



Historic England

# Bedfordshire

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.

This guide is based on original research and text by Martin Whiteley.

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[HistoricEngland.org.uk/advice/technical-advice/](https://HistoricEngland.org.uk/advice/technical-advice/)

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Front cover: Swan Hotel, Bedford. Totternhoe Stone. © Brian Gibbs / 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 county of Bedfordshire and the mineral planning and associated unitary authority areas.



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# 1

# Introduction

Bedfordshire is underlain by relatively soft sedimentary rocks that were deposited during the Jurassic and Cretaceous periods. They consist of a series of limestones and sandstones separated by thick sequences of clays. Although, historically, the clays have been used for brick making, it is the limestones and sandstones that are locally important as building stones. Bedfordshire is certainly not as well endowed with building stones as nearby Oxfordshire and Northamptonshire, but churches and vernacular buildings reflect the nature of these rather scarce resources and provide architectural distinctiveness across the county.

A glance at the bedrock geology map shows that the oldest rocks occur in the north-west, where the River Great Ouse has cut through the overlying strata to reveal a thin series of Middle Jurassic limestones and mudstones. Of these, only the Great Oolite Limestone forms a good building stone and it has been used extensively in the local villages. A large number of pits and small quarries were developed to extract this stone and the river was then used to transport it.

One of Bedfordshire's most distinctive landforms is the Greensand Ridge, which straddles the central part of the county in a narrow tract from Leighton Buzzard to Sandy. This steep, north-facing escarpment rises above the Vale of Bedford and is formed by relatively resistant sandstones of Lower Cretaceous age.

Figure 1: St Mary's Old Church, Clophill. Lower Greensand Sandstone.



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Figure 2: Wrest Park bath house, Silsoe. Local carstone.

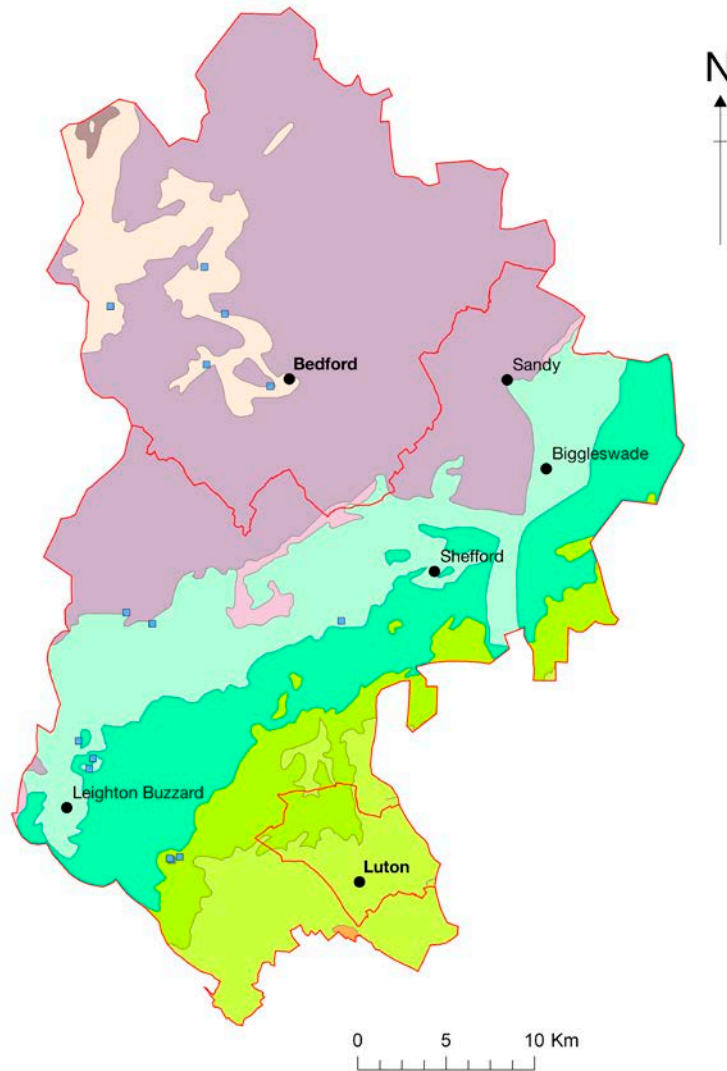


These rocks are known as the Lower Greensand and they are particularly important as a source of unconsolidated silica sand for the glass-making and construction industries. However, some of the sandstones are more tightly cemented, enabling them to be used as a walling stone, primarily in churches throughout mid-Bedfordshire.


Another clay vale separates the Greensand Ridge from the Upper Cretaceous chalk hills that characterise the southern part of the county around Dunstable and Luton. Again, the fact that the chalk forms a steep escarpment and is part of the Chiltern Hills indicates that it is relatively resistant. However, there are only two or three horizons within it that are sufficiently hardened to be used as building stone. By far the most important of these is the Totternhoe Stone, which is only a few metres thick, but has been quarried and mined extensively since Roman times. It has been widely used (incorrectly) as a freestone in churches and grand houses throughout the county and it is still extracted on a small scale for restoration work. Cobbles and flint are used commonly as random rubble set in mortar for walling or for decorative purposes.

In the north-eastern corner of the county, far removed from the outcrops of limestone, it is clear that only the local Lower Greensand and the plentiful supply of cobbles and flints in the overlying superficial deposits were available for building ancient churches. Cobbles are variable in size and rounded, having been eroded and transported by glaciers and rivers over the past half million years. Flints originate from the chalk and are highly robust, although they are rather small and irregular in shape.


# Bedrock Geology Map



## Key


 Building stone sources

## Bedrock geology


 Lambeth Group — clay, silt, sand and gravel


 White Chalk Subgroup — chalk


 Grey Chalk Subgroup — chalk


 Gault Formation and Upper Greensand Formation — mudstone, sandstone and limestone

 Lower Greensand Group — sandstone and mudstone

 West Walton Formation, Amphill Clay Formation and Kimmeridge Clay Formation — mudstone, siltstone and sandstone

 Kellaways Formation and Oxford Clay Formation — mudstone, siltstone and sandstone

 Great Oolite Group — sandstone, limestone and argillaceous rocks

 Lias Group — mudstone, siltstone, limestone and sandstone

Derived from BGS digital geological mapping at 1:625,000 scale, British Geological Survey © UKRI. All rights reserved



# Stratigraphic Table

| Geological timescale | Group                 | Formation   | Building stone   | Page             |    |
|----------------------|-----------------------|---|--|------------------|----|
| Quaternary           | various               | various   | Cobbles<br>Flint   | 17<br>15         |    |
|                      | Lambeth Group         | various   |  |                  |    |
| Upper Cretaceous     | Chalk Group           | White Chalk Subgroup                              | various  |                  |    |
|                      |                       | Grey Chalk Subgroup                               | Zig Zag Chalk Formation  | Totternhoe Stone | 12 |
|                      |                       |   | West Melbury Marly Chalk Formation   |                  |    |
| Lower Cretaceous     | Selborne Group        | Upper Greensand Formation                         |  |                  |    |
|                      |                       | Gault Formation                                   |  |                  |    |
|                      | Lower Greensand Group | Woburn Sands Formation                            | Lower Greensand Sandstone (rusty-brown)<br>Carstone<br>Lower Greensand Sandstone (green) | 7<br>7<br>7      |    |
| Upper Jurassic       | Ancholme Group        | Kimmeridge Clay Formation                         |  |                  |    |
|                      |                       | Ampthill Clay Formation                           |  |                  |    |
|                      |                       | West Walton Formation                             |  |                  |    |
| Middle Jurassic      | Great Oolite Group    | Oxford Clay Formation                             |  |                  |    |
|                      |                       | Kellaways Formation                               |  |                  |    |
|                      |                       | Cornbrash Formation                               | Great Oolite Limestone   | 5                |    |
|                      |                       | Blisworth Limestone and Blisworth Clay formations |  |                  |    |
| Rutland Formation    |                       |   |  |                  |    |
| Lower Jurassic       | Lias Group            | various   |  |                  |    |

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

# 2

## Local Building Stones

### Middle Jurassic

#### Great Oolite Group, Rutland Formation, Bilisworth Limestone and Blilsworth Clay Formations, Cornbrash Formation

##### Great Oolite Limestone

In Bedfordshire, the Great Oolite succession is only about 20m thick. It underlies the entire county but is generally obscured by younger rocks, except in the deeply incised valleys of the River Great Ouse north-west of Bedford. The succession is dominated by micritic shell-fragmental limestones, with occasional ooids and pellets.

The shifting currents also produced inclined, cross-bedding surfaces within the limestone. Further variety is created by marine fossils, typically fragments of brachiopods, bivalves and echinoids, which are commonly scattered throughout the rock or occasionally concentrated into distinctive shell bands. The Great Oolite Limestones are pale grey on fresh surfaces, but weather to characteristic shades of yellow. However, a dark grey superficial staining caused by atmospheric pollution commonly obscures this yellowing. A Great Oolite rock face near Pavenham shows a pale grey, unweathered 'heart' and the more typical pale yellow tint.

Figure 3: Pavenham. Great Oolite rock face.



The Great Oolite Limestones form hard and durable building stones, and the thicker-bedded intervals have a uniform grain size that makes them suitable as freestones. The presence of cross-bedding often characterises the appearance of the stone, particularly when it is used as sawn blocks. Typical uses include coursed rubble and plain ashlar walling, quoins, mouldings and carvings. Several villages in north-west Bedfordshire, such as Harrold, Felmersham, Pavenham, Sharnbrook and Turvey, are dominated by buildings made from the Great Oolite Limestones.

Many of the buildings in the village of Harrold use local limestone from the Great Oolite Group succession, which was extensively quarried in the valley of the River Great Ouse.

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Figure 4: The Lock Up,  
The Green, Harrold. Great  
Oolite Limestone.





In addition, several important buildings in Bedford have used the Great Oolite Limestone including parts of the 11th-century Church of St Mary the Virgin at Goldington, where parish records confirm that it was quarried in Pavenham. Some of the blocks at the church are reused mouldings derived from an earlier building, while the remainder are varied shelly and ooidal limestones from the Great Oolite Group succession.

It is important to note that much of the ooidal limestone that is used to such good effect in north Bedfordshire may not have been quarried locally but brought in from nearby counties. For example, the stone used in Bedford town hall and St Lawrence's Church at Willington originate from the Inferior Oolite Group of Lincolnshire and Northamptonshire, respectively.

Much of the stone seen in Turvey is thought to be from a large quarry formerly located about 1km north of the village. Hereabouts, the Great Oolite Group succession is highly variable and includes ooidal horizons, coarse shelly beds and fine-grained, cross-bedded, shell-fragmental limestones. Examples of each can be seen in the local buildings, usually in the form of rubble walling, although the better quality stone is rough dressed and laid in courses or used for quoins.

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Figure 5: St Mary's Church, Bedford. Great Oolite Limestone.



## Lower Cretaceous

### Lower Greensand Group, Woburn Sands Formation

#### Lower Greensand Sandstone, Carstone

Geologists now refer to the Lower Greensand sequence in Bedfordshire as the Woburn Sands Formation, but the original term prevails in older literature and is still widely used. The sequence is up to 120m thick and is absent throughout the northern half of the county. Most of the sandstones



within the formation consist of loose, unconsolidated grains of quartz that are not suitable as building stone. However, several horizons towards the top of the sequence have cements that bind the quartz grains tightly together, producing irregular beds of resistant rock. A good example is seen at the Scout Hut Quarry in Potton, where several hard bands are developed. However, here, they are too thin and impersistent to form a good building stone.

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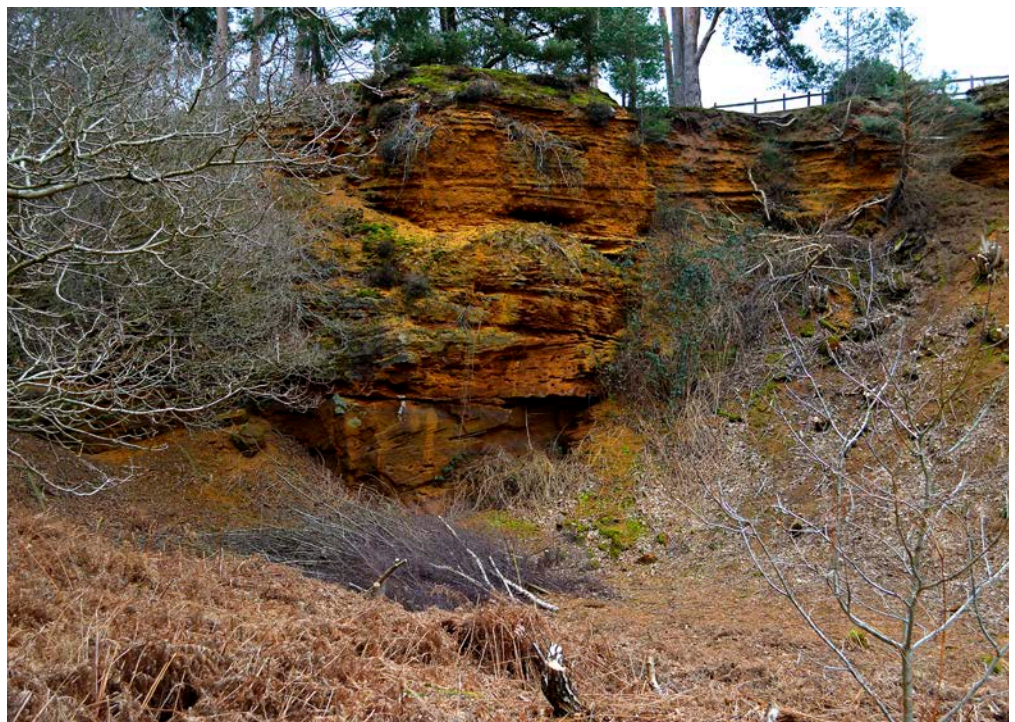
Figure 6: Scout Hut Quarry, Potton. Irregular beds of Lower Greensand stone.



The cement is usually formed by iron oxide compounds, although sometimes quartz occurs. These rocks are characteristically cross-bedded, having formed in a shallow estuarine environment where tidal activity moved the unconsolidated sediment across the seabed. The original bedding is also much disturbed by the burrows of various animals, typically worms and crustaceans, that sought refuge in the sandy sediments. Ironstone nodules, pebbly horizons and fragments of mudstone also occur within this highly variable rock.

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Figure 7: Lodge Quarry, Sandy Warren. Lower Greensand stone.





Despite its name, the Lower Greensand Group is not typically green, but brown. Occasional tinges of green are produced by an iron-rich mineral called glauconite, but generally the rock has weathered to produce an attractive range of rich, ochreous brown colours as the iron compounds within it oxidise. The extent to which the Lower Greensand forms a useful building stone depends principally on the composition and extent of the cements. A spectrum exists, from rather friable carstones that are suitable only for rough rubble walling, to highly durable stones that can be dressed for coursed work or used for quoins.

From medieval times until the 18th century, Lower Greensand Sandstone was used for building local churches, such as St Swithun's Church at Sandy and St Mary's Church at Everton, and for bridges, including Sutton Packhorse Bridge. An unusual example of Lower Greensand Sandstone is in a boundary wall at Village Farm in Sutton, where small elongated blocks have been laid in a distinct sweeping diagonal pattern. In contrast, a wall near All Saints' Church at Tilsworth is made of highly irregular blocks and slabs set generously in mortar and supported by a buttress, capped with large, heavy, undressed boulders.

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Figure 8: St Swithun's Church, Sandy. Lower Greensand stone.



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Figure 9: Boundary wall at Village Farm, Sutton. Lower Greensand stone.





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Figure 10: Wall near All Saints' Church, Tilsworth. Lower Greensand stone.



Many churches along the Greensand Ridge are built almost exclusively of Lower Greensand Sandstone. Typically, they are adorned with pale yellow ooidal limestone quoins, string courses and tracery, as seen at St Andrew's Church at Ampthill and All Saints' Church at Houghton Conquest, which provide a strong visual contrast to the architecture. St Mary's Church at Maulden is typical of many on the Greensand Ridge that use this attractive stone in both coursed and uncoursed random rubble walling, in tandem with paler ooidal limestone dressings. Here, the quality of the Lower Greensand Sandstone is excellent and it has even been used for the protective hood mouldings on the buttresses. The softer sandstone blocks, particularly in exposed western and northern elevations, usually show signs of selective weathering caused by the elements and the activities of masonry bees.

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Figure 11: St Mary's Church, Maulden. Lower Greensand stone.





One particularly spectacular example of Lower Greensand Sandstone that lives up to its name is seen in the church walls at St James, Husborne Crawley. Nowhere else in the county is the stone so obviously green, or so hard. It differs considerably from the characteristically rusty-brown blocks of Lower Greensand that have an iron-rich cement. The church is located on a pronounced ridge of Lower Greensand, suggesting that the bedrock here is resistant. Consequently, it is tempting to speculate that the late medieval church builders simply excavated part of the hillside to win the stone. Historical evidence for 'boulders or blocks of green-coloured sandstone' being found in a sand pit just beyond the churchyard further supports the notion that this is a local stone.

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Figure 12: St James' Church, Husborne Crawley. Lower Greensand stone.



A number of vernacular buildings around Leighton Buzzard use the Lower Greensand Group to good effect. This area has been extensively worked for both building stone and loose sand, often from the same quarry. Wellington House in Heath and Reach is a substantial dwelling built in the 1860s, combining sandstone coursework with limestone dressings. Page's Almshouses (1903) in Church Street Leighton Buzzard stand in the disused quarry that was opened specifically to provide stone for them and the demolished St Andrew's church. Wilkes Almshouses in the centre of Leighton Buzzard are made of good quality, even-textured ferruginous sandstone that has been dressed and laid in courses. Neatly coursed random rubble walls of Lower Greensand, with a straight coped gable and pale orange string courses, provide attractive ornamentation, quite apart from the brick mullions with leaded lights and the yellow brick door surrounds.



Figure 13: Wilkes Almshouses, Leighton Buzzard. Lower Greensand stone.



## Upper Cretaceous

### Chalk Group, Zig Zag Chalk Formation

#### Totternhoe Stone

Described by some as ‘England’s best-known chalk’, the Totternhoe Stone forms a thin horizon some 20 to 30m above the base of the Upper Cretaceous chalk succession. Unlike most chalks, which are composed of microscopically small skeletal remains of calcareous algae (called coccoliths), the Totternhoe Stone is a coarser grained, gritty chalk made of fine shell debris and phosphatic pebbles. It is also hard, having formed at a time when sedimentation ceased and the seabed was able to consolidate and become encrusted with burrowing organisms. In general terms, chalk

deposition commenced widely across Britain about 95 million years ago, and some of the hard bands within it, such as the Totternhoe Stone, Melbourn Rock and Chalk Rock, can be recognised beyond the county. Where they have been used as a building stone, they are often called 'clunch', a generic term that enjoys widespread usage.

Despite being generally less than 3m thick, the Totternhoe Stone beds sometimes produce a subtle topographical feature on the long concave slope at the base of the chalk escarpment. It thickens locally in the Totternhoe area to about 5m, but even here the surface outcrop is so small that much of the stone was mined in a series of adits sunk deep into the escarpment. Totternhoe Stone is greyish white to greyish brown in colour and it hardens on exposure to the air. Soon after the stone is quarried, when it is still saturated with water, it can be easily sawn, moulded or carved. Only after drying out for about a year does it become sufficiently hard to be incorporated into a building. It is susceptible to water ingress, frost action and salt crystallisation, and is best protected by more resistant hood mouldings or limewash shelter coatings when used externally. For these reasons, Totternhoe Stone has a limited life in external locations, as evidenced by the large amount of restoration work required on buildings more than two or three centuries old. Its freestone qualities are best displayed in fine carvings and intricate mouldings. Many of these date from the 12th century, and they are still well preserved in interior settings where they have been subjected to only small changes in humidity and temperature.

Figure 14: St Mary's Church, Eaton Bray. Totternhoe Stone pillars.





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Figure 15: Church of St Mary, Eaton Bray. Totternhoe Stone ashlar blocks.



Totternhoe Stone is commonly used in churches in south Bedfordshire, including at Dunstable, Kensworth and Toddington, although it is far more widespread in neighbouring south Buckinghamshire and Hertfordshire. An example of its use can be seen at the 13th-century St Mary's Church at Eaton Bray. Here, the internal north arcade consists of an elaborate series of fluted pillars, with ornate carved capitals that support richly moulded arches. The external ashlar is constantly being repaired or replaced.

Woburn Abbey is perhaps the best-known secular building employing Totternhoe Stone. The abbey and outbuildings were largely rebuilt and extended in 1747, and the walls are faced with ashlar in the Classical style of architecture. Progressive disfigurement by blistering, splitting and spalling has resulted in cutting back the decayed face of individual blocks and finishing them with a shelter coat of limewash.

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Figure 16: Woburn Abbey. Totternhoe Stone.



Figure 17: Wing House, Bedford. Totternhoe Stone.



Other fine buildings that incorporate Totternhoe Stone include Priory House in Dunstable, the Swan Hotel and Wing House in Bedford, and Southill Park. These examples of Georgian architecture are testimony to the enduring popularity of this unusual building stone, although the degree to which it has been subjected to conservation and replacement confirms its poor durability when used externally.

## Quaternary

### Various groups, various formations

#### Flints

Flints form as nodules or irregular-shaped masses, often in distinct layers, within the upper part of the Chalk Group succession. They are formed of pure silica (silicon dioxide), better known as quartz, and are exceedingly hard and resistant. Such concentrations of silica were probably derived from the skeletal remnants of siliceous sponges and other micro-fossils that colonised on the chalky seabed. Flints have a thick outer layer that is porous and pale in colour, whereas the inside is smooth and glassy and typically darker, in shades of brown, grey and black. These features are evident at All Saints' Church at Houghton Regis, where broken flints are laid in a strong mortar.

Their small size and hardness preclude them being worked like traditional building stones, and normally they are simply embedded in mortar to form thick uncoursed random rubble walls. Alternatively, flint can be split or knapped to reveal its glassy interior or, in skilful hands, worked into rectangular blocks for laying in courses.



Several churches in south Bedfordshire combine flints and Totternhoe Stone in a chequerboard pattern, both for ornamental effect and to slow weathering. Good examples are seen at St Mary's Church at Luton and All Saints' Church at Houghton Regis. At the latter, the effects of differential weathering are obvious, and much of the Totternhoe Stone has been replaced with a more resistant limestone or sandstone from outside the county.

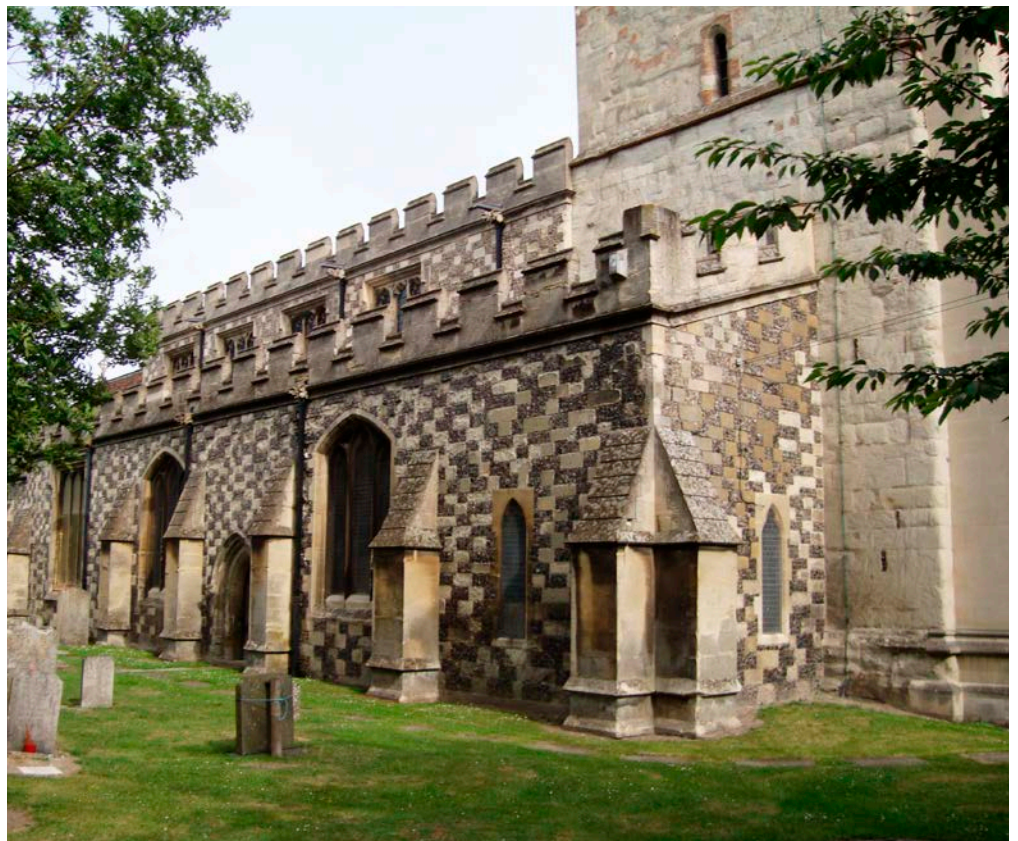
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Figure 18: All Saints' Church, Houghton Regis. Flints.



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Figure 19: All Saints' Church, Houghton Regis. Flint and Totternhoe Stone.





## Cobbles

Superficial unconsolidated deposits occur widely across Bedfordshire, obscuring the bedrock beneath and often forming low hills on the otherwise flat clay vales. These deposits contain a wide variety of reworked rock types that were transported into the area, initially by an ice sheet that extended over most of Britain about 450,000 years ago. During subsequent warm and cold climatic phases, the rocks were reworked and overlain by river gravels, forming deposits several tens of metres thick.

Cobbles are typically fist sized, smooth and rounded because they have been worn down by ice and water. Most of them are made from highly resistant rocks, such as flint or quartzite, and they are commonly stained reddish-brown or black by iron and manganese oxides. They are easily collected and are usually set in mortar for rubble walls or employed for decorative panels or infill. St Margaret's Church at Higham Gobion makes use of 'erratic' cobbles and boulders that originated in the Midlands, as well as locally derived flints. At St George's Church at Toddington, an uncoursed random rubble wall is set in mortar overlying large, rusty-brown, tool-faced blocks of coursed Lower Greensand. The rubble comprises a variety of quartzite cobbles, lumps of chalk, ironstone and the occasional red tile. Cobbles have also been used, almost exclusively, as a building material at St Deny's Church at Little Barford.

Figure 20: St Deny's Church, Little Barford. Cobbles.



Figure 21: St George's Church, Toddington. Random rubble wall above Lower Greensand blocks.



# 3

## Further Reading

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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# 5

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### Figures

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