CHAPTER II
REGIONAL GEOLOGY
by Graham K. Lott

The 'quarrying' and use of local stone in Nottinghamshire, for both building and decorative purposes, dates back to Roman times. However, the lithological units that characterise the geological succession within the county contain only a few beds of stone suitable for these purposes. This lack of indigenous stone useful for decorative carving is reflected in the composition of the suite of carved stone fragments that have been studied as part of this Corpus project. By far the majority of the stones examined consist of lithologies (primarily sandstones and limestones) sourced from outside the county border.

THE GEOLOGY OF NOTTINGHAMSHIRE

Nottinghamshire has a relatively simple geological succession comprising a sequence of eastwards-dipping sedimentary rock units whose outcrops extend from north to south across the county (see Fig. 3 and Table 1). The geologically oldest beds are of Upper Palaeozoic age and crop out in a narrow strip along its south-western border. They comprise the lithologically varied coal-bearing sandstone and mudstone successions of the Pennine Coal Measures Group (Upper Carboniferous) and form part of the Derbyshire-Nottinghamshire Coalfield. These beds are overlain to the east by a thin, variegated sequence of orange-brown to pale yellow-coloured, dolomitic (or magnesian) limestones, and soft red-brown clays and sandstones of Permian age. Together these geological units form the higher ground that characterises the county's western border extending from the sandstone cliffs of Nottingham Castle in the south to Gringley on the Hill in the north.

Continuing eastwards across the county the Permian succession is succeeded by a thick Triassic and early Jurassic (Mesozoic) sequence which underlies the remainder of the county. Typically in Nottinghamshire the Triassic comprises a thick succession of non-marine, green-grey to reddish brown sandstones, siltstones and mudstones, the latter including thinly interbedded, grey-green, dolomitic, very fine grained sandstones (known locally as skerry). In contrast, the early Jurassic marine succession is only sporadically exposed along the northern edge of the low-lying Vale of Belvoir and comprises a succession of grey limestones and mudstones (Lias Group). The eastern part of the county is locally blanketed by extensive tracts of glacial and alluvial sediments (unconsolidated sands, gravels, clays and muds) of Quaternary age.

CARBONIFEROUS

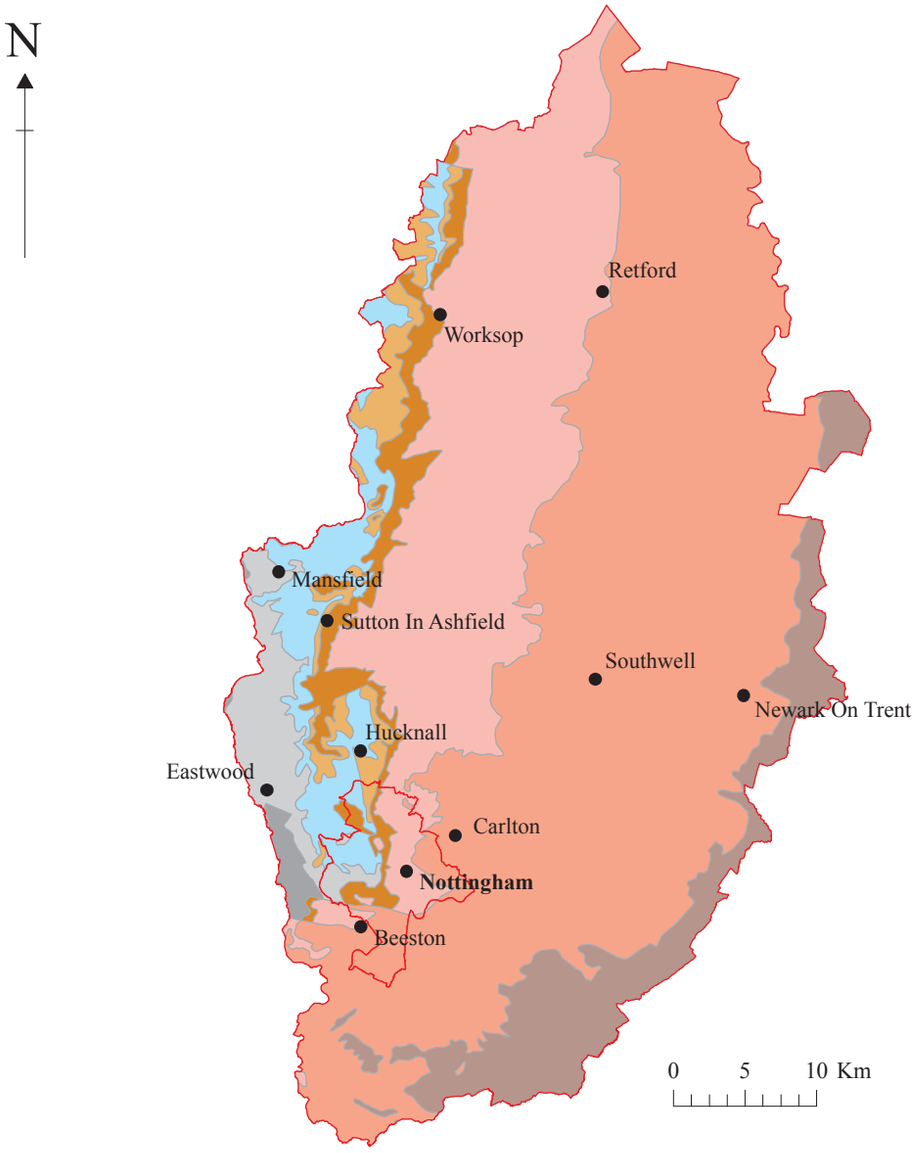
Pennine Coal Measures Group

The Carboniferous rocks that crop out in the west of the county form part of the Pennine Coal Measures Group. This succession is best known economically for its coal reserves but also contains a number of relatively thinly bedded, hard, fine-grained, quartzose sandstone beds, some of which have been quarried extensively for local building stone around, for example, Eastwood, Kimberley and Trowell. However, in general these sandstones are not suitable for carved stonework and have not been identified in the Corpus stones of the Nottinghamshire area.

PERMIAN

Zechstein Group

The overlying Permian succession in the western part of the county can be subdivided into a lower unit of dolomitic limestone (the Cadeby Formation) and an upper interval in which red clays (often termed marls) and sandstones dominate (the Edlington Formation). The Cadeby Formation, formerly known as the Lower Magnesian Limestone, is the source of Nottinghamshire's best-known building and decorative



Nottinghamshire Bedrock Geology

Bedrock Geology

- LIAS GROUP - MUDSTONE, SILTSTONE, LIMESTONE AND SANDSTONE
- TRIASSIC ROCKS (UNDIFFERENTIATED) - MUDSTONE, SILTSTONE AND SANDSTONE
- TRIASSIC ROCKS (UNDIFFERENTIATED) - SANDSTONE AND CONGLOMERATE, INTERBEDDED
- PERMIAN ROCKS (UNDIFFERENTIATED) - SANDSTONE AND CONGLOMERATE, INTERBEDDED
- PERMIAN ROCKS (UNDIFFERENTIATED) - MUDSTONE, SILTSTONE AND SANDSTONE
- ZECHSTEIN GROUP - DOLOMITISED LIMESTONE AND DOLOMITE
- PENNINE MIDDLE COAL MEASURES FORMATION AND SOUTH WALES MIDDLE COAL MEASURES FORMATION (UNDIFFERENTIATED)
- PENNINE LOWER COAL MEASURES FORMATION AND SOUTH WALES LOWER COAL MEASURES FORMATION (UNDIFFERENTIATED)

FIGURE 3
Nottinghamshire bedrock geology

TABLE 1
Stratigraphical divisions in Nottinghamshire

Geological Period		*Principal sculptural stone units*	*Rock Type*
Jurassic (Middle)			
Inferior Oolite Group Lincolnshire Limestone Formation	*(not at outcrop in Nottinghamshire)*	*present as imported stones*	*ooidal and bioclastic limestone*
Jurassic (Lower)			
Lias Group		*none*	
Triassic			
Penarth Group			
Mercia Mudstone Group mudstone-dominated (includes 'Skerry Sandstone')		*present*	
Sherwood Sandstone Group (sandstone-dominated)			
Permian			
Zechstein Group	Brotherton Formation (*Upper Magnesian Limestone*)	*none*	*dolomitic limestone*
	Edlington Formation	*none*	
	Cadeby Formation (*Lower Magnesian Limestone*)	*present*	*sandy dolomitic limestone*
	Marl Slate	*none*	
	Basal Permian Sand	*none*	
Carboniferous			
Westphalian			
Pennine Coal Measures Group	Pennine Upper Coal Measures Formation	*none*	
	Pennine Middle Coal Measures Formation	*none*	
	Pennine Lower Coal measures Formation	*none*	
Namurian			
Millstone Grit Group	*(not at outcrop in Nottinghamshire)*	*present as imported stones*	*sandstone, quartzose*

stones. These limestones were quarried extensively in the past for building stone at Bulwell, Linby and in the Mansfield area.

The Bulwell-Linby stones are distinctive, both comprising yellow-brown to orange, coarsely crystalline, sandy, dolomitic limestone lithologies. They form thinly-bedded successions in both these locations, with individual limestone beds averaging 15–20 cm and only rarely reaching thicknesses greater than 30 cm. Both stones were widely used in the past for local construction, particularly in the nineteenth- and early twentieth-century suburban developments of Nottingham. Evidence of the use of Bulwell Stone is widespread, well documented as far back as the sixteenth century by its common occurrence as large grave-stone slabs and in chest tombs of the period.

The very extensive, former quarry sites found around Linby in medieval times supplied stone for Newstead Abbey and are still operational on a small scale today. As with the Bulwell limestone the thinly-bedded nature of these limestones, and their coarsely crystalline character, has meant that they have only occasionally been used as a source of block-stone suitable for carved stonework. However, the evidence provided by the early carved stone panel now built in over the doorway at Papplewick church (p. 131, Ills. 63–7) suggests they could sometimes be used for decorative work.

Further north, around Mansfield the dolomitic limestones of the Cadeby Formation change quite dramatically in character, becoming finer grained and pale yellow and white in colour. At Mansfield the formation includes two relatively thickly-bedded, sandy dolomitic limestone varieties known locally as the Red and White Mansfield Stones. Both were once extensively quarried as freestones, with the 'white' beds being particularly suited for the production of block-stone, which was also well suited for carved stonework. These Mansfield limestones can be distinguished by their very fine-grained quartz sand content, which makes them particularly durable. They were widely used for block-stone and for carved stonework from at least medieval times. The White Mansfield Stone, which was until recently still quarried, provided the intricately carved interior medieval stonework of the Chapter House in Southwell Minster. The Mansfield quarries supplied stone for many prestigious early buildings in Nottinghamshire including Worksop Priory, in the twelfth century, and Welbeck Abbey, also from the twelfth century. The fourteenth-century priory gatehouse at Worksop has a fine collection of carved Mansfield stone figures in its external façade, which have suffered badly from the effects of nineteenth-century pollution. Numerous medieval parish churches in this north-western area of the county have also used these Cadeby Formation limestones for much of their ashlar walling and sometimes for elaborately carved stonework, for example in the twelfth century at Edwinstowe, and Blyth in the later eleventh. The Mansfield quarries continued to supply high-quality stone for ashlar and carved decorative stonework until quite recently. However, despite their obvious local importance and their long history of use, stone from these quarries has not been identified among the Corpus stones examined in Nottinghamshire.

Further north, along the western county border with Derbyshire, quarrying of the Cadeby Formation limestones was also intensive in the past, notably around Steetley. Here the dolomitic limestone lithologies change to almost pure white, fine-grained, ooidal and occasionally peloidal, varieties with no quartz sand content evident. Again the limestones are seen in numerous older local buildings between Mansfield (Mansfield Woodhouse Stone) and Worksop (Steetley Stone). At Carlton-in-Lindrick, the church with an early Norman tower provides testament to the early use of the local pale dolomitic limestones and their evident suitability for building and decorative stonework. A single carved Corpus fragment, reused in the external fabric of its chancel, was examined and was probably also sourced from the local Cadeby Formation succession (p. 94). A group of rather standard 'overlap' grave-covers examined at Blyth, Halloughton and Mattersey Priory also employ this stone type (Appendix A, pp. 199, 202, 203).

The Permian (Cadeby Formation) white dolomitic limestone from quarries in Derbyshire, notably at Creswell, and Roche Abbey and Cadeby in south Yorkshire, appears to have been widely imported and used as building stone and for decorative carved work in medieval buildings in north Nottinghamshire.

TRIASSIC

The Triassic succession in Nottinghamshire is broadly divisible into two parts, a lower interval dominated by red sandstone beds (Sherwood Sandstone Group, formerly the Bunter and Keuper sandstones) and an upper unit of red mudstones with thin dolomite sandstones (skerry) and thick gypsum beds (Mercia Mudstone Group, formerly the Keuper Marl).

Sherwood Sandstone Group

This group succession is divisible into a lower,

friable, pebbly red sandstone interval, locally named the Nottingham Castle Sandstone Formation, and an upper unit of fine, greenish-grey sandstone termed the Tarporley Siltstone Formation (formerly known as the Waterstones). The red sandstones are well exposed in the cliffs below Nottingham Castle but have not generally been worked for building or decorative stone as they are too friable to produce durable blocks. However, their comparatively soft nature was exploited in other ways in the past, notably by the excavation of extensive underground caves for houses and storage areas, particularly beneath the city of Nottingham.

In the south west of the county, sandstones of the Sherwood Sandstone Group crop out in the cliffs along the southern edge of the Trent valley. Here they are predominantly grey-green in colour and fine-grained in character. Quarries in these outcrops provided the large blocks of sandstone used to build numerous medieval church towers and other structures in this part of the county (at Kegworth, Ratcliffe on Soar, Bunny, Sutton Bonington, Keyworth, etc.). However, there is no evidence of their use in the Corpus stone fragments.

The overlying Tarporley Siltstone Formation also provided sandstone widely used for local building all along much of its outcrop, e.g. in churches at Gedling, Ollerton, Bothamsall, Eakring and Kirton (Lamplugh *et al.* 1911; Lott 2001). However, no examples of its use have been identified in the Corpus stonework fragments. At Stapleford the 'mystical' Hemlock Stone is an upstanding, elaborately weathered, baryte-cemented sandstone remnant of the Tarporley Siltstone Formation.

Mercia Mudstone Group

This group, despite being dominantly a red mudstone succession, also includes numerous thin beds of grey-green, dolomite-cemented, very fine sandstone, known locally as skerry. Skerry sandstone 'quarrying' is known to have been extensive in the past around Hockerton, Tuxford, Laxton, Maplebeck and East Markham. Their widespread use in buildings from Roman times onward suggests numerous small skerry pits were worked along their outcrops. The skerry beds thicken and thin across the county, enabling large (thick-bedded) and small (thin-bedded) skerry blocks to be produced. Large skerry blocks are typically seen in the fabric of churches at North and South Muskham, Tuxford and Mapperley. Small skerry sandstones have been used extensively in medieval churches and other buildings in Nottinghamshire, often in herring-bone fashion, as at Oxton, East Bridgford, Flintham, Averham, Thorpe, etc. (Lott 2001). However, only at South Leverton is there any evidence of their use for early carved or decorative work among the Corpus stone fragments (p. 170).

LOWER JURASSIC

Lias Group

The Lias Group succession comprises thinly interbedded grey limestones and mudstones and crops out along the eastern margin of the county. The limestone beds have been widely quarried along their outcrop and used as block-stone in buildings and churches from Willoughby on the Wolds in the south to Newark in the north. However, these finely crystalline limestones are soft and clay-rich and do not provide stone suitable or durable enough for carved stonework and they have not been identified among the Corpus stone fragments.

Higher in the group occur the distinctive dark yellow-brown, ferruginous limestones and sandstones (commonly referred to as ironstones) of the Marlstone Rock Formation. The Marlstone does not crop out within Nottinghamshire but is exposed and was quarried in the Vale of Belvoir to the south. Occasionally these 'ironstones' are used as block-stone in buildings in south-east Nottinghamshire, as at Hickling, Granby and Upper Broughton. However, they are generally soft and can, when exposed in a structure, weather badly. The Marlstone lithologies are not, therefore, well suited for external carved stonework; however, a single carved piece has been identified in the Corpus survey in the internal stonework at Upper Broughton (Broughton Sulney) church in south-east Nottinghamshire (Appendix G, p. 225).

PLEISTOCENE (SUPERFICIAL SEDIMENTS)

Much of the land surface of Nottinghamshire is mantled by a thin covering of Quaternary glacial and alluvial clays, sandstones and gravels. Sporadically during this period coarsely porous, white limestone tufas were also deposited at spring lines in various parts of the Vale of Trent. The development of these calcareous tufas is commonly associated with exposed carbonate cemented skerry bands within the Mercia Mudstone Group. Occasionally tufa blocks are evident in some early external church fabrics, e.g. at Caunton. However, no examples of their use in carved stonework have been identified in Nottinghamshire, nor are they present in the Corpus stone fragments.

IMPORTED STONE

Millstone Grit Group (Namurian, Carboniferous)
The sandstone dominated successions of this group do not crop out within Nottinghamshire, but occur extensively just beyond its western borders in Derbyshire. The Stapleford cross (p. 189, Ills. 125–40) stands within the Pennine Lower Coal Measures Group succession which includes a number of sandstone outcrops. However, the relatively coarse, occasionally granular nature of the siliceous sandstones used in this cross show greater mineralogical and sedimentological affinities to sources in the Millstone Grit Group. Although, in general, it is very difficult to distinguish the major sandstone beds of the Millstone Grit Group one from another, in the absence of any evidence that the stone was transported from further afield, it seems likely that the sandstone used in the cross at Stapleford would have been locally sourced. Possibly sources include the coarse-grained Ashover Grit or Rough Rock sandstones of the Little Eaton or Coxbench-Horsley areas in Derbyshire.

Evidence of the local use of these hard, coarse-grained, siliceous Millstone Grit sandstones in Derbyshire for early carved stone work can be found at Bakewell and Wirksworth churches (CASSS forthcoming). The elaborately carved Anglo-Saxon stones found in these churches are close to extensive outcrops of Ashover Grit, one of the most heavily worked sandstone resources in the Derbyshire area. Millstone Grit sandstone 'quarries' in general are common along the Derwent valley and have long supplied high-quality stone into Nottinghamshire, e.g. for constructing Lenton Priory in the twelfth century. Easy access from the 'quarries' to the River Derwent could have provided an important transport route, bringing roughly dressed sandstone block or the 'finished' carved stones into Nottinghamshire.

At Melbourne to the south west of Nottingham another small inlier of Ashover Grit sandstones is also known to have been extensively worked from earliest times, as is evident from its use in the long-and-short Anglo-Saxon stonework of St Michael's church at nearby Stanton by Bridge in Derbyshire. Transport of the sandstone quarried from these outcrops along the River Trent into Nottinghamshire was also possible (Fig. 4 below).

Lincolnshire Limestone Formation (Bajocian, Middle Jurassic)
The Middle Jurassic Lincolnshire Limestone Formation forms an extensive outcrop to the east of Nottinghamshire, extending from north to south across the counties of Lincolnshire, Rutland, Cambridgeshire and Northamptonshire. The formation is lithologically very variable but is dominated by ooidal and bioclastic limestone beds of variable thickness. The principal quarrying areas for these limestones were around Lincoln, Ancaster and Heydour in the north and Clipsham, Weldon, Ketton and Barnack in the south (Worssam 1999, 17–19). While these limestones most commonly show mixed ooidal and bioclastic lithogies, occasionally beds showing more uniform lithological development occur. Most notably these include the very coarsely bioclastic Barnack Ragstone (Cambridgeshire) and the well sorted ooidal limestones of the Ketton / Stamford (Lincolnshire) area.

In general, the majority of Lincolnshire Limestone stones examined in Nottinghamshire as part of the Corpus survey appear to be of the mixed ooidal and bioclastic type and were probably originally sourced from quarries in the Ancaster area of Lincolnshire (Everson and Stocker 1999, fig. 8). Only one sample of the distinctive Ketton ooid-dominated type was identified during the survey at Averham (p. 93). No examples of the shelly Barnack Rag lithology have been observed in Nottinghamshire: remarkably, the Barnack-style cover at West Leake (p. 205) was produced in a Permian limestone from the Cadeby formation. In part the lack of use of the southern limestones may have been a transportation issue, with the southern sources having to rely on overland transport while the northern sources were able to transport stones using the rivers Trent and Witham.