the supply of stone from outside the local area. This trend was considerably accelerated by the development of the railways: transport costs plummeted and by the mid 19th century stone could be supplied to almost any part of the country at reasonable cost. Hence, from the 19th century onwards, buildings are more likely to contain, or be constructed of, stone from outside the local area.

Limited amounts of stone for specific purposes had always been imported from aboard (for example, Tournai marble in medieval times) but this trend increased from the 19th century onwards (for example, decorative granites from Scandinavia for shop fronts and paving) and nowadays stone is sourced from all over the world, quite often more cheaply than local sources: recent buildings in London have used Indian marbles and Australian sandstones. Given the diversity of origin, identification becomes virtually impossible unless documented.
There were only two significant additions to the Cathedral during this period. The external buttresses on the south side of the Nave were erected in 1911 as part of the restoration and underpinning work carried out by Sir Thomas Jackson between 1906 and 1911; for these Weldon Stone from Northamptonshire was used (Fig.48). The recently completed Fleury Building (2011), in the junction of the North Transept and North Presbytery Aisle exterior walls, houses a new boiler room and other facilities. Doulting Stone from Somerset was chosen to provide a match with the existing Quarr Stone masonry (Fig. 49).

In 1821-22 work was carried out by John Nash to strengthen two of the nave piers at the eastern end on the south side by the insertion of cast iron shafts; wrought iron clamps were used and these have rusted, resulting in staining of the stonework. Of particular interest is that Coade stone, an artificial stone, was used to clad these piers.

For repair and restoration work a variety of stone has been used, including Doulting (Somerset), Clipsham, Ketton and Weldon (Rutland/Northamptonshire) and, from abroad, Lepine/Lavoux and Richemont (respectively, Vienne and Charente-Maritime départements, France).

Such stone, particularly for repair, tended to be selected on the basis of cost and availability, and this led to some unfortunate choices where a stone had a superficially similar appearance but very different weathering characteristics. Nowadays extensive scientific testing is carried out to ensure compatibility, particularly in terms of internal structure of the stone and its porosity and permeability, of any replacement stone. It is perhaps unfair to cite here the recent example of work at the British Museum, originally built of Portland stone. For a new portico facing the Inner Courtyard, age equivalent "Portlandian" limestone from France was used, causing uproar in the geological community. However, even if it is a completely compatible stone, as is claimed, it will never weather to match the original stone as it is now protected by the canopy covering the Inner Courtyard (Fig. 50; see Nield 2014, 49-52).
Buildings of note from this period in Winchester are:

The former Corn Exchange (1835-8; now the Discovery Centre) in Jewry Street (Fig. 51) – yellow brick with Portland stone portico, quoins and windows.

![Fig. 51: former Corn Exchange](image)

Market House (23 High Street, 1857: Fig. 52) - Bath stone with brick.

![Fig. 52: Market House](image)

University of Winchester (formerly King Alfred’s College); main building (1859-69) - Purbeck stone with Bath stone dressings.

Guildhall (1871) - the Broadway frontage of the new Guildhall is constructed in Bath limestone from Box Ground quarry in Wiltshire (Fig. 53). The pink stripes are of Permo-Triassic Red
Mansfield sandstone from the Midlands. The two white entrance plinths are Portland “Whitbed” stone, and they are surmounted by pink granite columns, probably from Scotland. There are a few external shafts in polished grey marble. The internal stonework is from Corsham, near Bath. On the roof, two contrasting slates were used to make distinctive stripes: the grey/green slates came from Cornwall or Wales; the purple slates from Penrhyn, North Wales. The Guildhall’s external stone stairs decayed rapidly and in June 1908 were completely replaced, the original stairs being carefully reproduced in pre-cast concrete described as “Empire Stone”. The concrete was made with an unattractive brown aggregate, which has been deliberately exposed by washing or sandblasting (White 2010).

The West wing of the Guildhall is the former School of Art dating from 1876 – flint with Bath stone dressings.

Fig. 53: Guildhall

Barracks (1899-1905: now Peninsula Square) – red brick with Portland stone dressings (especially the Long Block on the west side with central portico: Fig. 54).

Fig. 54: Peninsula Square

King Alfred’s Statue (1901) – plinth of Cornish granite Fig. 55).
St Peter’s Church (1924-6) – Lower Cretaceous Bargate stone with Bath stone dressings.

Barclays Bank (1957) – red brick with Portland base.

**Principal stone types**

The southwest corner of the Deanery is a very good illustration of the various types of stone used around the Cathedral (Fig. 56).
Chalk, clunch and flint

The Chalk of southern England is separated by geologists into two sub-divisions: the Grey Chalk and the White Chalk, more or less equivalent, respectively, to the traditional sub-divisions of ‘Lower’ and ‘Middle-Upper’ Chalk. The Grey Chalk formed between about 100 and 95 million years ago, while the White Chalk was deposited between 95 and 70 million years ago. Visually, the main difference between White Chalk and Grey Chalk is the presence of flint in the White Chalk. The Grey Chalk is also considerably harder than the White Chalk.

Chalk rock is the result of the accumulation of billions of calcite plates from marine plankton that accumulated at the bottom of the oceans that once covered what is now southern England. Water temperatures in these oceans were between 20-30°C, (similar to the tropical seas surrounding the West Indies).

Chalk is an extremely calcareous rock and as such it has been used for liming fields and in the production of lime mortar. However, because it is relatively soft and needs to be protected from the weather, it is rarely suitable for use as a building stone, though there are a number of exceptions (Ashurst and Dines 1990): the Totternhoe quarries and mines in Bedfordshire, Burwell in Cambridgeshire (both Lower Chalk), the Beer mines in Devon (Middle Chalk), and Lavant stone from near Chichester (Upper Chalk).

Chalk from Totternhoe was widely used for intricate internal decorative carving as in Peterborough Cathedral and the walling of the great abbey and house at Woburn. Burwell Stone was also used for intricate carved work, as in the Lady Chapel at Ely Cathedral. The Chalk of the Beer Quarries has been exploited since Roman times; it is a hard variety that has been widely used for both external and internal stonework, notably at Exeter Cathedral, and was used at Winchester for the remodelling of the nave in the late 14th century. Beer Stone is more fully discussed in a later separate section. Lavant stone is found in Chichester Cathedral and Boxgrove Priory (Bone and Bone 2000).

Chalk is commonly called clunch by masons and others but the term should be restricted to the types of chalk found in East Anglia. The term is also often applied to other types of rock, for example, the Upper Greensand of West Sussex.

The Upper Cretaceous chalk successions are also the principal source of another important building stone of past times, the extremely hard and durable, siliceous black white or grey flints. They provided the basic walling material for many buildings of the south east of England where freestones are generally in short supply. Flints are found as irregularly shaped nodular bands throughout the Middle and Upper Chalk successions of eastern England.

The process of flint formation is one of replacement. The generally accepted explanation is the biochemical model proposed by Clayton (1986), a simplified account of which, taken from the ChalkRock Ltd website, is given below.

The driving forces for flint formation are (i) bacterial decay of siliceous organisms (such as sponges, radiolaria and diatoms) composed of biogenic opal, buried in the sea bed, (ii) original permeability differences created by animal activity in the Chalk sea bed and (iii) gravity which drives the vertical migration of chemical change. Bacteria working on organic matter buried up to 1
m or more beneath the sea bed generate hydrogen sulphide \((\text{H}_2\text{S})\) which migrates up along the easiest permeability pathways (i.e. the relatively uncompacted more porous burrow networks) and meets oxygen being brought down by animals into the sediment of the sea-bed. The mixing zone where \(\text{O}_2\) and \(\text{H}_2\text{S}\) meet is sub horizontal (and parallel to the sea-bed above - controlled by gravity). The less homogeneous the Chalk (i.e. the more burrowed and varied in terms of early hardening) the more scattered and site specific the final flints will be. The more homogeneous the chalk in terms of permeability the more continuous the flint will be (e.g. the tabular and semi-tabular flints). The replacement process is not one of filling a burrow; it occurs along the walls of a burrow and can grow outwards (i.e. overgrowing the burrow and making the flint much larger than the original burrow) and inwards to apparently ‘fill’ the burrow. Hence burrow-filling is the wrong concept and should be burrow-replacement and overgrowth.

The colours of flint are black or dark blue-grey, and they are usually nodular in form, commonly coated in a white cortex of calcium carbonate, but tabular forms also occur. The nodules break with a conchoidal (shell-like) fracture, forming sharp edges that have always been valued for their cutting potential. Elaborate and sometimes sophisticated tools such as axes, adzes, spear points and arrowheads were made from flint by early man by hammering and flaking ‘green’ or freshly mined flint, anticipating the later production of knapped flints and gun flints, which were produced with similar techniques.

Flint is closely related to quartz, chalcedony, chert and jasper. The hardness of these materials is well known: they are resistant to scratching with a knife blade. In the context of building, flint, chert and jasper are the important rocks, with flint the most common and humble, and jasper, which St John tells us will be the stone of the new Jerusalem, the most precious.

The first extensive exploitation of flint for building is Roman, predominantly but not exclusively in the core work of composite walls. Where flints were abundant, as along the south and east coasts, they were used in prodigious quantities, laced with levelling and bonding courses of square bricks.

Saxon and Norman churches also made extensive use of coarse but unsplit flint, a practice that continued in the flint regions throughout the Middle Ages. More sophisticated and architectural use of flints dates from around the beginning of the 14th century, when knapping and squaring of flints produced flat surfaces, which could be framed in limestone, the practice known as ‘flushwork’. Flushwork became highly fashionable and at times adventurous in the late 15th century and it continued to be popular for about 100 years. From the time of Elizabeth I, flint was increasingly used in combination with other masonry materials such as limestone, sandstone or brick, in bands or chequer-work. During the 17th and 18th centuries brick generally took the place of flint in its traditional regions.

**Oolite (Bath Stone)**

The majority of the building material used in the construction of the Anglo-Saxon Old Minster was of local origin, much of which was recycled from earlier buildings, but all the carved details (both architectural and decorative) are of freshly obtained quarried stones, the bulk of which is Combe Down Bath stone, described as a cream, medium-grained, granular limestone (Fig.57). Bath stone is an oolitic limestone (Fig. 58) from the Jurassic limestone belt which extends northeasterwards from Dorset, through the Bath area and across the Cotswolds towards Northamptonshire. It is of Middle
Jurassic (Bathonian) age, around 165 million years, and had been quarried there since Roman times, initially as opencast quarries but from the mid 1850s by underground mining (Perkins et al 1979).

Fig. 57: Springfield quarry, Combe Down, Bath                   Fig. 58: Bath stone oolitic limestone

Quarr

For the construction of the new Norman Cathedral in Winchester a new and accessible source of stone had to be sought and this was found on the Isle of Wight in the area around Binstead (between Fishbourne and Ryde): the so-called Quarr stone (Fig. 59). It is a compact limestone of Tertiary (latest Eocene) age, deposited some 35 million years ago, and is, unusually, a fresh water limestone - the great majority of limestones were deposited under marine conditions. It is formed by a mass of tiny arcuate fragments of fresh water shells, which gives it a very characteristic “featherbed” structure.

I am indebted to Professor Andy Gale of Portsmouth University for the following account. It was originally thought that the stone from the Binstead quarries occurred as a lens within the (earliest Oligocene) Bembridge Limestone, a wider extending geological unit which is found across the north of the Isle of Wight from Yarmouth in the west to Bembridge in the east. Typically the Bembridge Limestone contains abundant largely entire shells of freshwater molluscs and this can be seen in the outcrops along the coast near Bembridge (Figs. 60 and 61), though this is not representative of the stone quarried for building at Binstead. The Binstead stone has now been shown to be from a unit called the Seagrove Bay Member, which underlies the Bembridge Limestone Formation. This unit, which occurs as channel fills, is usually a sand, full of voids after comminuted freshwater gastropod shells. Locally, as at Binstead (Fig. 62), it is a limestone with voids after aragonitic shell fragments, cemented by fine calcite spar and containing small rounded pieces of bone (distinctive in thin section).

Early exploitation of the Binstead quarries began in Roman times (2nd or early 3rd centuries, being used in the construction of Portchester Castle) and reached its peak in the Norman period. Quarrying was concentrated in a single limestone lens (the Featherbed), developed in the centre of Binstead, a mappable oval area some 400 metres by 200 metres in extent. As the bed is only 60-70 cm thick, it was a limited resource and had been worked out by early medieval times, though it was noted by Gideon Mantell (who first described Iguanodon) in 1847. None of the original workings can be seen today.
The use of the term Quarr stone is unfortunate as Quarr is a different place to Binstead, and stone was never worked there. However, as the usage is now so established in the literature, the term “Quarr stone” will be used in this account, rather that the geologically more correct “Binstead limestone”

Bembridge Limestone was probably available near Binstead, but most likely was obtained from the extensive shore quarries at St Helens. It was not a popular material in the early mediaeval period but was used very extensively in Southampton, for example, the beautifully cut arches in the 14th century walls.

Fig. 59: Geological cross section across the Hampshire Basin showing the Bembridge Limestone outcrop on the Isle of Wight (5. Oligocene: Bembridge Limestone). After Stamp 1955

Fig. 60: Bembridge Limestone, Whitecliff Bay

Fig. 61: Bembridge Limestone

Fig. 62: Quarr stone
Caen

Caen stone is a fine-grained pale cream to yellowish homogenous limestone, of Bathonian (Middle Jurassic) age, about 165 million years ago (Fig. 63). It is equivalent in age to the Bath oolites, but is not an oolitic limestone, rather a fine grained rock formed of minute shell fragments. It is the principal building stone used in Normandy. Its import into England is recorded from the time of Norman Conquest onwards, the Norman masons being very familiar with it, and was used in the White Tower of the Tower of London and in the rebuilding of Old St Paul's in 1087-8. Its subsequent use was both long lived and widespread: for example, it was used for the altar screen of Durham Cathedral in 1380 and in the construction of Eton College in 1443. Being a fine grained rock, it was capable of taking delicate carving and hence became preferred over the coarser Quarr stone. At Winchester Caen stone was first used in the construction of the Holy Sepulchre Chapel (c. 1160) and when the tower was raised by a few courses (c. 1200).

The increased use of Caen stone in the building of the Retrochoir probably reflects both the difficulty in being able to procure good quality Quarr stone and the ease of working Caen stone, especially as decoration was becoming more elaborate. Although most of the outer wall faces are still Quarr, the moulded plinth and much of the internal walling is of Caen.

When the reconstruction of the Nave began under Bishop Edington, the west front and the new porch appear to have been built with Caen stone, though it has been much restored since. When William of Wykeham resumed the rebuilding of the nave, Caen stone was again used, together with Beer stone for the internal refacing and the vaults.

Quarrying of Caen stone was initially open-cast but later on underground mining, using the pillar and stall technique, was employed. Today, in the region of Caen, there are said to be more than 300 hectares of underground tunnels. Quarrying went into steep decline at the beginning of the 20th century and had ceased completely prior to the beginning of the Second World War. However, there was a temporary revival in 1986 for the construction of the Caen Memorial when an old 19th century quarry was reopened and since 2004 a new quarry at Cintheaux has been supplying Caen stone to major restoration projects in both France and England (Musée de Normandie, 2010).

![Fig. 63: Caen stone](image-url)
Purbeck marble, which is still quarried in the area to the west of Swanage in Dorset (the Isle of Purbeck), is very important in Winchester Cathedral, and generally in medieval architecture, as a decorative stone (Leach 1975). Its use was widely distributed, from Durham in the north to Wells in the west, and its use continues to the present day.

Purbeck Marble is a hard dark limestone composed largely of the shells of small freshwater snails (called *Viviparus carinifera*). It is not a true marble, the definition of which is a completely recrystallised limestone, now devoid of any signs of bedding or fossil content, like the famous white Carrara marbles from Italy. However, the term marble is somewhat loosely used by quarrymen and masons and can refer to a dense limestone that is capable of taking a polish; this is the case with Purbeck marble. It was extensively used in medieval times as a decorative stone for fonts, monuments and paving, and in particular, as in the Retrochoir in Winchester, as slender polished columns in contrast to other lighter coloured stones.

![Fig. 64: Purbeck marble outcrop, Peverell Point, Swanage](image1)

![Fig. 65: Purbeck marble outcrop](image2)

Geologically it is very similar to Quarr stone, being a freshwater shelly limestone but much older (of Berriasian (Lowermost Cretaceous) ago: 140 million years) compared to Quarr (35 million years) and hence much denser and capable of being polished.

![Fig. 66: Purbeck marble slab](image3)

Purbeck marble occurs as three thin beds, never more than 4 ft in thickness and seldom more that 1 ft thick (Figs. 64, 65 and 66). Normally stone is laid "in the bed", that is, in the way that it was...
originally laid down, with the bedding planes horizontal. Columns are therefore generally compound, being built up from drums that are the thickness of the natural beds (Fig. 67). However, for the long freestanding columns of marble, these have been cut along the bed and in position in the Cathedral they have been set at right angles to the normal horizontal bedding of the stone (so-called "face bedded"). The structural strength is much less in this position and this accounts for the spalling seen on these columns (Fig. 68).

![Fig. 67: Purbeck marble columns (left) and drums (right), Beaufort Chantry](image1)

![Fig. 68: Purbeck marble columns showing spalling, Waynflete Chantry](image2)

Much of the paving in the Cathedral, together with numerous ledger stones and grave monuments, is Purbeck marble.

**Beer**

When William of Wykeham resumed the rebuilding of the nave in the late 14th century, Caen stone was again used and Beer stone for the internal refacing and the vaults. Despite the general unsuitability of Chalk as a building stone, Beer stone is an exception, being a hard form of Chalk, with very small shell fragments rather the pure soft planktonic fossils of the normal Chalk (Fig. 69). It is very suitable for carving, especially for interior work.

The Beer freestone is found as a local development near the base of the White Chalk in the area around Beer, near Sidmouth in Devon (Fig. 70). It is of Upper Cretaceous (Cenomanian) age, about 95 million years ago, and has been exploited since Roman times. The stone is very soft when first quarried, with a high water content, but hardens on exposure. The total thickness of the best stone is about 12 feet, with the thickest beds being between 4 and 5 feet. Because of the thickness of the overburden, much of the later extraction was from adits driven into the hillside. The deposits are now essentially worked out though it is still possible to visit the underground quarries (Fig. 71). Some quarrying has continued in the area, but the cost of the stone is very high (English Heritage 2012).
Upper Greensand

This sand formation derives its name from the presence of the green iron silicate mineral glauconite. It reaches its maximum thickness in the vicinity of Selbourne (Fig. 72) and was an important building stone in East Hampshire and West Sussex (Malmstone or Selborne stone: Fig. 73) and on the Isle of Wight (Green Ventnor or Bonchurch). The Upper Greensand is Lower Cretaceous in age, about 105 million years ago.

For the extension of the Lady Chapel by Bishop Courtney principally Caen stone was used but it also contains many Greensand blocks, most probably from the south coast of the Isle of Wight. It was also used at Winchester College. A particularly distinctive lithological variety of the Upper Greensand was quarried between Bonchurch and Ventnor and was termed Green Ventnor Stone.
because of the higher concentration of green glauconite grains present in the sandstones at this particular location. The principal quarries were developed along the area known as the Undercliff, and some were still active in 1921 and even appear to have extended their workings underground in places. The coastal location of the quarries also readily facilitated export of stone to the mainland. The sandstones generally comprise a framework of fine- to medium grained quartz, with subordinate glauconite and bioclastic debris (including foraminifera and sponge spicules). Bioturbation is a common feature and the sandstones may be cemented by both micritic calcite or silica cements.

Gilbert White, in “The Natural History of Selborne” (1789), describes the local freestone (Letter IV, to Thomas Pennant): “When chiseled smooth, it makes elegant fronts for houses, equal in colour and grain to the Bath stone; and superior in one respect, that, when seasoned, it does not scale.” This is the Upper Greensand Selborne freestone or Malmstone that is found to the north of the South Downs and was widely used a building stone in the later Middle Ages. It is a grey, lime-rich, fine-grained silty sandstone with few fossils (mostly bivalves), often weathering to a brown surface over the grey stone beneath. It is a distinctive traditional building material, used for churches, secular buildings and boundary walls along its outcrop, exploited through numerous small quarries. There have not been any active quarries for many years and present day outcrops are few and far between, often very overgrown in the banks of sunken lanes. Its use in Winchester was probably restricted to domestic and ancillary monastic buildings but after the Dissolution of the Monasteries in the 1530s it became more widely distributed as a significant “new” source of stone was obtained following the demolition of now redundant monastic buildings.

The Upper Greensand of East Hampshire and West Sussex has a traditional common name of malmstone, malm meaning ‘chalky rock’. Malm derives from the Middle English “malme” meaning sand but should not be confused with Continental Europe usage; there it is the upper division of the Jurassic rocks of the Swabian Jura named by Oppel in the mid 19th century. Interestingly it is said that the names used by Oppel were all of English origin: Lias (Lower Jurassic) meaning flat stones, Dogger (Middle Jurassic) from sandy concretions or “doggers”, and Malm (Upper Jurassic). These terms are still used today and in England the Lower Jurassic is commonly referred to as the Lias. Malmstone is also sometimes called clunch by masons but this term should be restricted to the types of chalk found in East Anglia.

White also notes: “In Wolmer-Forest [Woolmer Forest] I see but one sort of stone, called by the workmen sand, or forest-stone. This is generally of the colour of rusty iron …and composed of a small rounded crystalline grit, cemented together by a brown, terrene, ferruginous matter.” Here he is most probably referring to the Lower Greensand Bargate stone, used much around Godalming, for the building of Guildford Castle and for parts of Farnham Castle.
One of the most famous English building stones is Portland Stone (Hackman, 2014: Figs. 74 and 75); it is an Upper Jurassic limestone, deposited around 145 million years ago (slightly older than the Purbeck marbles). Before the 17th century Portland stone was little used except locally and its fame dates principally from the time of its selection by Sir Christopher Wren for the rebuilding of St Paul's Cathedral in London; by then, no further significant building work would be carried out at Winchester Cathedral though there is some use of Portland stone from that time onwards (for example, Curle's Passage). However, there are numerous examples of its use within the city.

The building stones come from the Portland Freestone, part of the upper member of the Portland Stone Formation (Arkell 1947a, Woods, 2011), a “freestone” being defined as a stone that can be easily cut and worked in any direction, irrespective of bedding.

A number of different beds within the succession have been worked (in descending order):

- Roach: coarsely fossiliferous oolite, full of casts and moulds of gastropods and bivalves, with the characteristic “Portland screw” gastropod shells (*Aptyxiella portlandica*).
- Whitbed: the best freestone, fine grained, well sorted, oolitic, containing a proportion of comminuted shell fragments.
- Base Bed, or Best Bed: a good freestone with few shells, soft, white, oolitic, with a very homogeneous texture.

The manor of Portland was granted by Edward the Confessor (with other manors) to the Abbey of St Swithun's at Winchester but was claimed for the Crown by William the Conqueror. Rufus Castle was built on the island during his reign. After his death, the manor appears to have been given back to St Swithun's, from whom it passed by exchange to the Clares in the 13th century (Purcell 1967). Given this connection with St Swithun's and its relative proximity, the lack of its use in Winchester is puzzling but the reason is principally geological: Portland is a hard stone and occurs in unusually large blocks (Fig. 76), so could only be cut to workable size very slowly and laboriously. Hence
other types of stone were preferred until the introduction of frame-saws and water-power in the seventeenth century, by which time no significant further building work would be carried out at Winchester Cathedral.

Fig. 74: Isle of Portland  
Fig. 75: Portland stone quarry  
Fig. 76: Untrimmed block of Portland stone

Later the Manor of Portland was owned successively by the Earls of Ulster and of March and finally became Crown property again in the 15th century. Charles I operated a royal monopoly, "managed by Inigo Jones with great rigour" according to Pevsner, and it was following Wren's survey of all the Crown Estates that Portland stone was selected for St Paul's (Lang 1956). By this time, stone working techniques had advanced and in fact one of the attractions of Portland stone for Wren was the size of the blocks available. Jones himself used Portland stone in the 1630s for the restoration of the north and south fronts of (Old) St Paul's and for his new grand Corinthian Portico at the west front.

It is also worth noting, contrary to what is sometimes reported, that Inigo Jones' Banqueting Hall in Whitehall was originally built from honey-coloured Oxford stone for the basement and pinkish-brown Northampton stone above, with only the main features of the façade - columns, pilasters, architraves and parapet - in Portland stone. This polychromatic effect was lost when in 1774 the basement was refaced in Portland stone by Sir William Chambers and in 1829 when Sir John Soane
and Sir Robert Smirke refaced the whole exterior with Portland stone (Historic Royal Palaces Agency 1997).

**Other stones:**

The construction of the canal network from 1760 onwards provided a national transportation system for moving bulky goods across the country and thus enabling the supply of stone from outside the local area. This trend was considerably accelerated by the development of the railways: transport costs plummeted and by the mid 19th century stone could be supplied to almost any part of the country at reasonable cost. Hence 19th century buildings are more likely to contain, or be constructed of, stone from outside the local area and there are examples in the Cathedral of Doulting stone (Somerset, as used at Wells), Clipsham, Ketton and Weldon stone (Rutland and Northamptonshire) and, from abroad, Lepine/Lavoux and Richemont stone (respectively, Vienne and Charente-Maritime département, France).

**Weldon**

Weldon Stone, of Bajocian (Middle Jurassic) age, about 170 million years ago, is from the Inferior Oolite Upper Lincolnshire Limestone in Northamptonshire, which contains some of the best Jurassic building stones in Britain. Weldon Stone has been quarried since medieval times and has been much used locally, and at Cambridge, but has only been used once in Winchester.

The external buttresses on the south side of the Nave were erected in 1911 as part of the restoration and underpinning work carried out by Sir Thomas Jackson between 1906 and 1911. For these Jackson selected Weldon Stone, this being chosen instead of Clipsham Stone (from Rutland, also part of the Lincolnshire Limestone) on the grounds of cost (£560 per buttress compared with £665 per buttress). It is an oolitic limestone, though not a pure oolitic limestone (like Bath Stone) as it contains a significant admixture of larger shell fragments (Fig. 77).

Two other limestones from the Middle Jurassic Lincolnshire Limestones in Rutland have also been used in Winchester, principally for repairs at the Cathedral: Ketton stone, a medium grained even-textured oolitic limestone, and Clipsham stone, an oolitic shelly limestone that has been used as a replacement for Quarr stone.
Chilmark

In Wiltshire, the equivalent beds of the Portland Stone appear beneath the Cretaceous rocks in the Vale of Wardour. The beds vary from highly calcareous, greenish-grey sandstone to pale cream sandy limestone, all with a variable speckling of glauconite grains. They have been quarried extensively for building since mediaeval times. It is generally known as Chilmark Stone, though the main outcrop is around Tisbury, where it is known as Tisbury Stone. At Chicks Grove quarry nearby around 20 metres of this Tisbury Member are still worked (Main/Lower Building Stones). The upper part consists of paler, creamy white limestones, with less obvious sand and glauconite.

Chilmark Stone was used extensively in the construction of Salisbury Cathedral (Bristow and Lott 1995) but its use in Winchester was much more restricted. It was used by Inigo Jones for his Classical screen, replacing the mediaeval *pulpitum*, separating nave from quire in Winchester Cathedral (Blakiston 1980). This was completed in 1640 but removed in 1820, to be replaced by Garbett’s Gothic screen (itself replaced by Scott’s wooden screen in 1875). The Inigo Jones screen was not destroyed but dismantled and stored in the South Transept triforium. In 1908, during Sir Thomas Jackson’s restoration work, the remains of the screen were removed and “in order to recover the design” were laid out on the grass of the old Chapter House. The middle part was incorporated by Jackson into the interior of his new Museum of Archaeology and Ethnology of 1910-15 (now the Museum of Archaeology and Anthropology) in Cambridge where it can still be seen (Fig. 78). The remaining part of the screen is now stored in the North Transept triforium at Winchester. The cornice and all the delicate sculptural work on the screen are of Chilmark Stone but the other parts, according to Jackson’s account, were Beer Stone, presumably reused from the old *pulpitum*.

Doulting

Doulting Stone is named after the village in the Mendips Hills in Somerset. The stones from the quarries in this area provided the building material for Wells Cathedral and Glastonbury Abbey and the surrounding churches. It is of Middle Jurassic age, from the middle part of the Upper Inferior Oolite, which about a mile to the north overlaps all the other Jurassic rocks onto the Carboniferous Limestone of the Mendip Hills. As a consequence, the stone is composed mainly of detritus, principally the remains of crinoids (extinct sea lilies) and corals, derived from the Carboniferous
Limestone, rather than shell fragments and ooliths from the contemporaneous Inferior Oolite sea. The stone has a coarse granular appearance, bound together with a calcite cement. It is said to be more durable than Bath Stone, though more difficult to carve. Watson (1910) describes two varieties: a coarser “Chelynch” bed, more suitable for exterior work, and a “Fine” bed, better adapted for interior use.

Doulting Stone has been used at various times over the past hundred years for repair and restoration work at the Cathedral but more recently for the construction of the Fleury Building, in the junction of the North Transept and North Presbytery Aisle exterior walls; it houses a new boiler room, storage space, toilets, a servery for refreshments, and an interview room. The choice of Doulting Stone was to provide a match with the existing Quarr Stone masonry (Fig. 79).

![Doulting stone](image)

**Fig. 79: Doulting stone**

**French limestones**

A number of French limestones have been used for repair work on the Cathedral at various times, in particular as a replacement for Beer Stone.

Lépine limestone (also known as Lavoux à grain) is an off-white, fine-grained limestone with some shells and a slightly chalky texture. It is from the Lépine quarry at Lavoux, 14 km east of Poitiers (Vienne), France. It is of Middle Jurassic (Callovian/Oxfordian) age.

Richemont Blanc is an Upper Cretaceous (Turonian) limestone from the Charente-Maritime region. It is a calcareous oolitic, fine-medium grained limestone that appears to come from a very similar depositional setting to that of Beer Stone.

**Coade Stone**

In the 18th century there was such a demand for architectural ornament and decoration that it was difficult to satisfy this demand using conventional carved stone. A number of manufacturers advertised “artificial stone” of which the most famous was Coade stone, manufactured by Mrs Eleanor Coade at her factory in Lambeth which was active from 1769 until the 1830s (Campbell and Pryce 2003, Lemmen 2006). Coade stone is a type of terracotta but to avoid the problems of shrinkage and cracking the clay was mixed with flint, crushed glass and grog (clay that had already been fired and then ground to a powder). Since the grog and the glass had been fired already, they
did not shrink further. Because this clay mixture was so rich in grog, it could not be sculpted directly and so all the pieces were made in plaster moulds. This meant that the sculptures were hollow and could be fired evenly; the plaster absorbed some of the water so that the clay shrank from the side of the mould; and the mould could be used repeatedly. Coade stone was used to clad the two nave piers (south side, eastern end) that had been strengthened by the insertion of cast iron shafts by John Nash in 1821-22.

**Decorative stones, paving and monuments**

This is not a comprehensive inventory of the various decorative stone types used in Winchester Cathedral. Many of the medieval monuments used the stone that was currently being worked in the Cathedral at the time: for example, Purbeck Marble for the tomb of Aymer de Valence in the Retrochoir, and Caen stone for the original statues on the Great Screen. Later, marble (true marble, probably from Carrara in Italy) was used, for example, for the monuments to Bishop Brownlow North in the South Presbytery Aisle and to Bishop Browne in the Nave.

**Tournai Marble**

Tournai marble is not a true marble according to strict geological terminology but rather a dense, fossiliferous black limestone. It is of Carboniferous (Tournaisian) age, laid down around 350 million years ago, and is found in the area around Tournai, in the Province of Hainault, in present day Belgium. The stone has been used over many centuries for decorative work, especially of an ecclesiastical nature, and many of the fonts in churches in Belgium are made of it. From the twelfth century onwards it was imported into England, where it was used for fonts and memorial slabs, of which the font in Winchester Cathedral is an outstanding example (Fig. 80). During the Georgian period especially, there was a great vogue for large black grave stones (ledger stones) and these are also of Tournai marble. The grave of the Unknown Warrior in Westminster Abbey, dedicated in 1920, is covered by a slab of Tournai marble.

![Fig: 80: Tourmai marble font](image-url)
Ledger stones and paving

Purbeck marble was extensively used for grave markers and grave stones (ledger stones). Later, large black ledger stones of Tournai marble were very much in fashion (Fig. 81). Of particular interest is the ledger stone of Francisca Cloberij (sic), the daughter of Sir John Clobery. She died in 1683 and her grave is in the south aisle of the Retrochoir, in front of her father’s monument. It is of a distinctive Ordovician limestone (around 465 million years ago) from the Island of Öland, Sweden, containing the straight-shelled Nautiloid, Orthoceras (Fig. 82).

Fig. 81: Tournai Marble ledger stone   Fig. 82: Ordovician limestone (“Swedish marble”)

Much of the ordinary paving in the Cathedral is Purbeck marble (Fig. 83). In the Lady Chapel the paving is Sussex marble, a freshwater limestone containing snail shells (Viviparus fluviorum), found within the Lower Cretaceous Wealden Clay. It is very similar to Purbeck marble, though slightly younger in age. It is also known as Paludina marble (Paludina being an alternative name for Viviparus), Petworth marble or Bethersden marble.

Fig. 83: Purbeck marble paving, South Presbytery Aisle
**Alabaster**

Alabaster is a massive, fine-grained granular variety of gypsum (hydrated calcium sulphate) that is found interbedded as a chemical precipitate within sedimentary rocks originally laid down in desert or arid conditions. Being quite soft and soluble, it is not a building material but because of the ease of carving it was extensively used in the making of interior monuments, from mediaeval times onwards.

The principal source of alabaster in this country is from the Triassic rocks of Staffordshire and Derbyshire. Nottingham was an important centre for production of alabaster carving during the Middle Ages and pieces were exported all over the Continent (though this trade came to an end at the time of the Reformation). Later, many stately homes used alabaster for interior decoration – Kedleston Hall in Derbyshire and the so-called Marble Hall of Holkham Hall in Norfolk. Alabaster has a superficial appearance of marble but is much softer; also, marble is cold to the touch whereas alabaster is not.

Examples of alabaster monuments at Winchester are the effigy in William of Wykeham’s chantry, and the effigy and the canopy of the monument to Bishop Samuel Wilberforce in the South Transept (Fig. 84); this was sourced from Chellaston in Derbyshire, an important centre for alabaster mining in Victorian times (Watson, 1916).

![Fig. 84: Wilberforce memorial](image)

**Jerusalem stone**

The name Jerusalem stone is given to various limestones of Upper Cretaceous age quarried in Israel and Palestine. These were much used in the construction of the ancient buildings of Jerusalem and between 1917 and 1948, when Jerusalem was under British rule, all facades of new buildings had to be built of these local limestones. They are mostly yellow or light brown in colour and in low sunlight appear yellow; hence the description of Jerusalem as “the golden city”.

45
The altar in The Chapel of St Alphege called Venerable, in the South Transept, is of Jerusalem stone but was prepared and polished in Italy; it was placed in the chapel in 2011 (Fig. 85).

![Image of the altar in The Chapel of St Alphege](image)

Fig. 85: Altar in The Chapel of St Alphege, called Venerable

**Choice of stone**

Apart from considerations of strength and durability, the principal factors in selecting a building stone are availability, cost and aesthetic suitability. Winchester lies on the southern edge of the South Downs, the bedrock of which is the Upper Cretaceous Chalk, a soft friable limestone unsuited for major building work, and hence ruled out on the grounds of strength and durability.

During the Anglo-Saxon period, use was made of local material such as flint, Greensand and recycled Roman bricks and tiles. The small amount of stone required for decorative purposes was brought from quarries in the Bath area. However, for the construction of the immense new Norman cathedral a new and accessible source of stone had to be sought. In the Middle Ages the cost of transporting stone over any distance over land (say, from Bath or from the Cotswolds) was many times the cost of the actual material, and hence transport by water was a preferred and more economical option. This was achieved by a considerable expansion of the quarries on the Isle of Wight in the area between Fishbourne and Ryde, the so-called Quarr limestone. Such stone would have been brought across the Solent to Southampton and then up the River Itchen, and hence met both the availability and cost criteria.

However, Quarr limestone is a very coarse stone and not suitable for intricate carving. Consequently the later choices were for much finer grained limestone from Caen in Normandy and from Beer in Devon, capable of much finer working, and selected for aesthetic, rather than availability, reasons. Building was now proceeding at a much more measured pace, compared with the frenetic pace of the initial Norman construction when about half of the Cathedral had been built in the 14 years between the start in 1079 and the consecration in 1093. That said, both Caen and Beer stone would have been brought to Winchester by sea.

There was no significant building at Winchester post-Reformation. In later years, the construction of the canal network from 1760 onwards provided a national transportation system for moving bulky goods across the country and thus enabling the supply of stone from outside the local area.
This trend was considerably accelerated by the development of the railways: transport costs plummeted and by the mid 19th century stone could be supplied to almost any part of the country at reasonable cost; hence availability was not a constraint. Thus, from the 19th century onwards, buildings are more likely to contain, or be constructed of, stone from outside the local area, selected principally for aesthetic reasons, though cost was also a consideration; for example, Jackson’s preference for Clipsham stone for the external buttresses on the south side of the Nave (1911) was overruled on grounds of cost and Weldon stone was substituted. Nowadays stone is sourced from all over the world, quite often more cheaply than the local original sources: recent buildings in London have used Indian marbles and Australian sandstones. Given the diversity of origin, identification becomes virtually impossible unless documented.

Quarries

Medieval quarries

Many of the quarries that supplied stone for building in the past are no longer active. Often they were for local use only, reserves were small, and many of the deposits were quickly worked out. Historical records, and the systematic Geological Survey reports from the 19th century, when quarrying was much more active, can provide a location but identification on the ground of the site of a particular quarry is proving increasingly difficult, given the value of "holes in the ground" for landfill. However, the sites of quarries abandoned in medieval times can often be recognised from their "hills and holes" topography. An example can be seen near Tisbury in Wiltshire (the source of stone for Salisbury Cathedral) where an area of hillside is covered with large humps and bumps; it is appropriately known as Dumpling's Down (Fig. 86).

Fig.86: Dumpling’s Down, Tisbury

Present day quarries

For the principal medieval sources of stone for Winchester, there is still active quarrying for oolite at Bath (and elsewhere along the Jurassic limestone belt of Somerset and Gloucestershire) and quarrying has resumed in Normandy for Caen stone. However, it is unlikely that the current operations correspond to the medieval sites. Quarrying at Beer is now very restricted and to a large extent has priced itself out of the market. Replacements have included Middle Jurassic Lepine/
Lavoux stone from the Vienne Département and Turonian Richemont stone from Charentes Maritime Département in France.

Purbeck marble occupies an important niche in the market but is commercially difficult to obtain. In 2004, when one old working seemed destined to become a caravan park, the landowner gave permission for a rescue dig that produced several hundred tonnes from the three ribs of limestone that provide the marble. However, future supplies are by no means assured. The Quarr quarries on the Isle of Wight have long been abandoned and no trace remains. Clipsham stone, a shelly Jurassic limestone from Rutland, has in the past been used as a Quarr replacement but for the recent Fleury Building extension Doutling Stone was chosen as a Quarr match. None of the local Greensand quarries, either between Winchester and Farnham or on the Isle of Wight, remain, the nearest source now being in Kent.

A Personal Postscript

I have always had a great interest in the relationship between geology, topography, land use and building. A seminal book when I was young was Dudley Stamp's "Geology and Scenery in Britain" and was certainly a contributory factor in my becoming a geologist, a decision I have never regretted. Thereafter, I discovered the writings of W.G. Hoskins on “The making of the English Landscape”, the television series and books of Alec Clifton-Taylor on English towns, and the appropriate volume of Nikolaus Pevsner's "Buildings of England" invariably accompanied excursions to any part of England.

However, my interest in building stones was triggered in 1995 when a friend of mine, living in Lincolnshire, contacted me for some advice in relation to the restoration of the local village church. For the restoration they were anxious to find a matching stone; the original stone was presumed to have been local and some loose blocks of a comparable stone had been found in a field some miles away. Could I confirm that the stone of the church and this loose material were the same, or similar (samples of both were supplied), in which case they would attempt to find a disused quarry or even (very ambitiously!) make their own excavation. At the time I was living in Holland and hence much of the research had to be done "at arms' length", so to speak. The British Geological Survey regional geology guide for the area had a short section on building stones, in which the Lower Cretaceous Tealby Ironstone, a ferruginous calcareous sandstone, was the closest in description to the samples that had been sent to me, and was also the closest geographically. A geological map confirmed that the loose material in the field was more or less on the outcrop (or, more strictly speaking, above the subcrop) of the Tealby Ironstone and the hunt was then on to find an outcrop or, preferably, a quarry from which stone for the restoration could be obtained. This proved to be impossible: there were no natural outcrops and all the former quarries - visited by Geologists' Association field excursions and described in their Proceedings only 15 years previously - were either completely overgrown or filled in: a not unfamiliar story! What to do? English Heritage advised: "find a ruined barn"; but in the event the architect and the builder were advised to use Clipsham Stone from the Vale of Belvoir which, although of Jurassic age and lacking the coarse shell fragments of the Tealby Ironstone, would give a similar appearance on weathering. Now, some 20 years on, the end result looks good (Figs. 87 and 88).
As a result of this research, I made a number of interesting contacts, as well as re-reading Clifton Taylor’s "The Pattern of English Building" - the "Bible" in this field - and also Clifton Taylor and Ireson's "English Stone Building". I also reacquainted myself with the magnificent collection of "British, Colonial and Foreign Building Stones" (Watson 1911, 1916) in all its Edwardian splendour in the Sedgwick Museum (now the Department of Earth Sciences) in Cambridge, to which I had paid scant attention when there as a research student many years previously.

Although nowadays there are many publications, usually by local geological groups, describing the geology of particular towns or buildings, the two classic accounts of urban geology are W. J. Arkell’s “Oxford Stone” of 1947 and Desmond Purcell’s “Cambridge Stone” of 1967. This account of Winchester Stone, based principally around Winchester Cathedral, was inspired by (though is only a pale shadow of) these two books.

No reference to the geology of building stones would be complete without acknowledging the pioneering work in this field by Dr Eric Robinson, for many years a lecturer in geology at University College London, and I was very privileged to have had the benefit of his knowledge and expertise here in Winchester.

This present account is an expansion of an earlier paper, “The Medieval Sources of Stone for Winchester Cathedral”, which appeared in the Winchester Cathedral Record No. 80 in 2011.
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