Introduction

Both the topography of Lincolnshire and the character of its varied vernacular architecture are very much a reflection of the county’s underlying geological succession. This succession comprises a mixture of mudstones, limestones and sandstones, which form a series of roughly north-south trending outcrops and dip collectively gently eastwards towards the coast before disappearing beneath the North Sea (see facing Bedrock Geology map). Most of the bedrock Lithologies have been worked as sources of building materials for the areas surrounding their respective outcrops. In the mudstone-dominated ‘vales’, brick-making predominated whereas on the limestone, chalk and sandstone ridges, the harder rock types were quarried, and buildings and villages constructed of stone tend to be more prolific.

Western parts of Lincolnshire take in the low-lying areas of the Trent Valley and Isle of Axholme, and are underlain by mudstone-dominated sequences of Upper Triassic and Lower Jurassic age. Further east, a significant ridge known locally as ‘The Cliff’ is present. Best developed at Lincoln itself, this principally comprises a succession of interbedded orange-brown, calcareous ironstones and yellow limestones which together represent the Middle Jurassic. Most significant amongst these limestones are those of the Lincolnshire Limestone Formation, which cap the ridge. These particular limestones were in the past, and remain so today, by far the most important source of building stone in the county. The intrinsic quality and abundance of the Lincolnshire Limestone spawned an industry which has supplied not only the county’s own building stone needs, but one that has made Lincolnshire a major exporter of building stone since Roman times.

East of ‘The Cliff’, the topography becomes subdued once more. This is a direct expression of the underlying presence of interbedded Upper Jurassic mudstones and limestones (the Ampthill, Oxford and Kimmeridge clays of the Ancholme Group). These beds give rise to the broad, low-lying expanse known as the ‘Central Lincolnshire Vale’, which extends southwards from North Kelsey through Market Rasen, Horncastle and Tattershall to Boston on the northern margin of the Wash-Fenland embayment. Much of the Vale follows the course of the River Witham, which – since at least medieval times – has served as a key part of the local communications network, facilitating the movement of stone and other commodities. In general, the lithologies encountered in this area are largely unsuitable for use as building stone. The Vale is curtailed to the north and east by the highest ground of the county, known as the Lincolnshire Wolds.

The scarp slope forming the leading edge of the Lincolnshire Wolds exposes a thin, lithologically diverse succession of uppermost Jurassic and Lower Cretaceous age. This includes the green, glauconitic sandstones (Spilsby Sandstone Formation) and ironstones that were in the past important sources of building stone for many of the villages located on or close to their outcrops.

Capping the Wolds ridge and forming the stratigraphically highest part of Lincolnshire’s geological succession are the white micritic limestones of the Upper Cretaceous Chalk Group. The Lincolnshire chalks did see limited use historically as a building and walling stone, but have long been superseded by brick as a construction material of choice. The southern limit of the Wolds is obscured by a thickening cover of soft, poorly consolidated sediments that forms the area of south Lincolnshire known as the Fenland(s). The Quaternary deposits of the Fenland(s) have effectively provided no useful sources of building stone, and most buildings in this area are constructed of local brick or stone imported from other parts of Lincolnshire and areas beyond. The unfailing supply of good quality indigenous stone, sourced in particular from the Middle Jurassic limestones, enabled Lincolnshire to remain self-sufficient in terms of building stone production from Roman times up until the late 19th century. Only with improvements to the road and rail networks did more exotic building stones begin to have an impact in the county’s expanding population centres.
Triassic

**Mercia Mudstone Group**

The predominantly low-lying, rolling landscape of western and northwestern Lincolnshire represents an eastwards extension of the Trent Valley and Isle of Axholme. It is within these western parts that the oldest rocks of the county, which are of Triassic age, are found. Assigned to the Mercia Mudstone and Penarth groups, the Triassic strata follow the course of the River Trent from Susworth in the north to Newton on Trent in the south. Much of the outcrop, however, is concealed beneath unconsolidated Quaternary fluvial and glacio-fluvial sediments. Bedrock is exposed only around Gainsborough, where it essentially comprises red mudstones with occasional thin interbeds of green-grey sandstone (known locally as ‘skerries’) and gypsum.

Jurassic

**Lower Jurassic**

**Lias Group**

Conformably overlying the Triassic ‘red-bed’ succession is a thick sequence of interbedded fine-grained grey limestones and calcareous mudstones that comprise the uppermost Triassic to Lower Jurassic Lias Group. The Lias outcrop extends from Scotter in the north to Grantham in the south, increasing in width as it does so, before disappearing in an easterly and southeasterly direction beneath the prominent topographic ridge (‘The Cliff’) formed by the Middle Jurassic limestones.

**Scunthorpe Mudstone Formation**

**‘Blue Lias’ Limestone**

The Scunthorpe Mudstone Formation, broadly equivalent to the Blue Lias Formation further south-west, is dominated by thinly bedded, pale blue-grey (but yellow-weathering!), fine-grained limestones. In the past, these basal Lias limestones were widely quarried both for local building stone and as a source of building and agricultural lime. The Lias limestones have seen sporadic use as thinly coursed, squared rubblestone in village buildings and churches along the western edge of the county e.g. Long Bennington, Dry Doddington (including the Church of St James, with its renowned leaning tower and broach spire), Norton Disney, Swinderby, Newton on Trent, and Lea.
Marlstone Rock Formation

The overlying ‘Middle Lias’ succession of Lincolnshire is characterised by a thin development of coarser grained, variably fossiliferous, ooidal and sandy ‘ironstone’ lithologies. These yellow-brown ironstones, which are assigned to the Marlstone Rock Formation, were exploited historically both as a source of iron ore and of building stone along their narrow and sporadic outcrop. The Lias ironstones most commonly feature as part of rubblestone fabrics within rural buildings and garden walls e.g. in the villages of Denton, Harlaxton, Allington, Barkston, Honington, Hough-on-the-Hill, Caythorpe and Fulbeck. In higher status buildings such as churches and ‘country houses’, however, Marlstone Rock is seen as regularly coursed ashlars, usually with paler Lincolnshire Limestone dressings. Occasionally, these ironstones were used for decorative effect (as bands and string courses) in a predominantly off-white or yellow Lincolnshire Limestone wall fabric. The converse is also true, as some ironstone buildings (e.g. at Woolsthorpe By Belvoir) include paler bands of yellow Lincolnshire Limestone, which stand in contrast to the dark ironstone that forms the principal component of the fabric.

To the north of Lincoln, Marlstone Rock has evidently seen only limited use as a building stone. It has been identified with a high level of confidence in the Church of St. Andrew in Fillingham (west wall of nave), but otherwise seems to feature only sporadically as isolated blocks within the buildings of villages located on or close to the Marlstone Rock Formation outcrop (e.g. Scampton, Harpswell, Hemswell and Blyborough).

Middle Jurassic
Inferior Oolite Group

Northampton Sand Formation

The thin, yellow-brown, sandy and ooidal ‘ironstones’ that occur locally at the base of the Middle Jurassic succession were once worked at various places along the length of their outcrop both as a source of iron ore and of building stone. ‘Northampton Sand’ has not been positively identified during the present study, however, although its sporadic and limited presence cannot be ruled out owing to its physical similarities to the stratigraphically underlying Marlstone Rock.
Lincolnshire Limestone Formation

The typically coarse-grained, creamy white to yellow-orange, ooidal and bioclastic limestones that characterise much of this formation are by far the best known of Lincolnshire’s vernacular building stones. The Lincolnshire Limestone has been quarried for building stone along the full length of its outcrop, at some localities since at least Roman times (e.g. around Lincoln, Ancaster, Heydour and Stamford). By medieval times, Lincolnshire Limestone was being extensively transported eastwards and southeasterwards along a fairly elaborate system of waterways for use in the monastic sites and other ecclesiastical buildings of the Fenland(s) (e.g. Crowland Abbey). In the 17th and 18th century, these quarries gradually expanded in order to satisfy not only Lincolnshire’s demand for limestone but that of the adjacent counties and areas beyond, including Cambridgeshire (e.g. Ely and Peterborough cathedrals), Norfolk, Northamptonshire, Rutland and even Suffolk.

To the north of Lincoln, the Lincolnshire Limestone Formation progressively thins and is less obviously ooidal in character than it is to the south. Although still widely used as a local vernacular building stone in villages (especially in their churches) situated on or near the outcrop, for example Snitterby and Welton, the unit does not contain sufficient thick, ooidal limestone beds to have yielded high quality ashlar blockstone. Where such stone was needed for carved and other decorative work, in particular for the churches, much of it appears to have been sourced from the quarries further south at Lincoln, Ancaster and Heydour.

Arguably the best display of ashlaled Lincolnshire Limestone is provided by the external fabric of the cathedral at Lincoln, but there are numerous other limestone buildings throughout the city, including the Castle and Guildhall, and the houses of Steep Hill. The limestone for the original cathedral fabric was initially quarried from the local outcrops presented by ‘The Cliff’ itself, and there is even evidence of extensive mining of the stone from galleries beneath the building. Today, much of the stone needed for effecting conservation repairs is supplied by the cathedral’s own quarries located not far from the site.
The most renowned of Lincolnshire’s limestone quarries are those located at Ancaster. Active since Roman times, they worked two principal beds in the Lincolnshire Limestone succession. The uppermost bed of the sequence is known as the Ancaster ‘Ragstone’ or ‘Weatherbed’ (2–3 m thick), and comprises cross-bedded, pale yellow (but occasionally reddish), ooidal and bioclastic limestones. Underlying the ‘Ragstone’ are the ‘Hard White’ and the ‘Freestone’ beds, which have a combined thickness of c. 3–4 m. The ooidal ‘Hard White’ limestone, as its name suggests, is sufficiently well-cemented to provide a marble-like polished finish. The ‘Freestone’ beds are in general less coarsely fossiliferous than those of the ‘Ragstone’, and they provided much of the high quality block required for the ashlar and decorative stonework of churches and monastic buildings.

The scale of production, transportation and distribution of these Lincolnshire limestones is surprising, particularly when one considers the relative isolation of the quarries in terms of major transport arteries. Early transportation relied on using waterways such as the Witham, Slea and Kyme Eau to supply the medieval monastic sites at Bardney and Crowland, as well as at Ely and Ramsey in Cambridgeshire. The River Trent was used in the late 16th century to carry Ancaster Stone to Nottingham to build Wollaton Hall.

The number of towns, villages and individual buildings constructed of Lincolnshire Limestone, particularly those located along the outcrop itself, is prodigious. Perhaps the finest display of the lithological variation shown by these limestones can be seen at Stamford on the southern border of the county. Many former quarries in the surrounding Lincolnshire Limestone Formation have for centuries provided the stone that makes Stamford a truly unique ‘stone town’. Its buildings span some 1000 years, and their constituent limestones were sourced not only from quarries in Lincolnshire but from others in adjacent counties. Named varieties include Barnack, Ketton, Wittering Pendle, Ancaster, Clipsham and Weldon, plus a more generic ‘Stamford Stone’ produced from smaller local quarries.

Of the many individual architecturally outstanding buildings constructed of Lincolnshire Limestone, only a few can be listed: the aforementioned Cathedral and Castle at Lincoln; churches at Boston (The Stump), Brant Broughton, Grantham (St. Wulfram’s), Deeping St James, Louth (St. James’), Stow and Stamford; great houses at Wollaton (in Nottinghamshire), Belton and Stoke Rochford; and colleges at Cambridge, including the chapels at King’s College (15th century) and St. John’s College (19th century), both of which were constructed of Ancaster Stone. There are few Lincolnshire churches in which Lincolnshire Limestone has not been used either for ashlar or decorative carved work, particularly for the elaborate window tracery exhibited by many (e.g. at Ancaster, Brant Broughton, Grantham, Heckington, Louth, Scotton, Tattershall and Wilsford).
Evidence of Lincolnshire Limestone having been put to decorative use during Anglo-Saxon times is provided by the elaborately carved cross-shafts and grave covers which date to this period, remnants of which are found across Lincolnshire, most notably in the Kesteven area (e.g. Ropsley, Cranwell and Digby). These artefacts are not restricted to Lincolnshire, however, with examples being found in adjacent counties (such as the cross-shaft fragments at East Bridgford and Shelford in Nottinghamshire).

In the 19th century, the limestones quarried at Ancaster were used at Windsor Castle, for the original university buildings in Nottingham and in York Railway Station to name but a few examples. Quarries very much remain active in the Ancaster area today, and recently provided stone for the new façade of The Collection Museum at Lincoln. They also continue to underpin conservation repair projects across the county and beyond.

**Great Oolite Group**

In Lincolnshire, the Great Oolite Group consists of non-marine sandstones and mudstones, plus units of compositionally variable limestone. The thick ooidal limestone beds that characterise the group further south-west in the Bath and Cotswold areas are not developed in Lincolnshire. Despite this absence, the limestones that do occur (Blisworth Limestone Formation) have been locally worked and used for field boundary and other walling; they are not regarded as an important building stone resource, however.

**Upper Jurassic**

**Ancholme Group**

The mudstone-dominated Ancholme Group succession (incorporating the Kellaways, Oxford Clay, West Walton, Ampthill and Kimmeridge Clay formations) contains no lithologies suitable for building purposes, but where locally exposed was worked for brick clay.
Cretaceous
Lower Cretaceous

Spilsby Sandstone Formation

The uppermost Jurassic and Lower Cretaceous succession of Lincolnshire is a lithologically complex one consisting of interbedded sandstones, mudstones and ‘ironstones’. Only the harder, better-cemented beds have proved suitable for use as local building stone. Amongst the constituent lithologies, the most striking is the calcareous Spilsby Sandstone, whose distinctive green coloration is a consequence of the abundant presence of the green iron silicate mineral glauconite. It is from this that the commonly used term ‘greenstone’ is derived. The glauconite occurs as sand-sized grains dispersed throughout the quartz and feldspar-dominated frameworks of these sandstones. Large calcareous fossils are an additional commonly observed feature of some Spilsby Sandstone beds, as are concentrations of quartz and ironstone pebbles. These sandstones are found within the shallow valleys that characterise the western edge of the Cretaceous outcrop, and have been widely used in many buildings located close to where they occur.

Spilsby Sandstone is particularly common in the churches of the area e.g. those at Horncastle, Fulletby, Teford, Alford, Donington-on-Bain and South Willingham. The sandstones are comparatively soft and, as a result, are commonly a target for the burrowing activities of masonry bees, which have inflicted considerable damage to the ashlar blocks of some church fabrics. There are currently no quarries working the Spilsby Sandstone for building stone, posing a considerable challenge to conservation repair efforts.

Claxby, Tealby, Roach and Carstone Formations

Overlying the basal Cretaceous sandstone is a sequence dominated by yellow-brown sandy ‘ironstones’ and ferruginous limestones that include the beds of the Claxby, Tealby, Roach and Carstone formations. The ironstones are generally quite varied both in composition and colour, ranging from pale yellow-brown to orange or even purple-red. They are muddy, calcareous, occasionally ooidal, and often coarsely fossiliferous, with ‘nests’ of large thick-walled bivalves (which commonly weather proud in the blocks). The ironstones have been exploited extensively both for building stone and as a low-grade iron ore since Roman times. They are perhaps best seen in the village of Tealby itself, but a number of other villages situated along the outcrop are largely constructed of these strongly coloured ‘ironstone’ lithologies. Specific examples include: Caistor, Claxby, Cuxwold, Market Rasen, Rothwell and Swallow.
Despite its widespread use, ‘Tealby Ironstone’ is relatively weak and over time tends to spall and cavitate. It is not unusual to see churches that are constructed of this stone in a poor state of repair, with strongly decayed fabrics. The long absence of operational quarries within the Tealby Formation, and more specifically the Tealby Limestone Member, has meant that previous episodes of conservation repairs have commonly been carried out using Lincolnshire Limestone — a much harder stone, whose use will inevitably promote further stone decay and failure.

Other localised developments of ‘ironstone’ are known to occur in the upper parts of the early Cretaceous succession in Lincolnshire, and include the Roach and Carstone formations. The constituent lithologies of these units are generally soft and friable, however, and definite examples of their use as building stones cannot be provided at the present time. There are currently no quarries working these ‘ironstones’ in Lincolnshire.

**Upper Cretaceous**

**Chalk Group**

The Upper Cretaceous of Lincolnshire is overwhelmingly dominated by beds of white to pale grey micritic limestone (chalk). These underlie much of the east of the county, and give rise to the rolling, ‘upland’ terrain known as the Lincolnshire Wolds. In some parts of the county, the basal part of this Upper Cretaceous succession includes a thin unit of distinctly red chalk (the Hunstanton Formation). This is the case at Goulceby, for example, where red chalk features within the Spilsby Sandstone-dominated fabric of the Church of All Saints. However, whilst this red chalk has been used to a moderate extent as a building stone along the southern margin of the Wash embayment in Norfolk (e.g. at Hunstanton itself), it does not appear to have been sufficiently durable and/or accessible enough to have been widely used in Lincolnshire.

The lower parts of the White Chalk Subgroup succession of eastern Lincolnshire do include some harder beds, which were widely quarried and used locally for building stone along the outcrop. Around Louth, for example, chalk is conspicuous, and is notably seen in the fabrics of the churches at Legbourne and Haugh. Blocks of white chalk also occur sporadically in the fabrics of many churches and farm buildings over its entire outcrop, and can be seen in buildings at Beesby (in association with Spilsby Sandstone), Conisholme, Covenham St Mary (in association with ‘Tealby Ironstone’), Fotherby, Ludborough (in association with ‘Tealby Ironstone’) and Utterby (again in association with ‘Tealby Ironstone’). The striking church ruins in the deserted medieval village at Calceby are largely constructed of white Chalk blocks, which stand in stark contrast to the green, glauconitic Spilsby Sandstone blocks also present.
**Flint**

The Chalk Group succession of Lincolnshire contains abundant flint in tabular form, but it does not contain bands of flint nodules that are suitable for knapping. There are consequently few examples of buildings featuring flint in the county. At Sutton Bridge, nodular black flints (in association with Lincolnshire Limestone dressings) have been finely knapped to create a very distinctive walling fabric for the Church of St. Matthew. It is likely, however, that these flints were imported from East Anglia, where decorative flint-knapping traditions and skills were much more prevalent.

**Quaternary**

**Cobbles**

The unconsolidated Quaternary deposits of Lincolnshire include occasional boulder-rich beds, which contain a variety of ‘exotic’ lithologies. These boulder beds have locally been exploited as a source of building material, with the individual boulders being used as small-scale infill (e.g. in the Church of St. Helen in North Thoresby, which principally comprises ‘Tealby Ironstone’, Chalk and Lincolnshire Limestone).

**Tufa**

The precipitation, during Quaternary times, of porous, calcareous tufa deposits from groundwaters flowing out of the Cretaceous chalks and the other limestone units of Lincolnshire would be neither unexpected nor was it seemingly uncommon. There appears to be very little surviving evidence of the systematic working of these deposits for building material, however. Occasional isolated blocks of tufa can, nonetheless, be seen in the fabrics of some churches, and it has also been used in the construction of the occasional Victorian grotto.

**Imported Stones**

The use (or indeed re-use) of building stone ‘imported’ into Lincolnshire for specific purposes dates back to at least Medieval times. The best known examples are provided by the Dorset-sourced Purbeck Marble columns and tomb slabs which feature extensively in Lincoln Cathedral and in several other local churches that date to this period. In the south, the Fenland abbey ruins at Crowland similarly boast the weathered remnants of decorative Purbeck Marble columns.

Other ‘imports’ include the black, sparsely crinoidal ‘marble’ tomb slabs from Egglestone in County Durham and the coarsely fossiliferous ‘Frosterley Marble’ (both Carboniferous limestones) seen in Lincoln Cathedral. This same building also contains some decorative columns of fossiliferous Middle Jurassic ‘Alwalton Marble’ from Cambridgeshire. Elsewhere, there are very fine examples — such as at South Cockerington church — of the use of white Triassic alabaster for finely carved monuments. This alabaster was mined along the Nottinghamshire-Derbyshire border.
The most extreme example of this practice, however, which must have presented considerable logistical challenges, is provided by Lincoln Cathedral’s massive, intricately carved Norman font. This black Carboniferous limestone structure was brought to Lincolnshire from Tournai in Belgium.

The import of ‘foreign’ stones is more generally associated with the widespread urban development that has taken place since Victorian times. Improved transportation links over time facilitated the use of a wide variety of sandstones and limestones from outwith the county. Most notable amongst these are the Carboniferous sandstones from Derbyshire and Yorkshire (yielded by the Millstone Grit and Pennine Coal Measures groups) and the uppermost Jurassic limestones (Portland Stone) from South Dorset, which have seen use in the façades of banks and other commercial premises. The greatest range of UK-sourced imported stone types is probably found in the graveyard monuments of the county. These include granites of various colours and textures, principally from Scotland but occasionally from Cumbria, and a wide range of Welsh slates (in addition to occasional Swithland Slate headstones from Leicestershire).

Lincolnshire, like many other counties, did not have a local source of durable roofing slates, but along the southwestern border of the county, such as in Stamford, the fissile, silty Middle Jurassic limestones originating from the ‘Collyweston Slate’ mines were commonly used. In general, however, early buildings were roofed with a variety of locally made clay tiles, while in the 18th and 19th centuries, metamorphic slates from Cumbria and Wales became more widely available and were put to extensive use.
Ashlar: Stone masonry comprising blocks with carefully worked beds and joints, finely jointed (generally less than 6mm) and set in horizontal courses. The blocks within each course are of the same height, though successive courses may be of different heights. ‘Ashlar’ is often wrongly used as a synonym for facing stone.

Bioclastic: Applied to a limestone containing the fragmental debris of calcareous organisms.

Calcareous: A rock which contains significant (10–50 %) calcium carbonate, principally in the form of a cement or matrix.

Chalk: A very fine-grained white limestone composed principally of microscopic skeletal remnants known as coccoliths.

Cross-bedding: A feature principally of sandstones reflecting the movement of sand grains in currents, often producing a layering oblique to the margins of the beds.

Dressings: To say a building is constructed of brick with stone dressings means that worked stone frames the corners and openings of the structure.

Ferruginous: Containing iron minerals usually in the form of an iron oxide, which gives the rock a ‘rusty’ stain.

Flint: Hard, resistant beds or nodules composed of cryptocrystalline silica. The use of the term flint is restricted to nodules and beds that occur in Upper Cretaceous chalks.

Fossiliferous: Bearing or containing fossils.

Granite: Coarsely crystalline igneous rock composed primarily of quartz, feldspar and mica.

Ironstone: A sedimentary rock composed of more than 50 % iron-bearing minerals.

Limestone: A sedimentary rock consisting mainly of calcium carbonate (CaCO₃) grains such as ooids, shell and coral fragments and lime mud. Often highly fossiliferous.

Lithology: The description of a rock based on its mineralogical composition and grain-size e.g. sandstone, limestone, mudstone etc.

Ooidal: Descriptive term indicating the presence of ooids (typically spheroidal grains of calcium carbonate formed by the precipitation – by algae – of calcium carbonate in concentric layers).

Outcrop: The area where a rock unit is exposed at the ground surface.

Rubble: Rough, undressed or roughly dressed building stones typically laid uncoursed (random rubble) or brought to courses at intervals. In squared rubble, the stones are dressed roughly square, and typically laid in courses (coursed squared rubble).

Sandstone: A sedimentary rock composed of sand-sized grains (i.e. generally visible to the eye, but less than 2 mm in size).

Slate: A compact fine-grained metamorphic rock with a closely spaced cleavage formed by the alteration of a mudstone or siltstone by heat and pressure.

Stratigraphy: Branch of geoscience dealing with stratified rocks (generally of sedimentary origin) in terms of time and space, and their organisation into distinctive, generally mappable units.

Tufa: A highly porous encrustation of limestone formed by the precipitation of carbonate minerals from springs, streams or other water bodies.

Glossary
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Further Reading


