Historic England

Warwickshire

and Birmingham, Coventry, Sandwell, Solihull

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.

Front cover: Kenilworth Castle. Kenilworth Sandstone.
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Source: Historic England.

This guide is based on original research and text by Hugh Jones (Warwickshire Geological Conservation Group).

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HistoricEngland.org.uk/advice/technical-advice/

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 Warwickshire County Council and part of the West Midlands Combined Authority mineral planning areas; and the unitary authority areas of the City of Birmingham, City of Coventry, Sandwell, Solihull; and the local planning authority areas of North Warwickshire, Nuneaton and Bedworth, Rugby, Stratford-on-Avon, and Warwick.

Contents

1 Introduction

The landscape in Warwickshire and the West Midlands is clearly dictated by the underlying geology, and this has had a major influence on the choice of building stones available for use in the past. The geological map shows that much of this generally low-lying county is underlain by the red mudstones of the Triassic Mercia Mudstone Group. This surface cover is, however, broken in the Nuneaton–Coventry–Warwick area by a narrow strip of ancient rocks forming the Nuneaton inlier (Precambrian to Early Devonian) and the wider exposure of the unconformably overlying beds of the Warwickshire Coalfield (Upper Carboniferous to Early Permian). In the south and east of the county, a series of low-lying ridges mark the outcrops of the Lower and Middle Jurassic limestone/mudstone successions.

The extensive urban development associated with the Birmingham area, obscures much of the evidence for a stone quarrying industry in the West Midlands. However, the presence of a number of significant historic stone buildings and structures suggests that, even here, stone quarrying was originally an important local industry. Lithologically, the rock succession across Warwickshire and the West Midlands is very varied and many different rock types have been used as sources of vernacular building materials. When the Romans left Britain in *c* 410, the skill of building in stone was largely lost. As a result, houses were constructed largely of wood, turf, straw or local mud, the last of which was known as cob. This building practice continued for the homes of the poor until the 15th century. A few examples of such earth buildings survive in Warwickshire, most notably at Dunchurch and along the valley of the Stour between Shipston-on-Stour, Tredington and Halford. Old garden walls built of cob survive where they are kept reasonably dry and protected, both from above and below however, once they finally collapse, they leave little trace.

Cob was suitable for small houses, but when more space was needed it became necessary to build a wooden frame and use wattle fencing daubed with mud as the infilling, called nogging, to make the walls. In nearly all surviving examples, the wooden frame was built on a low plinth wall of whatever stone was available locally. In many cases, this is the only indication we have of the early use of local stones. Adding the stone wall protected the wooden structure from rising damp. The infilling material was often replaced later with more durable brickwork or stone. Sometimes, as fashion or necessity dictated, the original timber-framed walls were encased in stone or brick cladding, especially at the front of the building where it was presumably a feature to be admired.

Compton Wynyates house near Shipston-on-Stour and the brick gatehouse of Charlecote Park near Wellesbourne are two examples of early brick revival buildings dating from the early 16th century. Bricks could be made wherever there was a supply of suitable clay, and this was abundant in the geological succession of Warwickshire. Small temporary kilns were built close to the construction site and batches of a few hundred hand-moulded bricks were fired for up to six weeks. The results were predictably variable in a way that lends additional charm to these ancient brick structures.

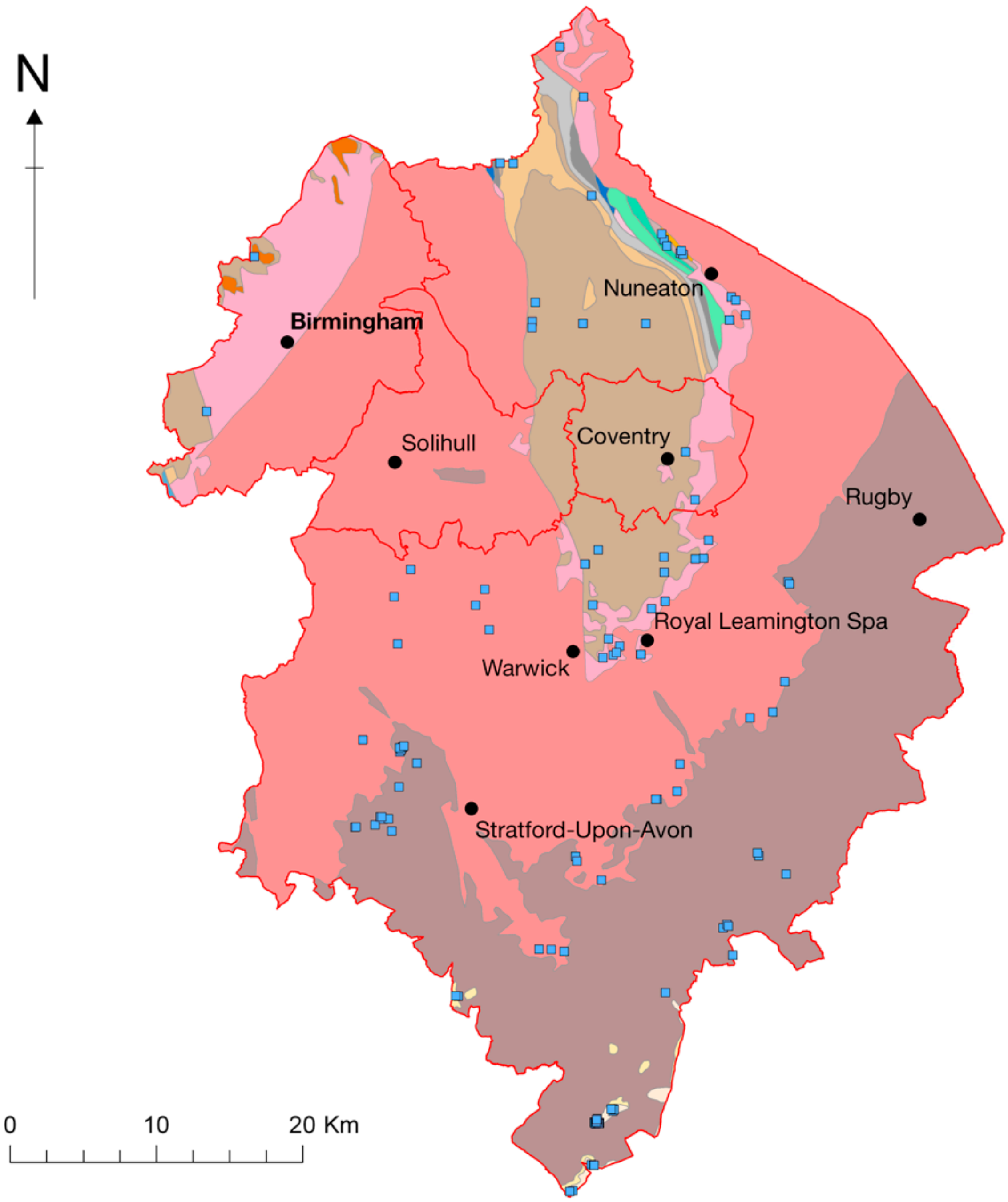
Quarrying for building stone in Warwickshire dates back to the Romans with evidence of quarry pits in the north of the county, around Mancetter.

Improved transport links, first the canals at the end of the 18th century and then the railways from the middle of the 19th century, allowed stone to be transported economically over great distances. Eventually, this led to the closure of most local quarries. A fine example of the impact of these imported stones on the local stone industry is provided by Rugby School. Pre-mid-19th-century buildings in the school complex use local Bromsgrove Sandstone for dressings. However, the 'new' school buildings, constructed by William Butterfield, use the architect's distinctive polychromatic style and feature a mix of red brick and yellow ooidal limestones (Bath Stone) from the Box Ground quarries in Wiltshire.

Today, stones are imported from all over the world for use in new town and city developments and the closure of local quarries has meant there is no longer any local competition to these imports. Birmingham city is typical of many of the UK's large urban centres. The Cathedral Church of St Philip, constructed in the early 18th century, used Arden Sandstone from the Rowington quarries. However, as a result of its subsequent severe decay, it was almost completely replaced during the 19th and 20th centuries with Stancliffe Darley Dale Sandstone (Millstone Grit) from Derbyshire, White Mansfield (Permian) from Nottinghamshire, White Hollington Stone (Triassic) from Staffordshire and Pennine Coal Measures sandstone from County Durham. By the 19th century, stones from throughout the UK were being used in Birmingham, perhaps the most distinctive being the coarsely fossiliferous Anglesey Marble (Carboniferous limestone) for the town hall. This was recently refurbished using the same limestone source: the Penmon quarries in Anglesey, Wales.

Figure 1: The Cathedral Church of St Philip, Birmingham. Originally constructed of Arden Sandstone but repaired with stones from Derbyshire, Staffordshire and County Durham.

Bedrock Geology Map



Key

Building stone sources

Bedrock geology

Great Oolite Group — sandstone, limestone and argillaceous rocks

Inferior Oolite Group — limestone, sandstone, siltstone and mudstone

Lias Group — mudstone, siltstone, limestone and sandstone

Triassic Rocks — mudstone, siltstone and sandstone

Triassic Rocks — interbedded sandstone and conglomerate

Permian Rocks — interbedded sandstone and conglomerate

Pennine Middle Coal Measures Formation and South Wales Middle Coal Measures Formation — mudstone, siltstone, sandstone, coal, ironstone and ferricrete

Warwickshire Group — mudstone, siltstone, sandstone, coal, ironstone and ferricrete

Warwickshire Group — siltstone and sandstone with subordinate mudstone

Pennine Lower Coal Measures Formation and South Wales Lower Coal Measures Formation — mudstone, siltstone, sandstone, coal, ironstone and ferricrete

Upper Devonian Rocks — interbedded sandstone and conglomerate

Arenig Rocks — mudstone, siltstone and sandstone

Tremadoc Rocks — mudstone, siltstone and sandstone

Upper Cambrian , including Tremadoc — mudstone, siltstone and sandstone

Middle Cambrian — mudstone, siltstone and sandstone

Lower Cambrian Rocks — interbedded sandstone and conglomerate

Unnamed Extrusive Rocks, Neoproterozoic — felsic tuff

Stratigraphic Table

Geological timescale	Groups	Formations	Building stones	Page
Pleistocene	various	various	Pebbles, Cobbles, Ferricrete (Heathstone)	23
Middle Jurassic	Great Oolite Group	various		
	Inferior Oolite Group	Birdlip Limestone Formation	Cotswold Stone	21
		Northampton Sand Formation		
Lower Jurassic	Lias Group	Whitby Mudstone Formation		
		Marlstone Rock Formation	Hornton Stone	21
		Dyrham Formation		
		Charmouth Mudstone Formation		
		Blue Lias Formation	Blue Lias, Wilmcote Limestone, Rugby Limestone	17
Triassic	Penarth Group	Lilstock Formation	White Lias	16
		Westbury Formation		
	Mercia Mudstone Group	Blue Anchor Formation		
		Branscombe Mudstone Formation		
		Arden Sandstone Formation	Arden Sandstone	14
		Sidmouth Mudstone Formation		
		Tarporley Siltstone Formation		
	Sherwood Sandstone Group	Bromsgrove Sandstone Formation	Bromsgrove Sandstone (Warwick Stone, Attleborough, Marston Jabbett and others)	12
		Chester Formation		
Permian		Hopwas Breccia Formation		

Geological timescale	Groups	Formations	Building stones	Page
Upper Carboniferous — Upper Devonian	Warwickshire Group (Barren Measures)	Ashow Formation		
		Kenilworth Sandstone Formation	Kenilworth Sandstone	10
		Tile Hill Mudstone Formation		
		Salop Formation (including the former Keele Formation)	Keele Sandstone	9
		Halesowen Formation	Halesowen Sandstone	9
		Etruria Formation		
	Pennine Coal Measures and Millstone Grit Groups	various		
	not defined	Oldbury Farm Sandstone Formation		
Ordovician	Midlands Minor Intrusive Suite		Igneous rocks (diorites, lamprophyres)	8
	not defined	Lickey Quartzite Formation		
	Stockingford Shale Group	Merevale Shale Formation		
Cambrian		Various including the Mancetter Shale and Purley Shale formations		
	not defined	Hartshill Sandstone Formation	Hartshill Sandstone	7
Precambrian	Charnian Supergroup	Caldecote Volcanic Formation	Volcaniclastic rocks, tuffs	7

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

2 Local Building Stones

Precambrian

Charnian Supergroup, Caldecote Volcanic Formation

Volcaniclastic rocks, tuffs

The complex succession of volcaniclastic rocks and associated intrusive igneous rocks that comprise the Caldecote Volcanic Formation are the oldest rocks of the county and crop out to the north-west of Nuneaton. These rocks are still extensively quarried for aggregate, but were, in the past, a significant source of paving stones (setts) at the Blue Hole Quarry.

Cambrian

Hartshill Sandstone Formation

Hartshill Sandstone

The oldest sedimentary rocks found in Warwickshire and the West Midlands are of Cambrian age and comprise the sandstones (quartzites) that form the Hartshill Sandstone Formation in the ridge between Nuneaton and Hartshill Hayes. The sandstones were deposited as loose quartz sand grains on the sea floor about 560 million years ago, when life on Earth was first beginning to evolve. Since then, they have been deeply buried and tectonically compacted, squeezing out mineral-rich pore waters to deposit silica cement in the space between their grains, and turning the loose sediment into a very hard durable stone that is still worked for crushed rock aggregate.

Geologically, the Hartshill Sandstone is renowned for its well-preserved trace fossil assemblages, which represent some of our earliest known life forms. This sandstone shows interesting shades of green and pale purple, which highlight its generally grey colouration. Although quite attractive, it has seldom been used for building work, but it is often seen as random blocks in local walls. The three buildings that have used this sandstone extensively are Hartshill Castle, the ancient Abbey Church of St Mary at Nuneaton and Holy Trinity Church at Hartshill. More recently, the sandstone has been used as irregular slabs for facing brick walls at Holy Trinity Church (Hartshill) and St John’s Church, Kenilworth.

Figure 2: Hartshill Castle. Hartshill Sandstone.

Ordovician

Midlands Minor Instrusive Suite

Igenous rocks (diorities, lamprophyres)

These rocks occur as intrusive diorites (mainly as sills) along the ridge north-west of Nuneaton, where they have been, and still are, extensively quarried, for example at Griff, Mancetter and Purley. The diorites are hard, intractable rocks and they are rarely used in buildings. With careful examination, though, occasional angular pieces of this blackish rock can be seen in some buildings, including the Church of St Peter at Mancetter. The diorites can be found locally as walling stone and they were used in the past for the construction of railway bridges in the local area. However, in modern times, the diorites have been worked extensively for road stone aggregates, for example at Mancetter Quarry. The quarries form a major landscape feature on the Nuneaton ridge.

Figure 3: Mancetter Quarry. Diorite.

Upper Carboniferous – Upper Devonian

Warwickshire Group, Halesowen Formation, Salop Formation, Kenilworth Sandstone Formation

The Upper Carboniferous rocks of the county comprise the Warwickshire Group and they are restricted in outcrop to the area of the Warwickshire Coalfield, which extends north to south from Tamworth to Warwick and eastwards to Coventry and Nuneaton. The often reddened sandstones from the Halesowen Formation, Salop Formation (formerly Keele Formation) and Kenilworth Sandstone Formation of this group were widely used locally for building stone. These sediments accumulated about 250 million years ago, when the extensive delta swamps that characterised the earlier Pennine Coal Measures Group successions dried up and the environment gradually moved towards the drier, desert conditions that characterise the Warwickshire Group.

These sandstones can be lithologically variable: in places, it is fine grained and almost white in colour, whereas other blocks are pebbly (conglomerate) and much browner in colour.

In the south wall just to the right of the main door of the Church of St Peter at Mancetter, the sandstone is still blackened with the industrial grime that once coated most old buildings in this area, downwind of the industrial city of Coventry. Above this grimy layer is a well-coursed wall section and buttress of brown sandstone. This was probably quarried from the local outcrop of the Halesowen Formation. The upper part of the wall comprises poorly coursed rubblestone containing angular pieces of blackish rock, which is probably a crystalline diorite.

Elsewhere, the use of reddened Carboniferous sandstones is widespread across their outcrop. Other examples include Astley Castle near Nuneaton and Coombe Abbey near Coventry, where the oldest parts are constructed of local red sandstone.

Figure 4: Astley Castle, Warwickshire. Carboniferous sandstone.

Figure 5: Church of St Peter, Mancetter. Brown sandstone from the Warwickshire Group.

Warwickshire Group, Kenilworth Sandstone Formation

Kenilworth Sandstone

Widely used in local walls and buildings, the strongly cross-bedded, reddish sandstones that comprise the Kenilworth Sandstone Formation are probably best seen in the castle and priory gatehouse at Kenilworth. Cross-bedding is evident in many of the sandstone blocks. Some have clearly been wrongly laid on edge in the wall, thus causing the stone to weather and gradually fail.

The iron oxide hematite that gives the sandstones their marked reddish colour has often been severely affected by pollution. Acid rain, generated by smoky chimneys and car exhausts, has removed much of this ferruginous, grain-coating cement, reducing the surface of the sandstones to a loose friable collection of quartz grains that are easily eroded away. The effects of erosion are very visible around the quoins and windows of Kenilworth Castle.

As there are no longer any local sandstone quarries in operation, much of the replacement red sandstone used for conservation repair work is currently brought from the Permian sandstone quarries of the Dumfries area of Scotland (for example, Locharbriggs Sandstone).

Figure 6: Abbey gatehouse, Kenilworth. Kenilworth Sandstone.

Perhaps one of the finest examples of the use of Kenilworth Sandstone in Warwickshire is the elaborately carved Norman doorway of the Church of St Nicholas at Kenilworth.

Figure 7: Doorway, Church of St Nicholas, Kenilworth. Kenilworth Sandstone.

Elsewhere, the reddened Kenilworth sandstones are juxtaposed with pale grey, fine-grained Arden Sandstone of the Mercia Mudstone Group, as seen in St Mary's Church at Haseley near Warwick, for example.

At Stoneleigh Abbey near Kenilworth, part of this substantial stone building is constructed of red Kenilworth Sandstone, which contrasts with the pale grey Bromsgrove Sandstone used for the principal facade of the west wing. Recent restoration work on the west wing employed white Triassic Grinshill Stone for major repairs. At Stoneleigh village, locally quarried sandstone from Motslow Hill is seen in the almshouse.

Figure 8: Stoneleigh Abbey, west wing, Kenilworth. Bromsgrove Sandstone.

Figure 9: East wing, Stoneleigh Abbey, Kenilworth. Kenilworth Sandstone.

Triassic

The Triassic succession is the principal source of building sandstones in the county. As elsewhere in the UK, the Triassic is divided stratigraphically into three units: the basal sandstone-dominated Sherwood Sandstone Group; the mudstone and evaporite-dominated Mercia Mudstone Group; and the thin transitional interval of marginal marine sediments and marine limestones, marking the top of the Triassic, known as the Penarth Group. Each of these groups was a prolific source of local building materials in the past, providing sandstones, mudstones (for brick production), and limestones for construction.

Sherwood Sandstone Group, Bromsgrove Sandstone Formation

Bromsgrove Sandstone (Warwick Stone, Attleborough, Marston Jabbett and others)

The Bromsgrove Sandstone (formerly the Keuper Sandstone) is pale brown to off-white in colour, fine to medium grained and commonly cross-bedded. Formerly, it was quarried extensively for building purposes across its outcrop, but there are no active quarries operating today. Most older towns and villages on the outcrop will have some stone buildings that have used the local Bromsgrove Sandstone as wall stones or dressings.

At Coventry, the ruins of the bombed Church of St Michael are Bromsgrove Sandstone, believed to have been quarried at Whitley. The new cathedral at Coventry is constructed of variegated purple-red and brown sandstone from the Triassic Hollington quarries in Staffordshire. In the south-west suburbs of Birmingham, the remains of Weoley Castle confirm that the Bromsgrove Sandstone Formation, here locally reddened, was always an important source of local building stone wherever it was accessible. At Warwick, the local Bromsgrove Sandstone, pale greenish-grey in colour, was very widely quarried and used, most noticeably in the castle, city walls and gatehouses as well as in many older churches and private houses. In this area, the sandstone is sometimes referred to as Warwick Stone.

Figure 10: St Michael's Church, Coventry. Bromsgrove Sandstone.

In other areas of its extensive outcrop, local quarry names for the sandstone have also been used, including Attleborough, Marston Jabbett and so forth. The sandstone is weakly cemented and many buildings in Warwick and elsewhere are commonly patched or repaired with harder Triassic sandstones from the Hollington (Staffordshire) or Grinshill (Shropshire) quarries. Hollington Stone was used for re-facing the Northgate Street frontages of the Law Courts and Shire Hall in Warwick in 1948. Notable Bromsgrove Sandstone buildings in the town include St Mary's Church, the County Gaol, Market Hall and St John's House Museum. Traces of many old quarries are found around Warwick, including one in Priory Park that is now a children's playground and one at Rock Mill beside the River Avon between Warwick and Leamington, now partly concealed beneath a housing development. It was from here that stone was carried, probably by river, to construct the elegant new Banbury Road Bridge, built in 1794 to replace the old bridge beside Warwick Castle.

Mercia Mudstone Group, Arden Sandstone Formation

Arden Sandstone

The Arden Sandstone is a unit that occurs approximately 300m above the base of the Mercia Mudstone Group. This sandstone is pale coloured, fine to medium grained and poorly cemented, and commonly exhibits trough, planar and small-scale ripple cross-lamination. It attains a maximum thickness of 11m and often forms well-developed escarpments, for example, north-east of Henley-in-Arden.

The Arden Sandstone has been quarried over a large geographical area in the past, although there are presently no active workings. The numerous former quarries were all rather small, perhaps because the sandstone units most suitable for use as a building stone are lenticular in shape and hence not laterally very extensive.

As the sandstone is poorly cemented, it tends to suffer badly from the effects of weathering. Consequently, block replacement and repair are common features in older buildings. Despite the stone's poor durability, many buildings in the Arden area originally used this sandstone as their principal building stone. In the Inkberrow (Worcestershire) area, however, the Arden Sandstone is particularly well cemented, which allowed for more durable, exceptionally large blocks to be quarried. Buildings constructed of Arden Sandstone are common along most of its outcrop area. Notable examples include churches at Wootton Wawen, Rowington, Tanworth-in-Arden, and the spire at St Alphege, Solihull, as well as the manor house at Baddesley Clinton.

Figure 11: Manor house, Baddesley Clinton. Arden Sandstone.

Figure 12: St Alphage Church spire, Solihull. Arden Sandtone.

The Church of St Peter at Wootton Wawen has some of the oldest Arden Sandstone masonry in Warwickshire. Much of the building is 14th century, but the tower belongs to the 11th century and the stonework is a very crude, uncoursed rubblestone. The later south-facing walls of the nave and chancel are, however, built of dressed blocks of Arden Sandstone.

Stratford-upon-Avon does not have many early stone buildings, presumably because much of the town dates from the 15th and 16th centuries when timber-framed construction was more widely practised. However, the 15th-century Clopton Bridge, financed by Sir Hugh Clopton, is built of weathered, pale grey Arden Sandstone that clearly shows its characteristic fine lamination. A more recent parapet at the top of the bridge is mainly ooidal

Figure 13: Clopton Bridge. Arden Sandstone.

limestone with odd fragments of other rocks, including brown stones that do not match any local rock type and are possibly Northampton Ironstone. The bridge is one of several medieval structures constructed of Arden Sandstone that span the Rivers Avon and Leam in Warwickshire.

Another fine example of the use of Arden Sandstone is the late 15th-century nave and tower of the Guild Chapel, also in Stratford-upon-Avon and again financed by Clopton. Here, in an unweathered state inside the building, the creamy-white stone shows little evidence of lamination. Externally, the Arden Sandstone has been partially clad with Hollington Stone from Staffordshire.

The oldest part of this chapel is the chancel, which displays the use of large blocks of White Lias limestone reminiscent of, but earlier in construction than, Compton Verney house near Kineton. In Warwick, the columns of the tower of St Mary's Church are constructed of Arden Sandstone from the Shrewley quarries.

Penarth Group, Lilstock Formation

White Lias

The Mercia Mudstone Group is overlain by the Penarth Group, which is up to 14m thick. The Penarth Group includes the Langport Member, a limestone bed that has been widely used as a building stone in the southern and eastern parts of the county. The White Lias Limestone is a pale grey, very fine-grained, micritic variety with occasional bioturbated facies and fossil concentrations. Another notable feature is the inclusion within some beds of locally reworked angular fragments of limestone (intraformational conglomerate). Good examples of such stones include the churches and other walls at Moreton Morrell and Southam. Most of the villages that commonly used White Lias Limestone lie along the outcrop. The limestone was employed extensively as dressed blocks in the walls of the 18th-century Compton Verney House, and in the columns and walls of the 17th-century Chesterton Windmill, overlooking the Fosse Way.

At St Nicholas Church at Loxley, the local building stone is the hard and pale grey White Lias limestone, which is used in small blocky fragments. Individual pieces are generally quite small, flattish and only 50 to 75mm thick. The limestone is used for the chancel of the church, where much of it was laid in a herringbone pattern, although some was laid flat and roughly coursed. In contrast, the quoins at the east end and the lancet window in the chancel are of red sandstone from the Warwickshire Group, probably sourced from the Kenilworth area. The grey stone of the rounded 18th-century window, also in the chancel, has the appearance of Arden Sandstone, and the nave (traditionally maintained by the parishioners) was rebuilt in the 18th century using pale brown Bromsgrove Sandstone from the Warwick area. The rich brown ironstone used in the 13th-century tower adds another striking contrast. This is the distinctive Hornton Stone (Marlstone Rock Formation) from Edge Hill, about 16km to the south in Oxfordshire. The topmost section of the tower was added later and is of pale brown Bromsgrove Sandstone. On the west-facing wall of the tower is yet another local stone: the banded Wilmcote Limestone so typical of the Stratford area and probably brought all the way from Wilmcote. The whole structure is beautifully set off by red clay tiles that have weathered to several different shades, enhanced with colourful patches of lichen and green algae.

Figure 14: St Nicholas Church, Loxley. White Lias.

Lower Jurassic

Lias Group, Blue Lias Formation

Blue Lias, Wilmcote Limestone, Rugby Limestone

The Lower Jurassic succession conformably overlies the Penarth Group and crops out over much of the south and east of the county. The Lias Group has provided grey and pale brown, fine-grained, micritic limestones for local building purposes across much of its outcrop. The oldest beds of the group form part of the Blue Lias Formation and can be seen in the quarry at Southam, overlying the Triassic White Lias (Langport Member) limestones.

The formation typically comprises hard paler bands of impure limestone alternating with softer, darker, fissile, clay-rich layers. Fossils, including ammonites and bivalves, are common in the limestones, and occasionally large reptilian fossils have been found in the quarries. The basal strata contain the best building limestone beds, locally known as the Wilmcote Limestone (Member). The unit was quarried at several localities to the north and west of Stratford, particularly at Wilmcote and Binton. The last quarries closed at the beginning of the 20th century and few traces now remain.

The limestone that they produced is quite hard but thinly bedded and can be quarried as big slabs. It was much sought after for walling, flooring, doorsteps and even gravestones. Unfortunately, the gravestones have not lasted well because, when set vertically in place, they eventually split and fail when damp and frost attack the exposed laminated edges. Wilmcote Limestone was also used for the flooring in parts of Sir Charles Barry's new Houses of Parliament in Westminster.

Numerous buildings and other stone structures testify to the importance of the use of these local Lias Group limestones across the outcrop, and the following are but a few examples. Ragley Hall near Alcester is built of Wilmcote Limestone with Arden Sandstone dressings. The medieval bridge at Bidford-on-Avon was constructed mainly of local Wilmcote Limestone, but it has been patched with several other stones. In the cutwaters, there are slabs of ooidal Cotswold Stone and Bromsgrove Sandstone, as well as patches of red brick where the stonework was dislodged by boats or tree trunks that were swept along on the swirling flood waters that sometimes surge down the river. Kinwarton Dovecote near Alcester is built of Wilmcote Limestone, covered with an old cement render, and has a sandstone doorway.

The medieval Church of St John the Baptist at Aston Cantlow is situated just off the Blue Lias escarpment and it is well known as the place where William Shakespeare's parents were married in the 16th century. The walls

Figure 15: Church of St John the Baptist, Aston Cantlow. Wilmcote Sandstone with window mouldings in Arden Sandstone.

are mainly of Wilmcote Limestone, whereas the window mouldings are of Arden Sandstone, or, in the newer replacements, pale yellow Cotswold Stone. Set into the north wall is a small window blocked with pale grey Arden Sandstone, containing a weathered, recumbent figure, flanked with pale brown Bromsgrove Sandstone.

At the nearby village of Billesley, which largely disappeared during the Black Death in the 14th century, there remains a Jacobean stone manor house and a fine church, built and floored with Wilmcote Limestone. Slightly further afield, both Mary Arden's House and Anne Hathaway's Cottage made use of Wilmcote Limestone plinths to support their timber-framed construction. In towns such as Stratford and Alcester, where many of the houses are timber framed, we can often ascertain what stone was available locally by looking at the low walls on which they stand.

Figure 16: Plinth, timber-framed building. Wilmcot Limestone.

The distinctive church ruin just outside Ettington is part of an interesting slice of local history. The original Norman Church of Holy Trinity was very close to the family seat of the Shirley family at Ettington Park, too close perhaps because they built a new church for the village and let most of the original building fall to ruin. Surviving parts now present a romantic setting alongside Ettington Park Hotel. St Thomas a Becket Church was erected in 1798 but became unsafe and was replaced by the current village church, built this time of Middle Jurassic Cotswold Stone in 1902. The tower survives as a ruin, but the nave and chancel have long since been demolished. As a structure, this tower is most unusual because it is made almost entirely of the very impure, clay-rich Rugby Limestone, which forms hard bands in the Blue Lias Formation but does not weather particularly well.

The Blue Lias Formation in Warwickshire has long been quarried in vast pits to feed the national cement industry. Its high clay content meant that it could be used to produce hydraulic lime rather than pure lime on burning.

The availability of such a range of local building stones in Warwickshire has meant that a number of stone buildings in the county have used many varieties of stone in their construction.

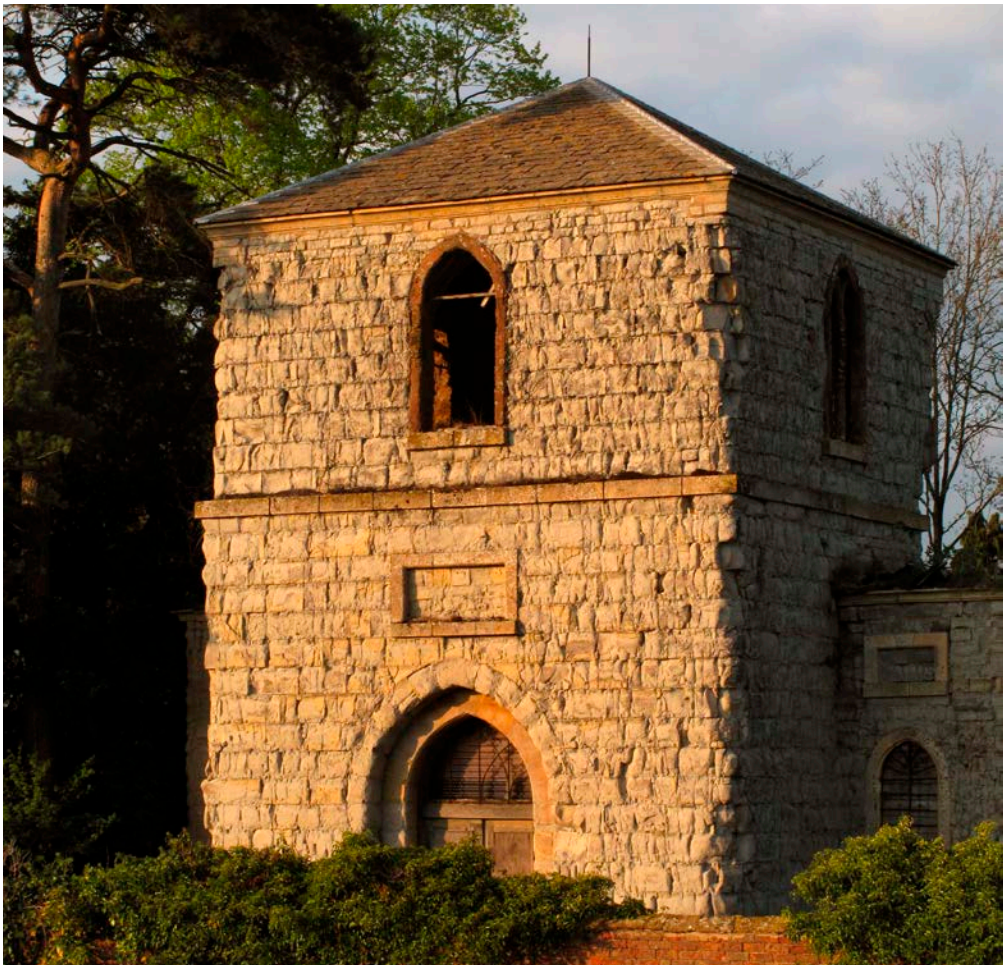


Figure 17: St Thomas a Becket Church, Ettington. Rugby Limestone.

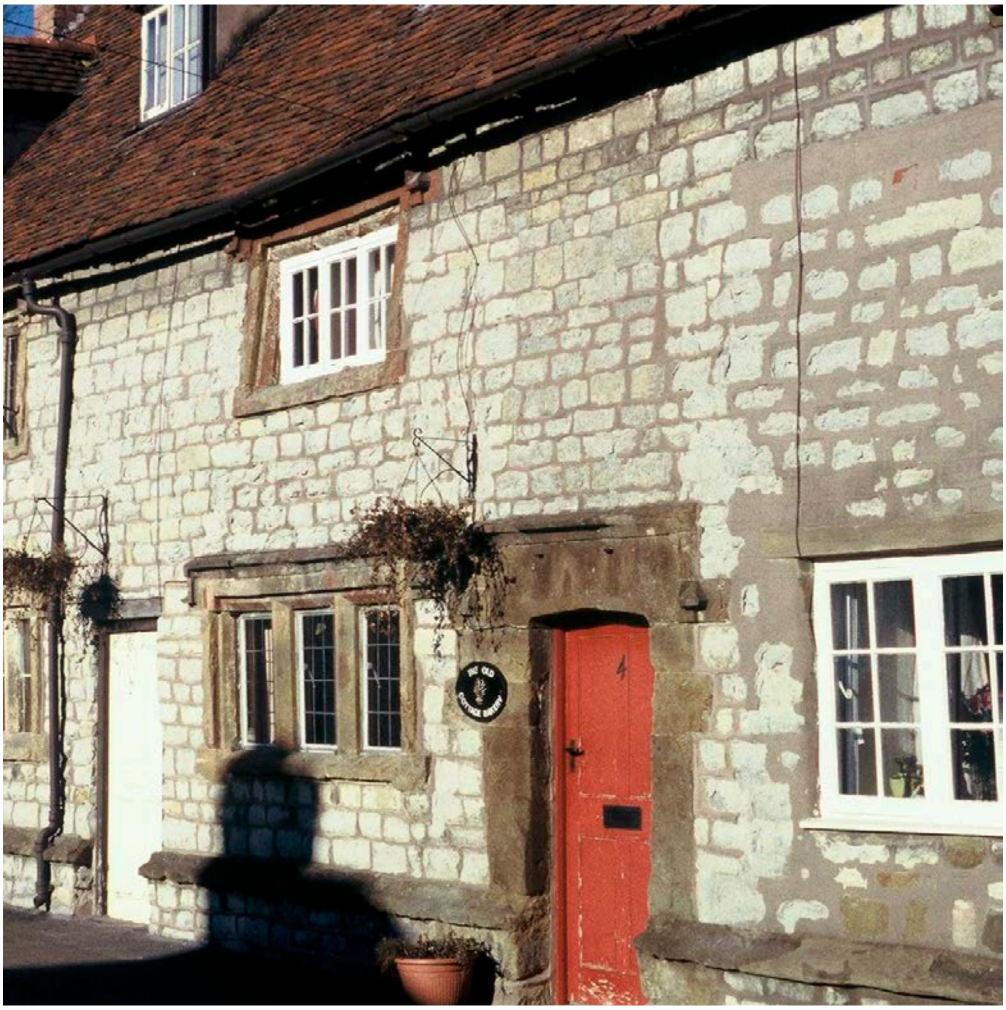


Figure 18: Cottages, Kineton. Blue Lias.

Lias Group, Marlstone Rock Formation

Hornton Stone

For centuries, the Marlstone Rock Formation, or Hornton Stone, has been worked as an iron ore and building stone at Edge Hill and Burton Dassett Hills. It is a distinctive dark brown ferruginous (calcite, sideritic and berthierine-rich) ooidal and shell fragment ironstone. In walls, it usually shows very dark rusty-looking streaks and sometimes contains fossils. The tops of Burton Dassett and Edge Hill are pock-marked by defunct iron ore quarries and pits.

Perhaps one of the most distinctive buildings that has made extensive use of the ironstone is the hotel at Ettington, which is constructed of a polychromatic mix of Hornton Stone, Cotswold ooidal limestone, Wilmcote Limestone and White Lias. The use of pale Blue Lias wall stones with contrasting window and door mouldings of brown Hornton Stone is a characteristic feature of the stone housing at Kineton and in many other villages in this part of the county. Hornton Stone also has an important place in local churchyards, where it is still widely used for gravestones and carved memorials. Furthermore, Hornton Stone gained considerable international fame as a medium used by the sculptors Barbara Hepworth and Henry Moore for many of their artworks.

Middle Jurassic

Inferior Oolite Group, Birdlip Limestone Formation

Cotswold Stone

There are limited outcrops of Middle Jurassic limestone along the southern borders of the county. Nevertheless, these pale yellow ooidal and bioclastic limestones are a common feature of buildings in the area, as seen in Long Compton village, for example. Only a few small quarries, such as Ebrington Hill and, Oakham, are known within Warwickshire, and much of the stone used probably came from the larger quarries of the Cotswold area to the south.

The limestone is widely seen in the uncoursed rubblestone walls of village houses and in the drystone field walls. However, in more elaborate buildings, such as churches and manor houses, the stone was of much higher quality, comprising squarely cut ashlar block.

In this southern area, Cotswold Stone slates are commonly used for roofing. The slates are arranged in characteristic diminishing courses, with the smallest slates used at the ridge and larger slates along the eaves. Only certain lithologies of the Cotswold limestones can split in this way and the principal local source was at Stonesfield in Oxfordshire. Here, the limestone was excavated from shallow underground mines and the abandoned access shafts can still be found around the village. Perhaps the earliest examples of the use of stone for construction in Warwickshire are the Rollright Stones, or more specifically the King Stone, as the Whispering Knights and the King's Men lie just over the border in Oxfordshire. This ancient standing stone is of the local ooidal Cotswold Stone, on which it actually sits, and it was probably sourced not far from its site. All the stones are very rough and irregular in shape and size, and they are believed to have been erected some 5,000 years ago.

Figure 19: Lych gate, St Peter and St Paul Church, Long Compton. Cotswold Stone.

Figure 20: Rollright Stones, near Chipping Norton. Cotswold Stone.

Pleistocene

Various groups, various formations

Pebbles, Cobbles, Ferricrete (Heathstone)

The youngest strata of Warwickshire are the unconsolidated Pleistocene fluvio-glacial sands and gravels that mask much of the land surface. Ice sheets advanced over Warwickshire during the Pleistocene, which comprised intense cold 'glacial' periods interspersed with much warmer 'interglacial' intervals. At times, the ice may have been more than 100m thick in the north of the county, but thinned southwards and never extended much beyond Edge Hill. This mobile ice sheet carried rock and soil scraped up from the country to the north, which was then deposited as glacial drift as the ice gradually melted. Occasionally, this drift contains large boulders, which are referred to as glacial erratics. Where the rock type is distinctive, the boulders can sometimes be used to pinpoint the source from which they came, and from that the direction of ice movement can be deduced.

Mostly, we have been left with a thin covering of sand and gravel, which here and there is thick enough to provide a ready source of aggregate for the construction industry. The thickest and most extensive deposits lie north and west of Rugby, including at Dunsmore Heath. In a few places, pebbles and boulders from the drift have been collected and used in the walls of buildings. Holy Trinity Church at Churchover is a particularly good example: the 15th-century tower is principally White Lias (locally sourced), but the nave and chancel, rebuilt late in the 19th century, are entirely clad in split cobbles and boulders of great variety. Another interesting example is St Mary's Church at Clifton-upon-Dunsmore, where the tower is a mix of grey and reddish sandstones typical of the Coventry area. The rest is mainly ironstone, some of which is the dark brown Hornton type and some the yellower, sandy Northampton Sand (or Ironstone), which becomes increasingly common towards Daventry in Northamptonshire.

Scattered among the ironstones are pebbles and cobbles of hard brown sandstone from the local drift and blocks of very dark brown conglomerate. The conglomerate comprises a variety of rounded pebbles, not more than a few centimetres across, and in some blocks lots of similar-sized angular flint pebbles.

Local studies have found this ferruginous pebble rock to be fairly widespread on Dunsmore Heath, where it seems to have formed as an iron pan or ferricrete at a depth where it interferes with deep ploughing. Such layers are often developed where mineral-rich groundwaters dissipate as they near the surface, precipitating a hard chemical crust or hardpan layer that was subsequently collected as a building material. This is sometimes termed Heathstone.

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.

Warwickshire and West Midlands references

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Figures

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