Historic England

Hertfordshire

Building Stones of England

The Building Stones of England

England's rich architectural heritage owes much to the great variety of stones used in buildings and other structures. The building stones commonly reflect the local geology, imparting local distinctiveness to historic towns, villages and rural landscapes.

Historic England and the British Geological Survey (BGS), working with local geologists and historic buildings experts, have compiled the Building Stones Database for England to identify important building stones, where they came from and potential alternative sources for repairs and new construction.

Drawing on this research, plus BGS publications and fieldwork, guides like this one have been produced for each English county. The guides are aimed at mineral planners, building conservation advisers, architects and surveyors, and those assessing townscapes and countryside character. The guides will also be of interest if you want to find out more about local buildings, natural history, and landscapes.

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Front cover: St Stephen's Church, St Albans. Sarsen stone and Totternhoe Stone. © REUTERS / Alamy Stock Photo.

How to Use this Guide

Each guide describes the local building stones in their geological timescale order, starting with the oldest layers through to the youngest. The guide ends with examples of other notable building stones from other parts of England and further afield.

Geological time periods, groups, formations and building stones

Each building stone is listed under the relevant geological timescale, group and formation. A formation may be divided into members and where relevant these are referenced in individual building stone sections.

Middle Jurassic
↑— geological time period

Inferior Oolite Group, Lincolnshire Limestone Formation
↑— geological group ↑— geological formation

Lincolnshire Limestone
↑— building stone (alternative or local name)

Bedrock geology map and stratigraphic table

To help you with the geology of the area, there is a bedrock geology map and a stratigraphic table which shows the layers of rocks and the associated building stones in this geological timescale, group, formation order.

Page numbers for each building stone are included in the stratigraphic table for ease of reference. The page numbers are inverted to correspond with the geological age order.

Contents list

If you click on the page number for a building stone in the Contents list, you will go straight to the relevant section in the guide.

Building stone sources and building examples

A companion spreadsheet to this guide provides:

- More examples of buildings. Information is included on building type, date, architectural style, building stone source, and listed/ scheduled status
- A list of known (active and ceased) building stone sources such as quarries, mines, pits and delphs
- Additional information on building stones including lithology, grain size, sedimentary structures, key identification features, and notes on failure/weathering, and use.

The Building Stone GIS map allows you to search the Building Stones Database for England for:

- A building stone type in an area
- Details on individual mapped buildings or stone sources
- Potential sources of building stone sources within a given proximity of a stone building or area
- Buildings or stone sources in individual mineral planning authority area.

Further Reading, Online Resources and Contacts

The guide includes geological and building stone references for the area. A separate guide is provided on general Further Reading, Online Resources and Contacts.

Glossary

The guides include many geological terms. A separate Glossary explaining these terms is provided to be used alongside the guides.

The guides use the BGS lexicon of named rock units.

Mineral and local planning authorities

This guide covers the Hertfordshire County Council mineral planning authority area; and the Broxbourne, Dacorum, East Hertfordshire, Hertsmere, North Hertfordshire, St Albans, Stevenage, Three Rivers, Watford, and Welwyn Hatfield local planning authority areas.

Contents

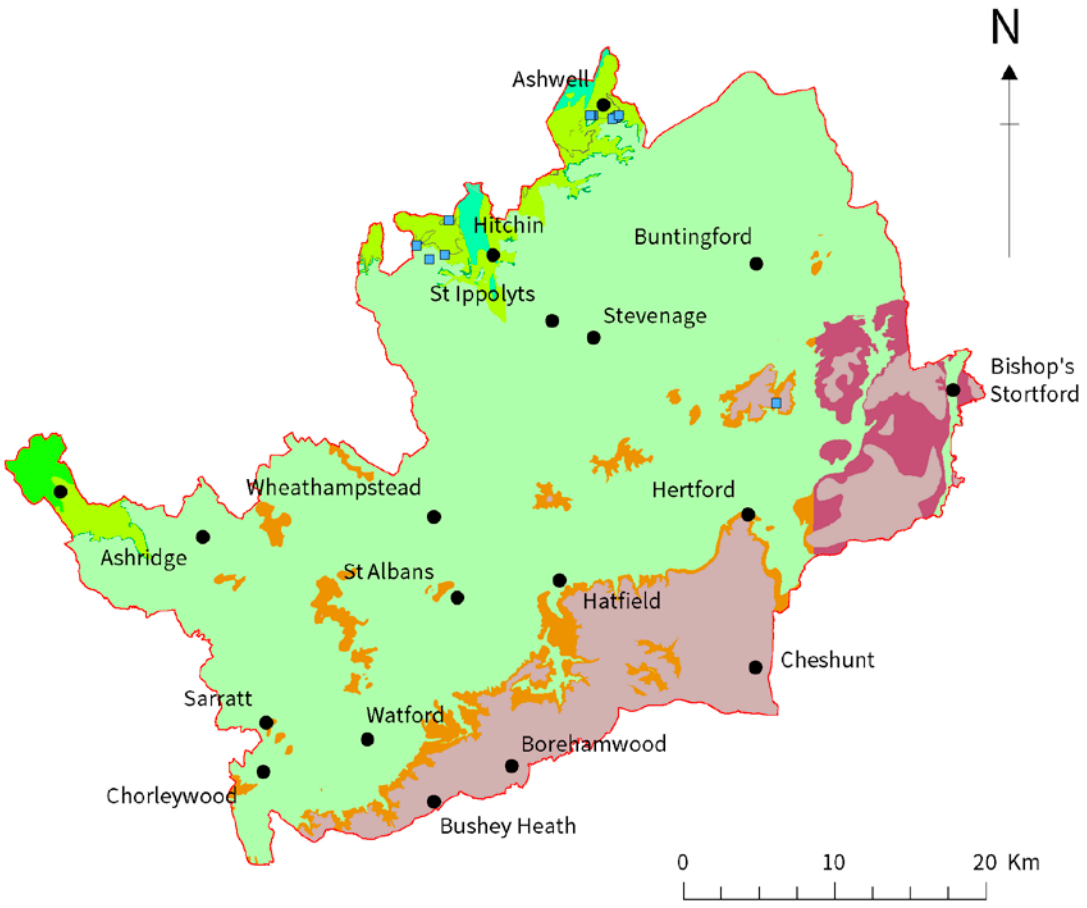
1 Introduction

The rocks of Hertfordshire form part of the large shallow syncline known as the London Basin and they dip in a south-easterly direction becoming progressively younger as one heads in that direction across the county. The oldest strata exposed at the surface in Hertfordshire occur in the north of the county at the foot of the chalk Chiltern Hills near Tring and Ashwell where there is a small strip of Lower Greensand, Gault Clay and Upper Greensand sediments. South of this strip, the Upper Cretaceous Chalk Group is present. Chalk dominates much of the bedrock geology of Hertfordshire and forms the Chiltern Hills. The southern part of the county exposes younger Palaeogene sands and clays belonging mainly to the Upnor, Reading and London Clay formations. During the past 2 million years much of the bedrock geology of Hertfordshire has become covered by the accumulation of fluvial sands, gravels and silts ('superficial deposits'); the eastern half of the county was affected by glaciers during the last Ice Age which created a thick layer of glacial boulder clays.

Overall, the Cretaceous and Palaeogene successions of Hertfordshire have yielded a limited number of stones suitable for building purposes. Both Chalk Block and Quarry Flint nodules from the Upper Cretaceous have been extensively used in the past for local building purposes. Quartz cemented sandstones (Sarsen stones) and Palaeogene conglomeratic beds (Hertfordshire Puddingstone) were also worked for building material and are commonly found in older buildings in the county. Tufa was very locally sourced and employed as an occasional building stone.

There are no building stone quarries currently operating in Hertfordshire. Some quarrying of sand and gravel occurs in the St Albans area and in the past clay has supplied a local brick-making industry which continues today near Hemel Hempstead. The limited availability of indigenous building stone in Hertfordshire has resulted in the extensive use of imported stones across the county.

Bedrock Geology Map



Key

Building stone sources

Bedrock geology

London Clay Formation — clay, silt and sand

Lambeth Group — clay, silt and sand

Thanet Formation and Lambeth Group (Undifferentiated) — clay, silt and sand

White Chalk Subgroup — chalk

Melbourn Rock Member — chalk and limestone

Grey Chalk Subgroup — chalk

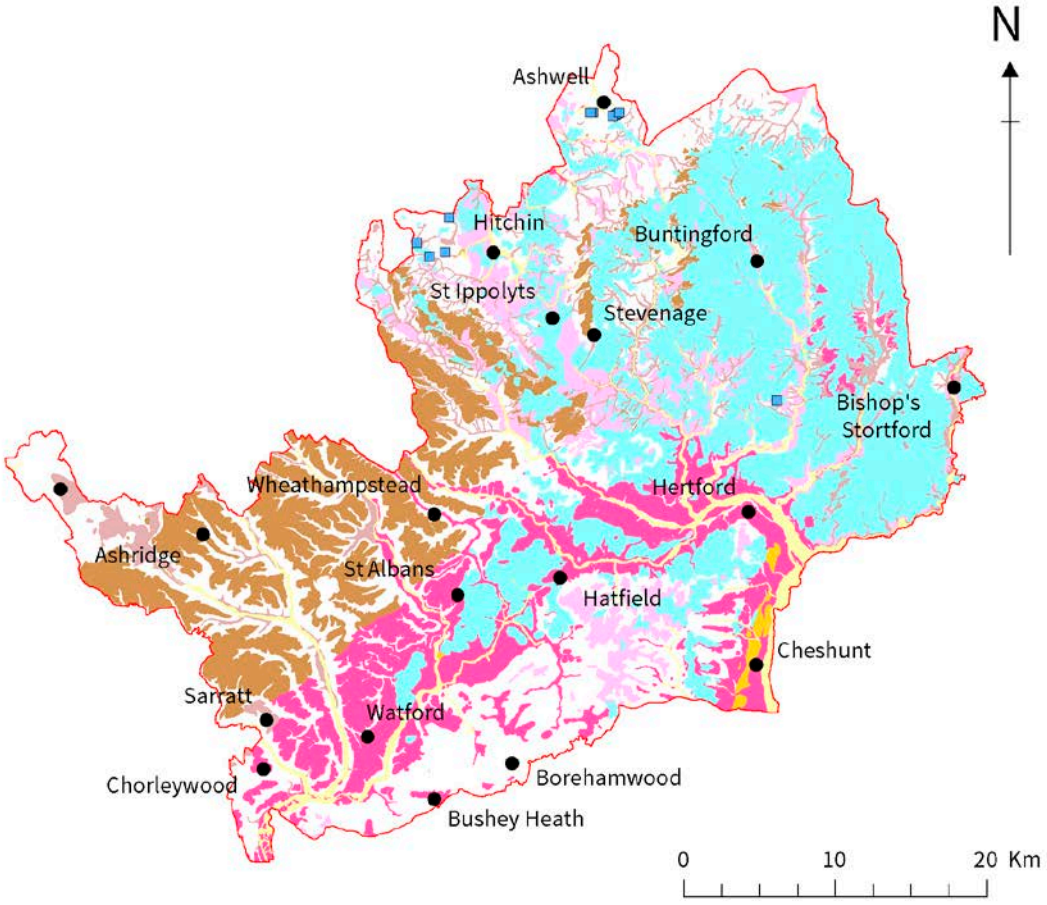
Totternhoe Stone Member — chalk and calcarenite

Gault Formation and Upper Greensand Formation (Undifferentiated) — mudstone, siltstone and sandstone (Selborne Group)

Gault Formation — mudstone (Selborne Group)

Woburn Sands Formation — sandstone

Superficial Geology Map



Key

Brickearth — peat, clays, silt and sand

Superficial geology

Head — sands, gravels, silt and clay

River Terraces — sands, gravels and clay

Glaciofluvial and Glaciolacustrine Deposists — sands, gravels, silt and clay

Glacial Tills — clays, sands, gravels, boulders

Clay-with-Flinys — sands, gravels, clay and silt

Stratigraphic Table

Geological timescale	Group		Formation	Building stone	Page
Quaternary	various		various	Tufa (Travertine) Glacial pebbles and cobbles Quaternary Flint (Field Flint, Brown Field Flint, Clay-with-Flints) Sarsen Stone (Silcrete) False Puddingstone	33 33 31 30 30
Palaeogene	Thames Group		London Clay Formation		
	Lambeth Group		Reading Formation	Hertfordshire Puddingstone (Puddingstone, Conglomerate, Mother Stone, Breeder Stone, Witchstone, Hagstone)	27
			Upnor Formation		
	Montrose Group		Thanet Formation		
Upper Cretaceous	Chalk Group	White Chalk Subgroup	Newhaven Chalk Formation		
			Seaford Chalk Formation	Chalk (Chalk Block, Clunch)	25
			Lewes Nodular Chalk Formation	Quarry Flint (Fresh Flint)	22
			New Pit Chalk Formation		
			Holywell Nodular Chalk Formation (including Melbourn Rock Member)	Melbourn Rock (Wellbury Rock)	21
		Grey Chalk Subgroup	Zig Zag Chalk Formation (including Totternhoe Stone Member at base)	Totternhoe Stone	19
			West Melbury Marly Chalk Formation (including Cambridge Greensand Member at base)	Cambridge Greensand pebbles and cobbles	19
Lower Cretaceous	Selborne Group		Upper Greensand Formation		
			Gault Formation (with Junction Beds at base)	Hitchin Carstone	18
	Lower Greensand Group		Woburn Sands Formation		

Building stones in geological order from the oldest through to the youngest layers.

2 The Use of Stone in Hertfordshire's Buildings

Background and historical context

Hertfordshire covers 164,300 hectares. Despite its relatively small size, the county has more than 8,000 listed buildings and 190 conservation areas. Its population is now more than 1 million, which is a threefold increase since the late 19th century.

Hertfordshire shares its geology with the adjacent counties. The chalk and clay-with-flints landscape of the Chilterns scarp and dip slope dominates the west of the county. The chalk escarpment extends north-east into Cambridgeshire, past Hitchin, Ashwell and Royston. The gently sloping plateau of the dip slope occupies a large part of the east of the county. The chalky boulder clay extends under much of northern Essex and southern Suffolk. To the south of the Chilterns and the boulder clay lies the Vale of St Albans, part of the Northern Thames Basin. It is underlain by deposits of sands and gravels, laid down during the Anglian glaciation (approximately 450,000 years ago), partly by the Thames (which at that time flowed through the vale and across Essex) and partly by glacial meltwater. To the south of the Vale of St Albans, the land rises towards the Middlesex border. Most of this area is underlain by London Clay, with some outcrops of Palaeogene sands and gravels. In the far north of the county, north of Tring and Ashwell, small areas extend from the foot of the chalk scarp into the Gault Clay of the Bedfordshire and Cambridge Claylands. Each of these areas has a significantly different history of settlement, agricultural and economic development, vernacular architecture and building stone use.

Timber was the main material used for construction in Hertfordshire throughout the medieval period. The county lies at the junction of the Essex/ East Anglian and Midland styles of timber-frame construction. In the east, buildings are usually of box frame construction, sometimes with flamboyant displays of upright timber close studding. In the west, some cruck frame buildings survive. However, most of the buildings have box frames, often with arch braces and wide panels of wattle and daub.

From the 16th century, timber frame was gradually superseded by brick. Timber frames were often overlain by lath and plaster. The plaster was sometimes given decorative moulding called pargeting, especially in the

east of the county. Weatherboarding was frequently used as cladding for agricultural, cottage and mill buildings from the 18th century.

Despite the dominance of timber frame and general lack of indigenous building stone in the county, there is still a long history of stone use in Hertfordshire. It features in castles, grand houses and churches. St Albans was the only Anglo-Saxon monastic foundation in the county. The abbey amassed a large endowment of land and rights over many parishes. It had a significant influence on the landscape, the economy and the extraction and use of building stone in the county. From the 14th century, St Albans Abbey owned at least two of the quarries at Totternhoe in Bedfordshire. The stone was imported for use at the abbey from the 12th century. It was supplied for churches across Hertfordshire from the end of the 12th century, where it was utilised for dressings and interior work, including arches, parapets, buttresses, window tracery and reveals, capitals to columns, fonts and general sculpture.

Figure 1: Cathedral and Abbey Church of St Alban, St Albans. Originally flint and Roman brick, rebuilt in Ancaster Stone.

There are at least 250 churches in Hertfordshire, including 141 parish churches. They represent the largest body of extant medieval stone buildings in the county. Pre-Reformation churches slightly outnumber post-Reformation churches. Most of the pre-Reformation churches developed piecemeal over the centuries. They were variously altered, enlarged and added to, and exhibit a mixture of features, fabric and building materials. The few churches that were largely constructed in one phase are the result of drastic rebuilding, such as the 14th-century Church of St Mary at Ashwell, built mainly of types of chalk.

More than 90 per cent of the county's 102 pre-Reformation churches used flint in their construction, sometimes with glacial pebbles and cobbles, puddingstone and/or imported stone (most commonly Totternhoe Stone). Barnack Stone from Northamptonshire was also occasionally used for dressings.

During the 13th century, the population grew rapidly. In the east and north-east of the county, where the population was the wealthiest, many churches were rebuilt in stone for the first time while others were enlarged. Nearly all their chancels were rebuilt and extended at this time. Many churches were subsequently rebuilt, but their 13th-century stone chancels were retained.

Increasing prosperity among the surviving merchant class and lesser gentry, and an obsession with intercessory prayer, partly in response to further outbreaks of the Black Death in the 1360s, led to the enrichment of churches. Most west towers, clerestories and chantry chapels date from the 14th and 15th centuries. The county's proximity to London and the establishment of a number of landed country estates led to the remodelling of many churches.

After the Reformation, the use of brick became dominant, although one-third of all the churches were built of flint. Imported stone was used far more frequently, including Kentish Ragstone, in particular, and also ooidal limestone and (in one instance) Triassic sandstone.

During the 19th century, many churches were restored, rebuilt or built new, stimulated by the Incorporated Church Building Society and the Oxford Movement. The society funded 36 new churches and the rebuilding of 10 others. After brick, flint was the most popular material used in new churches in the 19th century. Brick or imported stone was generally used for the dressings. Often complex styles of flint work were introduced. For example, St Paul's Church at Langleybury (restored by Henry Woodyer) has squared and coursed flint, and St Thomas' Church at West Hyde has circular knapped flint. Few churches were rebuilt in the economically depressed north and north-east of the county; G E Pritchett's knapped flint Church of St Mary at Therfield is a notable exception.

Several Norman castles were built at strategic locations in the county during the 12th century. These included Berkhamsted, Hertford and Waytemore, Bishop's Stortford. Flint walls survive at all three, including remains of the curtain wall and octagonal tower at Hertford Castle.

Figure 2: Hertford Castle curtain wall, Hertford. Quaternary Flint and chalk block, with glacial pebbles and cobbles and Quarry Flint nodules.

As castles were abandoned, the construction of fortified manors in stone became fashionable. Many were built in flint with Totternhoe Stone dressing and quoins. Ecclesiastical manor houses, such as the Old Rectory at Therfield and Nyn Hall at Redbournbury were also built in flint and Totternhoe Stone. Occasionally, houses were built entirely from Totternhoe Stone, such as Hinxworth Place, near Baldock.

Upon the Dissolution of the Monasteries, much of the land confiscated by the Crown from St Albans Abbey passed to courtiers and businessmen, all of whom were keen for status and a retreat from London. As a result, there was a growth in country house building during the mid-16th century. Between 1540 and 1650, some 30 large country or manor houses were built. Nearly all were in brick, often with stone dressings, including Hatfield House, Knebworth House and Old Gorhambury House.

Country house building took place in waves: pre-1580 and between the 1640s and 1660. Much improvement was undertaken between 1680 and 1720, and a further building boom took place between 1750 and 1780. From the mid-18th century, stone became fashionable for the rebuilding or new construction of large houses. Classical early brick buildings such as Moor Park, near Rickmansworth, were encased in Portland Stone.

Figure 3: Moor Park, near Rickmansworth. Brick encased in Portland Stone.

The proximity of London led to extensive suburban development in the southern part of Hertfordshire during the 20th century. New towns were built at Letchworth, Welwyn Garden City, Hatfield, Hemel Hempstead and Stevenage. The southern border of the county is only 25 to 30km from central London. A significant number of Arts and Crafts Movement houses were constructed in Hertfordshire, particularly in the Chilterns area and at Letchworth. Some use was made of imported stone for dressings. Charles Voysey used imported Westmorland Slate for roofs and stone dressings for a cluster of houses near Chorleywood, including Hollybank and his own home, The Orchard.

National Character Areas (NCAs)

Local landscape character and the combination of history, cultural and economic activity, geodiversity and biodiversity have been mapped for the whole of England and National Character Areas (NCA) defined (see Further Reading, Online Resources and Contacts). For each NCA there is a profile document which describes the natural and cultural features that shape the landscapes, how the landscapes have changed over time, the current key drivers for ongoing change, and a broad analysis of each area's characteristics and ecosystem services. The profiles include notes on local vernacular and building materials which are expanded in the following section on the six NCAs covered by this guide:

NCA 86 South Suffolk and North Essex Clayland
NCA 87 East Anglian Chalk
NCA 88 Bedfordshire and Cambridgeshire Claylands
NCA 110 Chilterns
NCA 111 Northern Thames Basin
NCA 115 Thames Valley

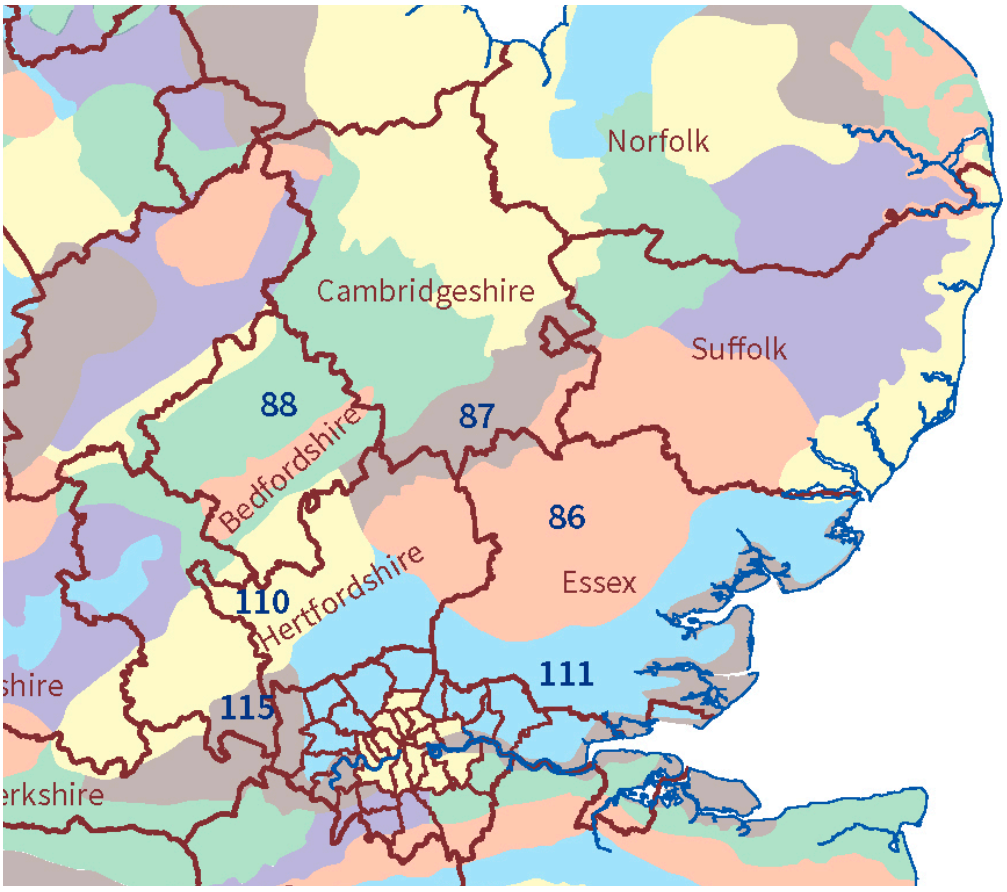


Figure 4: Map showing the National Character Areas (and the NCA numbers).

South Suffolk and North Essex Clayland

This chalky boulder clay plateau stretches from Stevenage and Bishop's Stortford eastwards to the county boundaries with Essex and Cambridgeshire. Its northern boundary is formed by the East Anglian Chalk and its southern boundary by the River Lea, between Hertford and Roydon and the River Stort. Settlements within this include Bishop's Stortford, Barkway, Buntingford, Walkern, Much Hadham, the Pelhams, Stevenage, Sawbridgeworth and Watton-at-Stone.

Timber was the main building material of this area and significant numbers of late medieval timber-framed buildings survive. They include large manors such as Balhams Hall, High Cross, barns such as the aisled barn at Shingle Hall, Sawbridgeworth, houses, inns and small cottages. Pargeting is a characteristic of many of the buildings of the settlements in the area. Thatch and clay tile were the dominant roofing materials until slate became more widely available during the 19th century.

Flint is the main indigenous stone that has been used for building in the area. The 12th-century bailey walls to Hertford Castle were built almost entirely of uncoursed rubble flint. The majority of the pre-Reformation churches of the area were also constructed of flint. Flint walls are a feature of the settlements of Great Amwell, Anstey, High Wych and the Hadham Road approach to Bishop's Stortford. Rounded flint pebbles were often used as a paving and surfacing material. There are excellent examples in Much Hadham High Street and in many other villages.

Flint continued to be used throughout the medieval period and up until the 17th century in vernacular buildings, as uncoursed rubble walling and frequently as the foundation base or plinth of timber-framed structures or early brick buildings. During the 18th and 19th centuries, flint was frequently used for cottages, in Anstey, Westmill, Hamels, Ardeley, High Wych and Great Amwell, for example, and for outbuildings, gazebos and grottos, such as Scott's Grotto in Ware, the largest subterranean grotto in England.

Figure 5: Scotts grotto, Ware, Hertfordshire.

Many of the churches constructed during the 19th century were also of flint, with brick and/or stone dressings, such as the Church of St James at High Wych. Imported stone was often used for dressings in the restoration works to churches. For example, Bath Stone was used as dressings in the Church of St Mary at Gilston.

Puddingstone was often used as foundation blocks to church towers, as in St Mary's Church at Brent Pelham, St Mary's Church at Stocking Pelham and St Nicholas' Church at Great Munden. It was also used as the base to the war memorial at Brent Pelham and is found in boundary walls at Hadham Cross, Much Hadham.

Blocks of False Puddingstone are present in the walls of St Leonard's Church at Bengeo and in the footings of St Nicholas' Church at Great Munden, All Saints' Church at Little Munden and Great St Mary's Church at Sawbridgeworth. Sarsen stone was used occasionally, as seen at the Church of St Andrew at Much Hadham and the Church of St Nicholas at Great Munden.

Roman brick was used in some Anglo-Saxon churches, including the Church of St Andrew at Much Hadham. Brick became dominant for larger houses from the 16th century. A good example is Furneux Pelham Hall. By the 17th century, brick was used more widely: in farm buildings, such as the spectacular 42m-long barn at Upp Hall, Braughing, and in most houses and cottages. Only three churches were built in the county during the 17th and 18th centuries. All were built in brick, including the Church of St Peter at Buntingford.

Stone was imported from a relatively early date. For example, Ward's Hospital (almshouses) in Buntingford is built of brick with Portland Stone dressings. During the 19th century, new mansions were occasionally constructed of stone: for example, Gilston Park was built of coursed limestone rubble with ashlar.

East Anglian Chalk

The East Anglian Chalk of Bedfordshire, Cambridgeshire, Hertfordshire, Suffolk and north-west Essex is part of the narrow ridge of chalk that runs north-east to south-west across southern England, from Devon to Lincolnshire. The chalk ridge forms the highest land in Hertfordshire. It runs from Tring in the west, past Hitchin, Baldock, Ashwell and Royston, and east into north-west Essex and Cambridgeshire.

Historically, the area was sparsely populated. Scarp foot springs emerge from the outcrop of Totternhoe Stone, which overlies the less permeable West Melbury Marly Chalk Formation. Settlements such as Ashwell, Hitchin, Norton and Royston were established on the spring line.

The area's buildings made use of a mixture of materials: timber frame, red and gault brick, flint and chalk, with thatched and tiled roofs. Timber-frame

Figure 6: Village lock-up, Ashwell. Chalk clunch and slate.

houses are in the East Anglian tradition, with close boarding. They are often rendered, and pargeting is commonplace. Brick started to be used from the 16th century. Buildings were frequently re-clad using brick during the 17th and early 18th centuries, as is evident in settlements such as Baldock, Royston and Ashwell and the surrounding villages.

Chalk and Totternhoe Stone were used for buildings, from the magnificent Church of St Mary to the more prosaic village lock-up and garden walls at Ashwell. Hinxworth Place, one of the finest 15th to 16th-century stone manor houses in Hertfordshire, is built of Totternhoe Stone. A few chalk buildings survive in the towns, such as 48a Kneesworth Street, Royston.

Flint was used in the pre-Reformation churches, alongside chalk, Totternhoe Stone dressings and brick. The Knights Templar Church of St Mary at Baldock exhibits flint and stone chequerwork. The Church of St John the Baptist at Royston, the only surviving part of a former Augustinian priory, is built of flint with chalk block and Totternhoe Stone. Knapped flint was often used for walling, commonly with brick, or sometimes mixed with chalk block or bat and cob, as seen at Ashwell and Royston. Parts of the medieval flint walling of Royston Priory survive. Some buildings were built in flint during the 19th century, such as the school at Fish Hill, Royston.

Cambridge Greensand pebbles and cobbles are used in local churches, including the Church of St Mary at Ashwell and the Church of St Nicholas at Hinxworth. Sarsen stone, together with chalk, flint rubble and brick, was occasionally used as part of the walling of pre-Reformation churches, such as in the diminutive Church of St Margaret of Antioch at Bygrave.

Clay plain tile roofing is characteristic of the area, with some thatch. The construction of the Hitchin to Cambridge railway during the 19th century enabled importation of slate for roofing.

Bedfordshire and Cambridgeshire Claylands

The Bedfordshire and Cambridgeshire Claylands occupy a very small part of Hertfordshire, where the administrative boundary projects northwards from Tring into the Vale of Aylesbury in Buckinghamshire. Settlement is sparse, and it is restricted to moated farms and isolated properties. Box timber framing, often with arch braces, was dominant in the area during the medieval period. Timber framing continued to be dominant for farm buildings into the 19th century, often with weatherboarding and thatch or clay tiles. Brick became the main building material from the 18th century. Many timber-framed houses and cottages were then re-faced in brick. There are significant numbers of Rothschild Estate brick and tile cottages in villages such as Wilstone.

Flint was used not only for pre-Reformation churches, such as St Mary's Church at Puttenham, but also, in knapped form, for 19th-century churches, such as the Church of St Cross at Wilstone. St Mary's Church at Puttenham has distinctive flint and Ketton Stone chequerwork. The Portland Stone in these buildings was probably sourced from Jurassic outliers of the Midvale Ridge of Oxfordshire, or from near Quainton or Stone in Buckinghamshire.

Figure 7: St Mary's Church, Puttenham. Knapped flint and Ketton Stone chequerwork.

The infrastructure of the Grand Union Canal is a significant feature of the area. There are four substantial balancing reservoirs that lie at the base of the Chiltern foothills. They served the adjacent main course and the Wendover and Aylesbury arms of the canal. The canal's associated structures made some use of building stone, in particular Millstone Grit sandstone, although brick is dominant.

Chiltern Hills

The eastern part of the Chiltern Hills falls within Hertfordshire. They cover much of western Hertfordshire, stretching east to Stevenage and south to St Albans and Chorleywood. The area is characterised by the more dissected clay-with-flints plateau of the Chilterns dip slope. Through valleys are characteristic of the Chilterns in Hertfordshire. Major transport routes radiating from London have followed the valleys from prehistory. These facilitated the transportation of stone into the county from Bedfordshire and Buckinghamshire, as well as from areas further afield once the canal and railway networks developed.

The Chilterns produced limited quantities of five main types of local stone: chalk, Quarry Flint, Quaternary Flint, Sarsen stone and puddingstone. Timber framing with thatched roofing was dominant during the medieval period. Flint was the most widely used stone. It is found in nearly all the pre-Reformation churches of the area and in a wide range of buildings, from town houses to barns.

Close to the scarp, Totternhoe Stone or chalk block was occasionally employed, usually with flint, as seen at the Church of St Mary at Pirton and the Church of SS Peter and Paul at Tring. There are several stone buildings in Pirton: Rectory Farm uses chalk with red brick and rendered timber framing, whereas Old Hall is built of flint with brick quoins and stone dressings.

Sometimes, Sarsen stone or Hertfordshire Puddingstone was used for foundation blocks or cornerstones, such as in the Church of St Lawrence at Nettleden, the Church of SS Peter and Paul at Little Gaddesden and the Church of the Holy Cross at Sarratt. At Westbrook Hay, there is a folly house built of Hertfordshire Puddingstone.

Figure 8: Church of the Holy Cross, Sarratt. Puddingstone.

There is a concentration of 18th and 19th-century mansions and associated parks and gardens that reflect the area's proximity to London. Around Tring, there are several Rothschild estates, including Tring Park with its characteristic brick, flint and half-timber 19th-century cottages. Most of the mansions were constructed in imported stone or brick, although some use was made of chalk, flint and Sarsen stone. One of the largest mansions, Ashridge House in Little Gaddesden, was built of Totternhoe Stone by James Wyatt for the Earl of Bridgwater.

Timber framing, often with weatherboarding, was used for barns and other farm buildings, such as hay barns, cart and implement sheds, granaries and livestock housing. They were often built on brick bases and sometimes incorporated Sarsen stone in the footings. In conjunction with brick, flint became the dominant building material of the area from the 18th century.

The 19th-century expansion of the railway network led to a rapid growth in population. A large number of Anglican churches were built or rebuilt to serve the increased population. These were largely constructed of local flint, often with imported stone dressings. Non-conformism was established early in the Chilterns. There is a particularly rich legacy of 18th and 19th-century chapels.

Brick was produced locally from the 15th century and became the dominant building material of the area from the 18th century. It remains in production today at Bovingdon. Chilterns flint was commonly used in combination with brick. Welsh Slate became commonplace during the 19th century due to improved transportation, brought about by the construction of turnpikes, the Grand Junction Canal and the railway system.

Northern Thames Basin

This area extends from Hertfordshire in the west to the Essex coast in the east. It takes in the south of Hertfordshire, including the suburbs of north London and historic towns and cities such as St Albans, Hatfield, Hertford, Welwyn, Hoddesdon and Cheshunt, as well as the 20th-century new and extended towns of Welwyn Garden City and Hatfield. The River Lea forms the eastern boundary with Essex. The major towns are located in the valleys and along the valley sides of the Ver, Upper Colne and Lea.

A reasonable number of medieval timber-framed houses have survived in both the towns and countryside, including significant numbers of farm buildings and barns. The towns have many 16th and 17th-century timber-framed buildings. They were often re-fronted in brick during the 18th century when brick was dominant.

During the 16th to 17th century, the increasing influence of London led to the growth of market towns and substantial farming estates and prompted the construction of many country houses. Brick became dominant from the late 17th century. The construction of railways stimulated both the development of commuter settlements and the expansion of existing towns and villages during the 19th and 20th centuries. Welwyn Garden City and Hatfield new

towns also expanded development further during the 20th century. Some imported stone was used for the dressings of buildings in the civic area of the former.

Stone has been used in the Northern Thames Basin from the Roman period. The Roman city of Verulamium (now St Albans) used flint as its main building material, together with Totternhoe Stone and brick. Materials from the city were reused in St Albans Abbey, which dates from the Norman period. Flint was used in Hertford Castle and extensively in the area's pre-Reformation churches. It was often mixed with other materials, such as chalk, Totternhoe Stone, puddingstone and glacial pebbles and cobbles. Flint was used for buildings and walling in much of the area.

Figure 9: City wall, St Albans. Quaternary flint nodules and Roman tiles, with occasional glacial pebbles and cobbles.

Chalk block was also occasionally used, for example in Ver Cottage, St Albans, although unfortunately this building is now rendered. Puddingstone is found in small qualities in many pre-Reformation churches in the area. The stone was often used for foundations, at the Church of St Mary at Hemel Hempstead, for example. Small blocks are often found in churches, including the Churches of St Michael and St Stephen at St Albans. False Puddingstone blocks occur in several churches in the area, including in the rubble walling of the Church of St John the Baptist at Aldenham, the Church of St Mary at North Mymms and the Church of St Giles at South Mimms.

Sarsen stone was used occasionally, for example in the Church of St Mary at Hemel Hempstead, the Minsden Chapel near Preston, the Church of St Mary at North Mymms, and the Churches of St Michael and St Stephen at St Albans. In the Church of St John the Baptist at Aldenham, dressed puddingstone blocks were used in the tower. These were possibly sourced from a pit at nearby Radlett.

The area has a long history of stone importation. Totternhoe Stone from Bedfordshire was particularly used in churches built by the St Albans Abbey, such as St Michael's, St Peter's and St Stephen's, all in St Albans. The stone was also used in lay buildings, such as Kingsbury Manor, St Albans. The Eleanor Cross in Cheshunt is built of Caen Stone, and blocks of Carboniferous sandstone were used in the clock tower in St Albans.

Figure 10: Church of St Michael, St Albans. Flint and Roman tiles with Totternhoe Stone, Hertfordshire Puddingstone, Bath Stone and possibly Ham Hill Stone.

Imported stone became more readily available after the Lea Navigation, canals and railways were built during the 18th and 19th centuries. Imported stone was used for civic and commercial buildings, including Bath Stone for Hertford's Corn Exchange, Red Mansfield Stone for the dressings of 10 St Peter's Street, St Albans, and Portland Stone for St Albans' town hall and Haileybury college, Hertford Heath.

During the 19th century, several churches were constructed, rebuilt or restored. Although many used flint with brick or imported stone dressings, some were built entirely of imported stone. The Church of St Peter at Bushey Heath and its adjacent church hall were built in rock-faced Kentish Ragstone, and the Church of All Saints at Hertford was built of Triassic Runcorn Stone from Cheshire.

Thames Valley

A small area of Hertfordshire, the Lower Colne Valley to the south of Rickmansworth, Maple Cross and Chorleywood, falls within the Thames Valley NCA. Here, 20th-century development has been extensive and substantial gravel extraction has taken place in the lower part of the valley.

Timber frame was once dominant, with brick used generally from the late 17th century onwards. Rickmansworth has a good selection of 16th and 17th-century houses and cottages, including the Old Vicarage and the Priory. These were mostly re-fronted in brick during the 18th and 19th centuries. Granite, probably imported from south-west England, was used for kerbing in the town.

Flint was often used in the plinths to timber-frame and brick buildings. It was employed extensively in pre-Reformation churches and those restored, rebuilt and newly built during the 19th and early 20th centuries. St Peter's Church at Rickmansworth is built of knapped flint with Bath Stone dressings. Our Lady Help of Christians Roman Catholic Church, also at Rickmansworth, was built in concrete but faced with field flint and stone dressings.

Mansions with parks were common in the wider Thames Valley NCA. Those in Hertfordshire are generally built of brick with stone dressings and they boast classical features such as stone porticoes.

3 Local Building Stones

Lower Cretaceous

Selborne Group, Gault Formation

Hitchin Carstone

Hitchin Carstone is a new name applied here to a distinct medium to coarse-grained, ferruginous sandstone that varies in colour from dark olive-brown to purplish black. Irregular ochreous patches and mottling are commonplace. The overall appearance of the stone is quite 'gritty' or granular, and small (<2mm) rounded clasts of pale quartz, feldspar or phosphatic material are evident in many blocks. The stone does not obviously contain fossils, but indistinct traces of lamination or low-angle cross-bedding are sometimes apparent.

The geographical origins of Hitchin Carstone are not known, but the lithological characteristics and appearance of the stone point to a source within the so-called 'junction beds'. Stratigraphically, the junction beds occur at the base of the Gault Formation and immediately overlie the Woburn Sands Formation in the Hitchin district. Hitchin Carstone is best seen in the west tower and south-west walls of the Church of St Mary at Hitchin.

Figure 11: Church of St Mary, Hitchin. Chalk block, Totternhoe Stone, Quarry Flint, Quaternary Flint, glacial pebbles and cobbles and Hitchin Carstone, with Ancaster Stone, Bath Stone and Permo-Triassic sandstone.

Figure 12: Church of St Mary, Hitchin. Hitchin Carstone.

Upper Cretaceous

The Upper Cretaceous Chalk Group forms the bedrock geology to most of central, northern and western Hertfordshire. The Chalk Group succession attains a total thickness of approximately 300m. It is divided into a thinner lower unit, the Grey Chalk Subgroup, or 'Lower Chalk', which has a relatively high clay content and contains marls but no flint; and a thicker upper unit, the White Chalk Subgroup, or 'Middle and Upper Chalk', which comprises nearly pure chalk and contains abundant flint.

Chalk Group, Grey Chalk Subgroup, West Melbury Marly Chalk Formation

Cambridge Greensand pebbles and cobbles

Former coprolite workings in the Cambridge Greensand Member near Ashwell yielded rounded and angular pebbles and small boulders of various rock types, including granite, schist, hornfels, basalt, sandstone, greywacke, slate and dolomitic limestone. Some of these 'exotic' pebbles and cobbles were used for building purposes and feature in the walls of the churches at Ashwell and Hinxworth.

Chalk Group, Grey Chalk Subgroup, Zig Zag Chalk Formation

Totternhoe Stone

The Totternhoe Stone Member varies in thickness from less than 0.5m in the Hitchin area to 1 to 2m elsewhere. Locally, it may reach up to 5 or 6m, but the base and top of the unit may grade into the adjoining chalk deposits and thus the boundaries can be difficult to recognise. Totternhoe Stone is a distinctly harder unit of chalk within the Grey Chalk Subgroup and typically comprises fine-grained, creamy to pale brownish-grey, chalky calcarenites. It often appears sandy due to the presence of coarse fossil fragments. The unit varies from thin to thickly bedded and is phosphatic in parts. Some beds contain characteristic dark brown phosphatic pellets up to a few millimetres across, which occasionally become nodular and attain sizes of several centimetres across.

The use of indigenous Totternhoe Stone in Hertfordshire was quite limited. The stone was worked at Ashwell Quarry and near Barkway. Churches located close to the outcrop, such as the Church of St Mary at Pirton and the Church of SS Peter and Paul at Tring, made much use of Totternhoe Stone. It was also employed in chequerboard work (with Quarry Flint) at Thunderdell Lodge on the Ashridge estate, near Berkhamsted.

Figure 13: Thunderdell Lodge, Ringshall, near Berkhamsted. Knapped flint and Totternhoe Stone chequerwork.

Figure 14: Abbey gatehouse, St Albans. Totternhoe Stone.

Totternhoe Stone imported from Bedfordshire was employed for tracery and other decorative purposes from the Saxon period onwards. Examples are provided by a substantial number of churches across the county that date from the 12th century. These include the Church of the Holy Cross at Sarratt, St Lawrence's Church at Abbots Langley and St Mary's Church at Kings Walden. However, the most impressive and extensive use of Totternhoe Stone in Hertfordshire can be seen at Ashridge House near Berkhamsted.

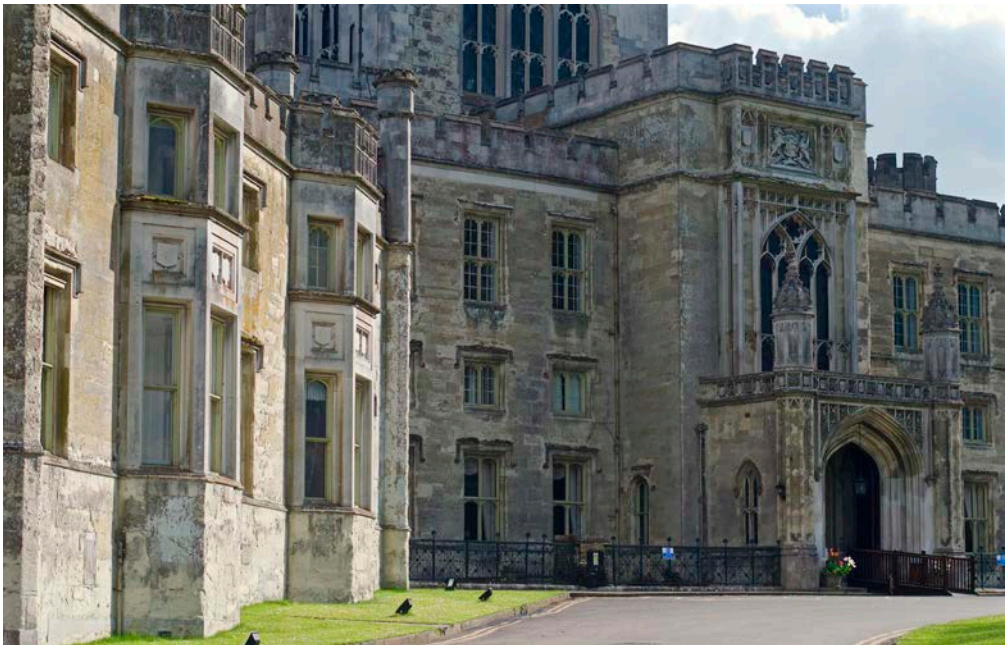


Figure 15: Ashridge House, near Berkhamsted. Totternhoe Stone ashlar, with Portland Stone and Ancaster Stone repairs.

Figure 16: Ashridge House, near Berkhamsted. Totternhoe Stone ashlar blocks.

Chalk Group, White Chalk Subgroup, Holywell Nodular Chalk Formation

Melbourn Rock (Wellbury Rock)

Melbourn Rock (or Wellbury Rock) is a hard variety of chalk that is off-white in colour and exhibits a blocky, fractured texture. It is typically associated with thin marl bands. The Melbourn Rock Member ranges in thickness from about 3m in the Chiltern Hills area to between 2 and 7m around Hitchin. It can be difficult to distinguish from chalk block, but its use as a building stone is considered to be relatively limited in Hertfordshire. Records indicate that it was employed in the construction of St Mary's Church at Ashwell.

Chalk Group, White Chalk Subgroup, Lewes Nodular Chalk Formation

Quarry Flint (Fresh Flint)

Quarry Flint is one of the most common and widely used building stones in Hertfordshire. It originates from bands and more isolated nodules of flint that occur within the chalky limestone beds of the White Chalk Subgroup.

Quarry Flint is an extremely fine-grained (cryptocrystalline) and hard form of silica, containing microscopic quartz-crystal aggregates. It usually occurs as irregularly shaped nodules that are 100 to 200mm across, or as (sub-)rounded pebbles and cobbles. Occasionally, it is also found as weakly banded tabular sheets or layers up to 200mm thick. The colour is very distinctive: fresh flint nodules have a white outer cortex with a black or dark grey interior.

Quarry Flint breaks with a characteristic conchoidal fracture, producing razor-sharp fine edges. The cleaved surfaces may exhibit banding resulting from the alternation of layers of slightly different composition. Flint nodules may contain cavities lined with translucent botryoidal chalcedony or small transparent quartz crystals. Some flint nodules contain well-preserved fossils, with echinoids, sponges, bivalves and burrow structures being the most commonly encountered types.

The use of Quarry Flint was particularly prevalent in the Chilterns, East Anglian Chalk, Northern Thames Basin and Thames Valley areas of the county. It was extensively used in buildings and village walls throughout much of Hertfordshire in a wide variety of ways, including as knapped, faced, trimmed or cleaved-faced stone and in squared chequerwork. It is occasionally found coursed in church walls.

The extremely hard and resistant nature of Quarry Flint nodules has resulted in them being recycled by natural processes into younger deposits. These reworked types of flint, which show specific characteristics, are described below in the Quaternary section of this guide.

Quarry Flint and Quaternary Flint are often the main components of the rubble walling of pre-Reformation churches in Hertfordshire. Other stone types include chalk, Hertfordshire Puddingstone, Sarsen stone and glacial pebbles and cobbles.

After the Reformation, one-third of all churches were built mainly of flint. During the 19th century, 46 new or reconstructed churches were built in the county, often using flint with either brick or imported stone dressings. Complex styles of flint work were introduced. For example, the Church of St Paul at Langleybury has squared and coursed flint, and the Church of St Thomas at West Hyde has circular knapped flint.

The stone was employed in fine medieval and early post-medieval houses, such as Old Gorhambury, near St Albans, and Berkhamsted Place. It was also used in many villages for general walling and for farm buildings.

Other examples of Quarry Flint can be seen at the Church of St Mary at Ashwell, Thunderdell Lodge, Ashridge (in chequerwork with Totternhoe Stone), St Mary's Church at Reed, The Old School, Wheathampstead, St Mary's Church at Hitchin (very large nodules up to 200mm across), St John the Baptist Church at Aldbury and the abbey gate and lodge house to the Roman Theatre of Verulamium at St Albans.

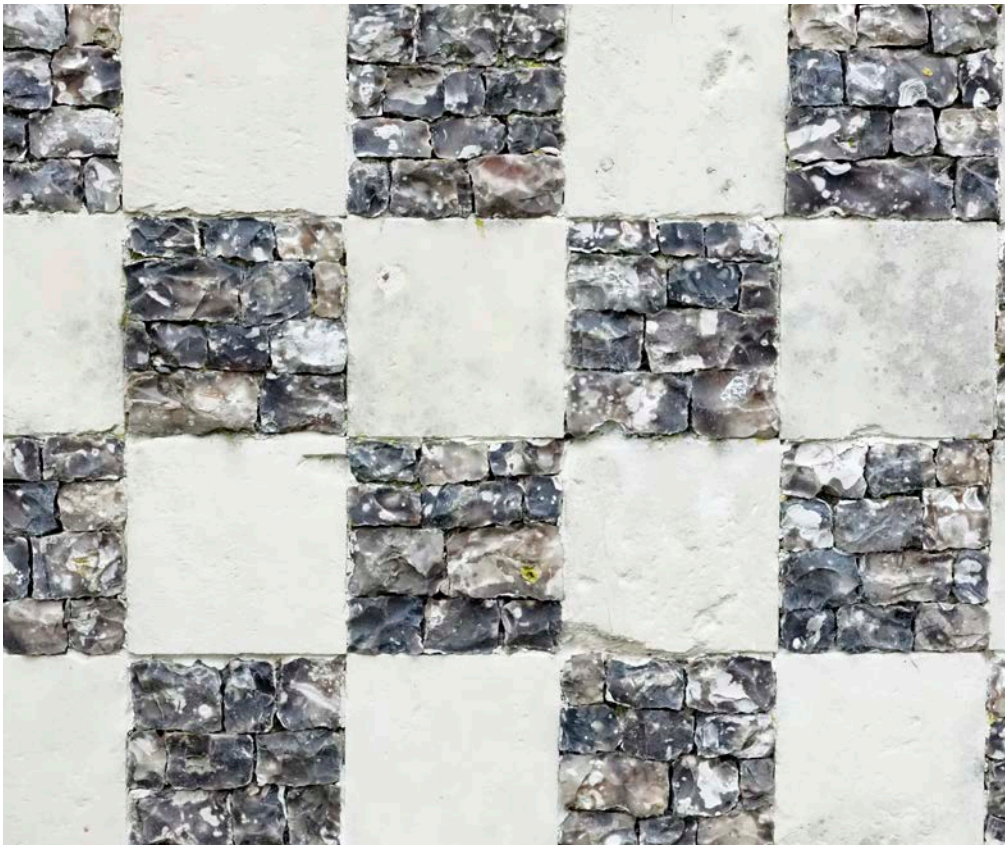


Figure 17: Thunderdell Lodge, Ashwell. Knapped Quarry Flint and Totternhoe Stone chequerwork.

Figure 18: Old School House, Wheathampstead. Knapped flint nodules.

Figure 19: Abbey gate, St Albans. Quarry Flint with chalk block dressings.

Figure 20: St Mary's Church, Hitchin. Quarry Flint nodules.

Figure 21: Verulamium Lodge, St Albans. Quarry Flint, Ancaster Stone and Bath Stone.

Chalk Group, White Chalk Subgroup, Seaford Chalk Formation

Chalk (Chalk Block, Clunch)

The white chalky limestones of the Upper Cretaceous White Chalk Subgroup are among the most distinctive and easily recognised building stones employed in Hertfordshire. They are white to very pale grey, typically structureless limestones, which in places contain fossil oysters (inoceramids) and echinoids, and occasionally crinoids, brachiopods and belemnites.

Chalk is generally unsuitable for exterior stonework because repeated wetting and drying, coupled with frost action, causes the relatively soft rock to powder and disintegrate into small angular brash. Softer forms of the stone, when used externally, may show concave weathering away from mortar lines.

Quarrying and mining for chalk and flint have a long history in the county. There is a considerable number of medieval to 19th-century quarries in the north of the county. The mining of chalk was particularly common from the 18th to the 20th century, usually for agricultural lime and lime mortar and for use in the production of bricks, tiles and pottery. It was also occasionally employed for building stone, mainly for building foundations and for decorative work, but also to make compacted chalk floors.

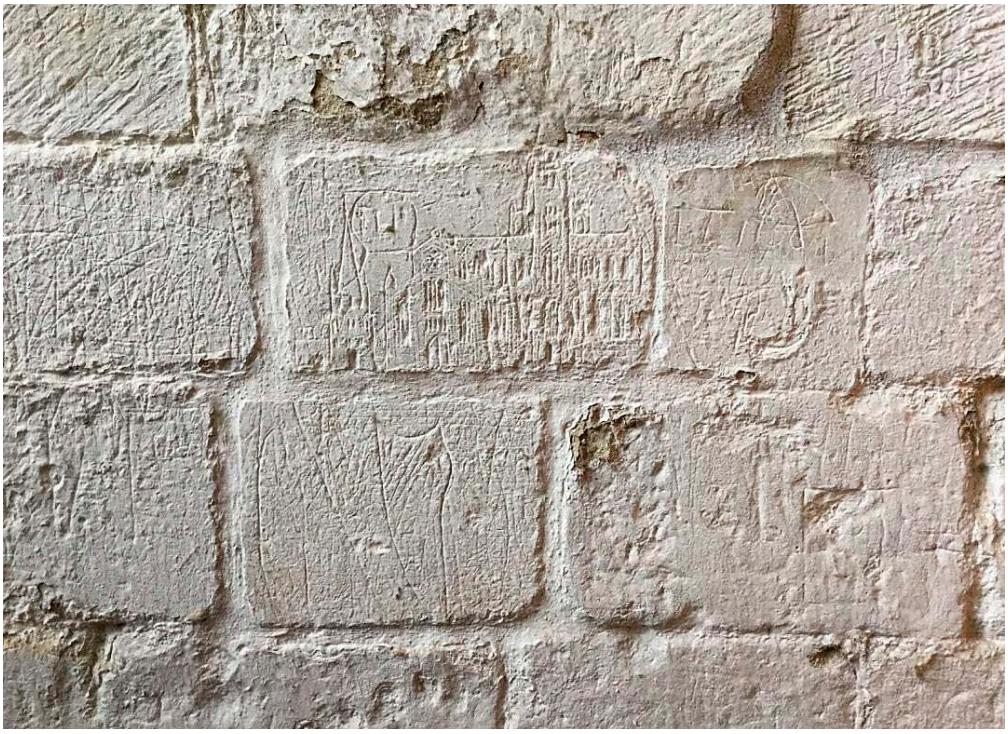
Chalk is typically used as a rough walling stone, often accompanying other stone types, especially flint, or for decorative purposes, including window dressings or banding and so forth. The stone may be roughly cut, which has enabled the creation of areas of squared blockwork. Occasionally, houses were built entirely of chalk block, such as Hinxworth Place. Chalk was also employed in some lesser buildings, such as the village lock-up in Ashwell and for village boundary walls. Away from the main outcrop, walls constructed entirely of chalk block are rare.

Noteworthy examples of the use of chalk include St Mary's Church at Reed, St Bartholomew's Church at Wigginton, St Mary's Church at Ashwell, St Mary's Church at Hitchin and the drinking fountain in Old Cross, Hertford.

Figure 22: Drinking fountain, Old Cross, Hertford. Chalk.

Figure 23: St Mary's Church, Ashwell. Chalk, including Totternhoe Stone and Melbourn Rock, with Quaternary Flint and glacial pebbles and cobbles.

Figure 24: St Mary's Church, Ashwell. Chalk block.



Palaeogene

Lambeth Group, Upnor Formation, Reading Formation

Hertfordshire Puddingstone (Puddingstone, Conglomerate, Mother Stone, Breeder Stone, Witchstone, Hagstone)

Hertfordshire Puddingstone is one of the best-known and most distinctive stone types in the county. It is a conglomerate containing sub-rounded pebbles of flint, which mainly exhibit grey interiors but may be stained by various iron compounds to produce attractive hues of red, orange or (occasionally) green. The size of the pebbles varies considerably, even within a single block of puddingstone, but they typically range from 10 to 100mm.

Figure 25: War memorial base, Brent Pelham. Hertfordshire Puddingstone.

However, much larger cobbles sometimes occur. The pebbles are cemented by relatively uniform pale grey or buff quartz. Overall, Hertfordshire Puddingstone is a hard, coherent and durable rock that tends to break in a regular, planar manner both around and through pebbles. Synthetic concrete may resemble puddingstone, but it fractures unevenly.

Hertfordshire Puddingstone was evidently a popular building stone. It is found in a range of buildings and walls, although it is rarely the main constituent of a structure. Examples include the war memorial Brent Pelham, the garden walls at West Radlett, the entrances to the icehouse, grotto and rock garden at Ashridge, Little Gaddesden and, as scattered blocks, the wall of St Andrew's Street car park in Hertford. It was often used for wheel guards to buildings and for mounting blocks.

Hertfordshire Puddingstone occurs as roughly dressed blocks in the walls of many pre-Reformation churches in the county, including St John the Baptist Church at Aldenham, St Michael's Church at St Albans and Holy Cross at Sarratt. Hertfordshire Puddingstone is also used as a foundation stone for church walls and buttresses at St Lawrence's Church at Nettleden, St John the Baptist Church at Great Gaddesden and SS Peter and Paul's Church at Little Gaddesden.

Large isolated blocks of Hertfordshire Puddingstone can be seen at Kingsbury Mill, St Michael's Street, St Albans, in the castle grounds outside the museum in Hertford and in the gardens at Ware Priory. They also occur at Berkhamsted and in other places such as Brent Pelham, Furneux Pelham, Standon, Much Hadham, Little Hadham and Bishop's Stortford.

Figure 26: Church of the Holy Cross, Sarratt. Hertfordshire Puddingstone with Quarry Flint and Totternhoe Stone dressings.

Figure 27: Church of the Holy Cross, Sarratt. Hertfordshire Puddingstone.

Figure 28: Outside Kingsbury Mill, St Michael's Street, St Albans. Hertfordshire Puddingstone boulder.

Figure 29: Detail of Hertfordshire Puddingstone boulder.

Quaternary

Various groups, various formations

False Puddingstone

False Puddingstone is the name given to breccio-conglomerates that have an overall deep purple to red or deep brownish colouration and contain a mixture of sub-rounded dark reddish-grey flint pebbles, angular orange-brown clasts, flakes of flint and chert and whitish quartzite pebbles. It is readily distinguished from Hertfordshire Puddingstone by its overall darker colour and deep red-purple iron-rich cement.

False Puddingstone is a relatively hard, durable rock, but it has a sporadic occurrence and is rarely encountered. It can be found in the walls of 14 churches across the county. Sites include the rubble walling of St John the Baptist Church at Aldenham, St Mary's Church at North Mymms, St Giles' Church at South Mimms, St Leonard's Church at Bengeo and St Ippolyts Church near Hitchin. It was also used in the footings to churches, including those at Great Munden, Little Munden and Sawbridgeworth.

Figure 30: Church of St Ippolyts, St Ippolyts. False Puddingstone with Quaternary Flint pebbles and cobbles.

Sarsen Stone (Silcrete)

Sarsen stone typically occurs as rounded or elongate pebbles, cobbles, boulders or even metre-scale isolated slabs (up to 2m in length). It is grey to pale brown in colour, becoming distinctly creamy-buff when weathered, and possesses a very fine-grained 'sugary' texture, comprising sub-rounded quartz grains set within a silica matrix, which is visible on fractured surfaces. Sarsen stone is very hard and resistant to weathering. Its surfaces are often smooth and may occasionally show poorly defined bedding structures.

Sarsen stone occurs less frequently than puddingstone in pre-Reformation churches, but it has a widespread distribution across the county. Churches include Holy Cross at Sarratt, Great St Mary at Sawbridgeworth, St Mary's at Hemel Hempstead, the ruined Minsden Chapel, St Mary's at North Mymms, and St Michael's and St Stephen's in St Albans. It can also be seen

in the churches of SS Andrew and Mary at Watton-at-Stone, St Catherine at Sacombe, St Lawrence at Bovingdon and St Margaret of Antioch at Bygrave.

Sarsen stone was also employed as paving setts, as seen, for example, in Berkhamsted, Hemel Hempstead and in the St Michael's area of St Albans.

Figure 31: St Michael's Street, St Albans. Sarsen stone and granodiorite kerbing.

Quaternary Flint (Field Flint, Brown Field Flint, Clay-with-flints)

Quaternary Flint typically occurs as irregularly shaped nodules, which are found lying on the surfaces of fields, within deposits of clay-with-flints or as pebbles within river terrace gravels and other superficial deposits. The size of the nodules ranges from 100 to 300mm, although larger nodules occasionally occur. The colour is variable: less weathered flint nodules or pebbles have a cream outer cortex with darker coloured (greyish) interior; weathered flints, or those that have lain in soil or superficial deposits for a long period of time, may be variously discoloured or bleached, and often have brown stained interiors due to the precipitation of iron hydroxides from percolating ferruginous waters. This weathered appearance helps distinguish field flint from the much fresher looking Quarry Flint.

Its widespread availability, combined with its hardness and resistance to weathering, has resulted in Quaternary Flint being one of the most dominant types of building stone used in Hertfordshire. Many walls and buildings (especially churches) throughout the county employ Quaternary Flint in one form or another, and the stone has been used extensively in many towns and villages.

As a walling stone, Quaternary Flint was employed in a wide variety of ways: as nodules or pebbles laid roughly to course, as squared blocks as part of chequerwork, and as knapped, faced, trimmed or cleaved-faced stone in random or decorative arrangements. Nodules were often selected for their shape and size and laid in either a random or coursed manner.

Several Norman castles were built at strategic locations in the county during the 11th and 12th centuries. Flint walls and structures survive at Berkhamsted and Hertford. From the 15th century, ecclesiastical manors and larger houses were often built of Quaternary Flint with brick or stone dressings.

Notable examples of Quaternary Flint (often in association with Quarry Flint) can be seen in the curtain wall to Hertford Castle; the Roman city wall, clock tower, St Michael's Church in St Albans; St Mary's Church at Reed; and St Mary's Church at Ashwell. It was also used at Our Lady Help of Christians Roman Catholic Church at Rickmansworth to face a largely concrete structure.

Figure 32: Cathedral nave wall, St Albans. Quaternary Flint pebbles, knapped Quarry Flint, Hertfordshire Puddingstone and Roman tiles.

Figure 33: Hertford Castle curtain wall, Hertford. Quaternary Flint and chalk block, with glacial pebbles and cobbles and Quarry Flint nodules. Portland Stone and brick repair work.

Figure 34: Hertford Castle walls and gate, Hertford. Quaternary Flint pebbles.

Glacial pebbles and cobbles

Accumulations of Quaternary-aged fluvio-glacial deposits in Hertfordshire are usually thin (rarely exceeding 5m in thickness) and encompass a diverse range of poorly sorted, relatively soft and unconsolidated sediments. These vary in composition, but sometimes contain harder pebbles and cobbles of flint, chert, chalk, brown or purplish Permo-Triassic quartzitic sandstones, Carboniferous limestones and sandstones, Jurassic limestones, Lower Cretaceous Greensand and ironstones (carstone) and occasional igneous and volcanic rocks, including basalt, rhyolite and tuff.

Formerly, these deposits were widely exploited for construction materials, mainly on a local farm or village scale. The harder pebbles and cobbles yielded as a by-product of this activity served as a convenient source of stone for local buildings.

The presence of pebbles and cobbles in buildings in Hertfordshire is sporadic. Examples can be seen in churches in the north of the county at Hitchin, Ashwell and Hinxworth. A few churches are predominantly built of pebbles and cobbles, such as the Church of St Mary the Virgin at Great Wymondley and the Church of St Peter at Holwell.

Figure 35: Church of St Nicholas, Hinxworth. Chalk, Quarry Flint, Quaternary Flint and glacial pebbles and cobbles.

Tufa (Travertine)

Tufa is a whitish or pale grey-coloured limestone formed by the precipitation of calcium carbonate (lime) in or adjacent to springs issuing from calcareous rocks, such as chalk or limestone. It is often highly porous and open textured, with up to 50 per cent void space. Blocks may be ‘fibrous’ and contain the impressions of vegetation. They sometimes exhibit faint traces of banding. When freshly quarried, tufa is soft and crumbly and is easily cut into blocks suitable for use as ashlar. However, upon exposure to air, it hardens to become a useful, more general building stone.

Tufa is very localised in its occurrence in Hertfordshire. It is reported from the Upper Lea Valley near Coldharbour Farm. Other Holocene-aged exposures are likely to occur in other Hertfordshire river valleys. Deposits are also reported from the Hinton area and around St Ippolyts (between Hitchin and Stevenage). Tufa has a very localised and sporadic use as a rubblestone in medieval church walls. St Ippolyts at St Ippolyts, Great St Mary's at Sawbridgeworth, St Mary's at Cheshunt, St Mary's at Gilston and St Albans Abbey all provide examples. Some of these may include reuse from earlier, probably Roman, sites.

Figure 36: Church of St Ippolyts, St Ippolyts. Tufa, Quaternary Flint and Hitchin Carstone, with occasional glacial pebbles and cobbles and isolated blocks of Hertfordshire Puddingstone and False Puddingstone.

Figure 37: Church of St Ippolyts, St Ippolyts. Tufa with Quaternary Flint pebbles.

Figure 38: Church of St Ippolyts, St Ippolyts. Detail of tufa, showing porous structure.

4 Examples of Imported Building Stones

Overall, Hertfordshire has few locally sourced building stones and there are no quarries currently extracting building stone in the county. This limited availability of indigenous building stone has resulted in the extensive use of imported stones. These have been sourced from various parts of England and also from further afield.

Stone has been imported into Hertfordshire since at least the Roman period. From Anglo-Saxon times until the 17th century, stone for the dressings of churches and larger houses was frequently imported from nearby sources in Bedfordshire (for example, Totternhoe Stone) and Buckinghamshire (Upper Jurassic limestone). Barnack Stone from Cambridgeshire was used quite extensively from the Roman period onwards, particularly for dressings in pre-Reformation churches. It was employed in Roman Verulamium and subsequently reused in St Albans Abbey. The stone was also used for the quoins of St Mary's Church at Northchurch, for example. It features in churches at Reed, Walkern and Westmill, and can also be seen, together with flint rubble and clunch, within the fabric of St Leonard's Church at Bengeo.

The scale of importation increased dramatically from the 18th century with improved transportation. A wide range of stones was used for the ornamental dressings of mansions, civic buildings, churches and chapels, as well as for street paving and kerbing. From the 18th century, Portland Stone from the Isle of Portland in Dorset began to be used. The chancel of the Church of St Mary Magdalene at Offley was completely rebuilt using Portland Stone in 1777, for example. Furthermore, the Church of New St Lawrence at Ayot St Lawrence and the facade of Haileybury college were constructed of the same stone. Granite from south-west England and diorite from Leicestershire were used for paving in St Albans.

The rapid population growth of the 19th century led to the construction of a comparatively large number of new civic buildings and both Anglican and Roman Catholic churches. Imported stone, including Bath Stone, was extensively used for decorative effect in churches of the Victorian High Gothic, often in conjunction with brick and flint. Middle Jurassic ooidal limestone was used for the churches of the three new parishes created in the county during the 19th century: Boxmoor, Lemsford and Langleybury.

Imported stones were also often used for 19th-century restorations of pre-Reformation churches to replace decayed and damaged Totternhoe Stone and chalk. Middle Jurassic ooidal and bioclastic limestones, such as Ancaster Stone and Barnack Stone, were often (and continue to be) employed.

Kentish Ragstone was also used in no fewer than 14 churches during the 19th century, including those in Bengeo, Bishop's Stortford, Bushey Heath, Hatfield Hyde, High Cross, Hockerill, Little Berkhamsted, Perry Green, Thundridge and Ware.

Very occasionally, an entire church was constructed of imported stone. For example, the Church of All Saints at Hertford was designed by architects from Lancaster (Paley, Austin and Paley), who chose to use Triassic Runcorn Stone from Cheshire.

Sedimentary building stones

Lower Carboniferous

Peak Limestone Group, Bee Low Limestone Formation or Monsal Dale Limestone Formation

Carboniferous limestone, Derbyshire

A pale to dark grey-coloured bioclastic limestone, distinctly packed with fossil shells and ring-shaped crinoid ossicles (up to 20mm across) and crinoid stems (up to 50mm long). These fossils are typically white or pale cream in colour and contrast strongly with the grey limestone matrix, especially on polished surfaces.

Figure 39: Column, cathedral entrance, St Albans. Polished Carboniferous limestone.

Upper Carboniferous

Millstone Grit Group, various formations

Millstone Grit sandstones, Derbyshire

Hard, medium to coarse-grained sandstone, sometimes pebbly and feldspathic, with a distinctive granular appearance (arising from sugar-like, grey quartz grains) and occasional small flakes of white mica. It exists in various colours, ranging from pale grey and pink (on fresh surfaces) to a buff or pale brown colour (particularly when weathered). Employed sporadically in Hertfordshire, it is usually associated with industrial or transport infrastructure, such as bridges and walling along canals and railways.

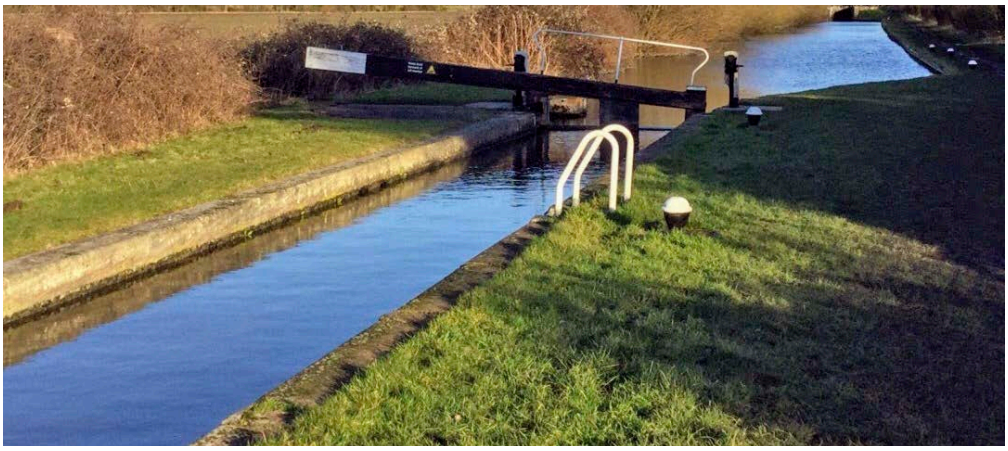


Figure 40: Grand Union Canal, Wilstone. Millstone Grit Sandstone.

Pennine Coal Measures Group, various formations

Carboniferous sandstone, Bradford, West Yorkshire

A fine to medium-grained, flaggy to massive, yellow-orange sandstone that is commonly micaceous. It is relatively soft and weathers with a distinct exfoliation pattern.

Figure 41: The Clock Tower, St Albans. Carboniferous sandstone and local flint.

York stones, West/South Yorkshire

Buff to pale grey or greenish-grey, typically fine-grained sandstones, often micaceous and laminated, but occasionally show small-scale cross-bedded structures. York Stone usually weathers evenly but may separate along mica-rich horizons. It is little used as a building stone in Hertfordshire, and is mainly employed as flagstones, paving stones or plinths.

Figure 42: Cathedral path, St Albans. York Stone paving slabs.

Permian

Zechstein Group, Cadeby Formation

Red Mansfield Stone, Mansfield, Nottinghamshire

A distinctive uniform, red-brown sandy dolostone/dolomitic sandstone, employed very occasionally in Hertfordshire as a facing and decorative stone. One of the best examples of its use can be seen at 10 Peter's Street, St Albans.

Figure 43: 10 St Peter's Street, St Albans. Red Mansfield Stone.

Triassic

Sherwood Sandstone Group, Helsby Sandstone Formation

Helsby Sandstone (Manly Stone, Runcorn Red), Cheshire

A pale red, pink or red-brown and buff-coloured sandstone that often exhibits attractive bands of small-scale cross-beds, laminations and ripple marks in many blocks. It is only occasionally employed in Hertfordshire and mainly for decorative purposes, especially as cornerstones, quoins or window dressings. It is sometimes also used as ashlar.

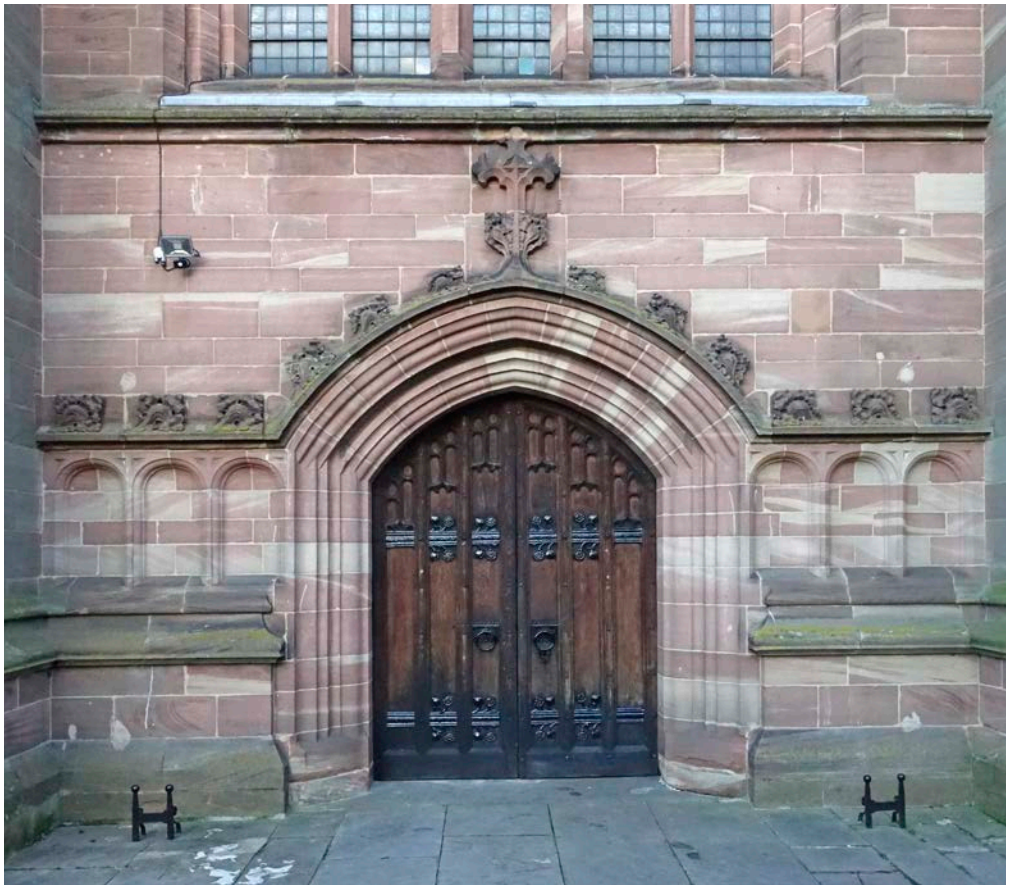


Figure 44: West tower, Church of All Saints, Hertford. Runcorn Red Sandstone ashlar.

Permo-Triassic

Various groups, various formations

Sandstones, possibly from the Midlands

Red-brown, fine-grained, dolomitic quartz sandstones. The individual sandstone types and source of these New Red Sandstones are often impossible to determine without documentary or petrological evidence. These sandstones are employed only occasionally in Hertfordshire, but feature in ashlar work and decorative bands of certain buildings. One of the best examples can be seen in Lululaund, Bushey, where the stone is employed alongside Bavarian tufa, which was probably sourced from either Andelsbuch in the Vorarlberg area of the Austria Alps (Andelsbuch Tufa) or the Brannenburg area of Bavaria (Thiersee Tufa).

Figure 45: Royal British Legion Hall 'Lululaund', Bushey. Permo-Triassic red sandstone and Bavarian tufa.

Lower Jurassic

Lias Group, Bridport Sand Formation

Ham Hill Stone, Montacute, Somerset

A medium to coarse-grained shelly limestone that is readily sawn and dressed. When freshly cut, the stone has a light golden yellowish-brown colour but this darkens with age and weathering. The latter picks out the weaker, less well-cemented seams and cross-bedding features, which are characteristic of this sandy limestone. Ham Hill Stone is relatively little used in Hertfordshire, and where it has been recorded the stone is usually employed in only small amounts for decorative work and is seen to be relatively devoid of cross-bedded features.

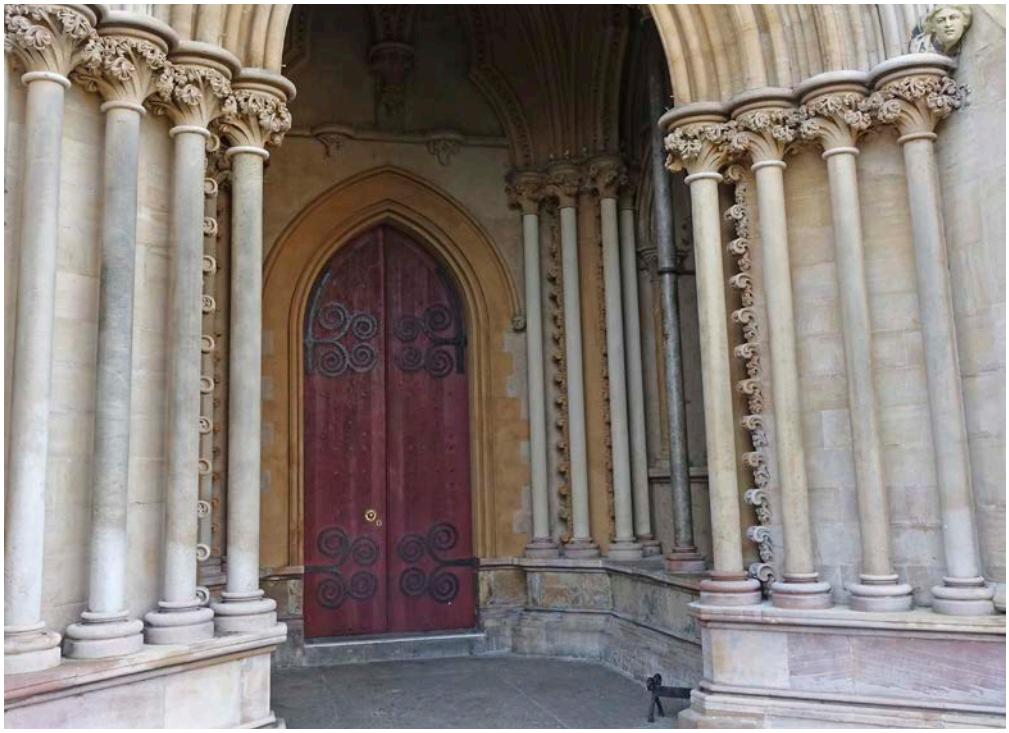


Figure 46: Cathedral west porch, St Albans. Ham Hill Stone and perhaps Bath Stone.

Middle Jurassic

Inferior Oolite Group, various formations

Doulting Stone, Doulting, Somerset

A cream-coloured, cross-bedded fossiliferous limestone with a uniform, coarse 'sugary' texture created by abundant crinoid debris set in a matrix of calcite. Doulting Stone is rarely used in Hertfordshire and it appears mainly as dressings.

Figure 47: Church of All Saints, Borehamwood. Red brick with Doulton Stone dressings.

Inferior Oolite Group, Lincolnshire Limestone Formation

Ancaster Stone, Ancaster, Lincolnshire

A medium to coarse-grained, creamy-white to pale yellow-coloured (although rather ochreous in places) ooidal and bioclastic limestone, the weathered surfaces of which commonly display a streaky bacon-like patterning. In Hertfordshire, Ancaster Stone, along with other imported Inferior Oolite limestones from the Lincolnshire Limestone Formation (including Ketton Stone), tends to have been used in the construction of prestigious buildings, especially for the dressings of churches or chapels.

Figure 48: Cathedral west front, St Albans. Ancaster Stone ashlar.

Barnack Stone, Barnack, Cambridgeshire

A typically hard, pale buff-coloured, coarse-grained, shelly oolitic limestone cemented with sparry calcite. The stone usually displays cross-bedding, and differential weathering of its constituent grains (ooliths of varying sizes and fossil shell debris up to 5mm in size) imparts a rough feel to exposed surfaces. In Hertfordshire, the stone is mainly employed for dressings in churches and other ecclesiastical buildings that pre-date the Reformation.

Figure 49: Church of St Mary, Reed. Quarry Flint with Quaternary Flint nodules, chalk clunch and Barnack Stone dressings.

Clipsham Stone, Clipsham, Rutland/Lincolnshire

A rather poorly sorted, medium to coarse-grained, peloidal and bioclastic limestone. It is usually pale cream or greyish buff in colour, but features sporadic blue patches. Blue-hearted blocks weather over time to the more typical greyish buff colour. Rarely encountered in Hertfordshire, Clipsham Stone appears to be restricted to the dressings of churches and other ecclesiastical buildings.

Figure 50: Cathedral north transept and nave, St Albans. Clipsham Stone.

Great Oolite Group, Chalfield Oolite Formation

Bath Stone, Bath, NE Somerset and possibly Corsham area, Wiltshire

A creamish to buff-yellow, variably bioclastic, ooidal limestone (freestone). Bath Stone is extensively used throughout Hertfordshire, especially in Victorian new-build projects and church refurbishments, ashlar and window and door mouldings, in particular. There are good examples of its use in some of the buildings along Fore Street, Hertford (the former post office, Corn Exchange buildings and the bank at 104 Fore St).

Figure 51: Corn Exchange and Public Hall, Fore Street, Hertford. Bath Stone ashlar.

Calcaire de Caen Formation

Caen Stone, Normandy, France

A white to pale creamy yellow-coloured limestone with a fine-grained texture and few large fossils. It may exhibit spalling, and certain blocks of Caen Stone may also show uneven weathering. It has been employed only very occasionally in Hertfordshire, mainly for decorative purposes.

Figure 52: Eleanor Cross, High Street, Waltham Cross. Caen Stone, partly rebuilt in Bath Stone.

Upper Jurassic

Portland Group, Portland Stone Formation

Portland Stone, Isle of Portland, Dorset

A near-white or very pale coloured limestone that (in its 'basebed' guise at least) is typically a fine and even-grained freestone. Portland Stone has seen widespread use across Hertfordshire, especially in urban areas in carved form. It has been utilised for milestones, obelisks, monuments, war memorials, gravestones, fountains and columns. Portland Stone is also employed as a high-quality walling stone and ashlar, often forming the fronts of civic buildings, banks and schools (for example, Haileybury).

Figure 53: Almshouses, Ward's Hospital, Buntingford. Brick with Portland Stone dressings.

Lower Cretaceous

Lower Greensand Group, Hythe Formation

Kentish Ragstone, Weald of Kent

A medium to coarse-grained, pale greenish-grey or pale brown limestone that contains greater or lesser amounts of quartz, glauconite and shell debris. Kentish Ragstone was employed only occasionally in Hertfordshire, in 14 churches and a few ecclesiastical buildings, for example.

Figure 54: Church of St Peter, Bushey. Kentish Ragstone with Middle Jurassic limestone quoins and dressings.

Lower Greensand Group, Woburn Sands Formation

Bedfordshire Greensand, Bedfordshire

Bedfordshire Greensand comprises greenish-grey to deep orange-brown, fine to medium-grained ironstones and ferruginous sandstones, some of which contain glauconite. Fossils are scarce and mainly represented by non-marine bivalves and gastropods. The stone has not been employed to any great extent for building purposes in Hertfordshire. Its main use is in pre-Reformation churches as rubble walling, as seen at the Church of the Holy Trinity at Weston, or as hewn ashlar blocks at St Mary's Church at Pirton, for example.

Figure 55: St Mary's Church, Pirton. Flint, with chalk clunch and various limestone and sandstone rubble, including Bedfordshire Greensand.

Igneous building stones

Lower Permian

Dartmoor Granite Intrusion

Dartmoor Granite, Dartmoor, Devon

A pale-coloured, coarse-grained igneous rock, comprising an interlocking network of grey-coloured quartz crystals with (often larger) white-coloured feldspar crystals and small amounts of darker ferromagnesian minerals. Small flakes of pale or dark coloured mica are also present. The large white feldspar crystals (phenocrysts) sometimes possess a regular tabular form and can be aligned in a roughly similar direction within the rock. Dartmoor Granite is a very hard-wearing durable stone that is usually employed in Hertfordshire for paving setts, kerbing and so forth.

Figure 56: Sumpter Yard, St Albans. Dartmoor Granite.

Permo-Carboniferous

Cornwall Granites

Granites, granodiorites

Coarse-grained igneous rocks, comprising a network of interlocking crystals of quartz (typically pale grey coloured), feldspar (often white or pink coloured) and lesser amounts of various ferromagnesian minerals (black or dark green coloured). Small flecks of white or dark brownish mica are also often present. A wide range of granites from various sources are employed in Hertfordshire for different purposes, including monuments and other ornamental stonework.

Figure 57: Bridgewater monument, Ashridge Estate, near Berkhamsted. Granite, possibly from Devon or Cornwall.

Precambrian–Neoproterozoic

South Charnwood Diorites

Diorites, Markfield, Leicestershire

A greenish-grey to pink, medium to coarse-grained igneous rock with a distinctive mottled appearance (granophyric texture) caused by the intergrowth of the constituent ferromagnesian and feldspar crystals. A hard-wearing durable stone, diorite has been employed in Hertfordshire mainly as paving setts and kerb stones.

Figure 58: Lamb Alley, St Albans. Diorite.

Metamorphic stones

Roofing slates

Several different types of roofing slates have been imported into and variously used in Hertfordshire since at least the 19th century. Welsh Slate, for example, was commonly employed in many of the county's villages and towns. Other named types of roofing slates used in Hertfordshire include Cumberland Slate and Westmorland Slate.

Figure 59: Old School, Church Street, Wheathampstead. Knapped flint with gault brick and Westmorland Slate and Welsh Slate roof.

Figure 60: The Orchard, Shire Lane, Chorleywood. Roughcast brick with limestone (probably Bath Stone) dressings and a Cumberland Slate roof.

5 References

The Further Reading, Online Resources and Contacts guide provides general references on:

- Geology, building stones and mineral planning
- Historic building conservation, architecture and landscape.

There is also a separate glossary of geological terms.

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Figures

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