CHAPTER II

REGIONAL GEOLOGY

by C. Roger Bristow

TOPOGRAPHY

Geographically, the counties of Derbyshire and Staffordshire extend from the high ground (up to 636 m OD at Kinderscout) of the Peak District in the north, down to about 30 m in the Trent Basin in the south east. This topographic range is largely a reflection of the underlying geology with the harder, Carboniferous, rocks forming the higher ground in the north, and the somewhat less well cemented, commonly reddened, Triassic sandstones and softer Mercia Mudstone occupying the lower ground in the south.

In the south, the River Trent, a major transport route, flows dominantly south-eastwards until it is joined by the north-flowing River Tame and the west-flowing River Mease just east of Alrewas and then swings north-eastwards up through Burton where it is joined by the eastward-flowing River Dove, and continues eastwards towards the county boundary where it is joined by the River Derwent. Drainage in the north of the area is dominantly by southward-flowing rivers (Manifold, Dove and Derwent) before turning eastwards to join the River Trent on its way to the North Sea.

METHODOLOGY

With one exception (Lichfield 1), all the carved stones in the present area have been examined, *in situ*, using a hand lens. As the stones could not be 'hammered' to produce a fresh surface, examination depended partly on the vagaries of preservation and location. It means that some stones could not be properly examined—for example those with a heavy lime wash (Alstonefield 4) or a heavy overgrowth of lichen (Aston-on-Trent 1). The above-mentioned lens has an in-built graticule which allows the size(s) of the constituent grains to be determined fairly accurately. The grain-size terminology is based on Wentworth (1922) which distinguishes five sandstone categories: very fine 0.032–0.125 mm, fine 0.125–0.25 mm; medium 0.25–0.5 mm; coarse 0.5–1.0 mm and very coarse 1.0–2.0 mm. The term 'granule' refers to grains between 2 and 4 mm; 'pebbly' refers to clasts/grains > 4.0 mm.

The qualification of the term 'sorting' as used herein does not follow the strict geological definition as no grain-size analysis was undertaken. 'Well sorted' means that most of the grains are of approximately the same size; 'poor' is the opposite, with a wide variation in grain size; 'moderate' falls between the two preceding definitions.

The colours and their numeric reference used to describe the carved stones are taken from the Rock-Color Chart produced by the Geological Society of America, 1963. As many of the stones are outside, or have only recently been brought inside, the surface colour has commonly been modified by air-borne pollutants, or the stones are heavily lichen-encrusted. Consequently, the colour of a sculptured stone can rarely be determined with accuracy unless the stone has been accidentally damaged or scratched.

STONE TYPES USED FOR THE SCULPTURES

The various types of stone used for sculptures are described in stratigraphical order. Geological formations may contain other beds than those of building (or sculptural) stone quality

The carved Anglo-Saxon stones are derived principally from two sources: the Millstone Grit and Sherwood Sandstone. Additionally, there is a calcareous sandstone (Bakewell 31) which is attributed to the Bowland Shale Group, two bioclastic limestones (Bakewell 19 and 20) attributed to the Hopedale

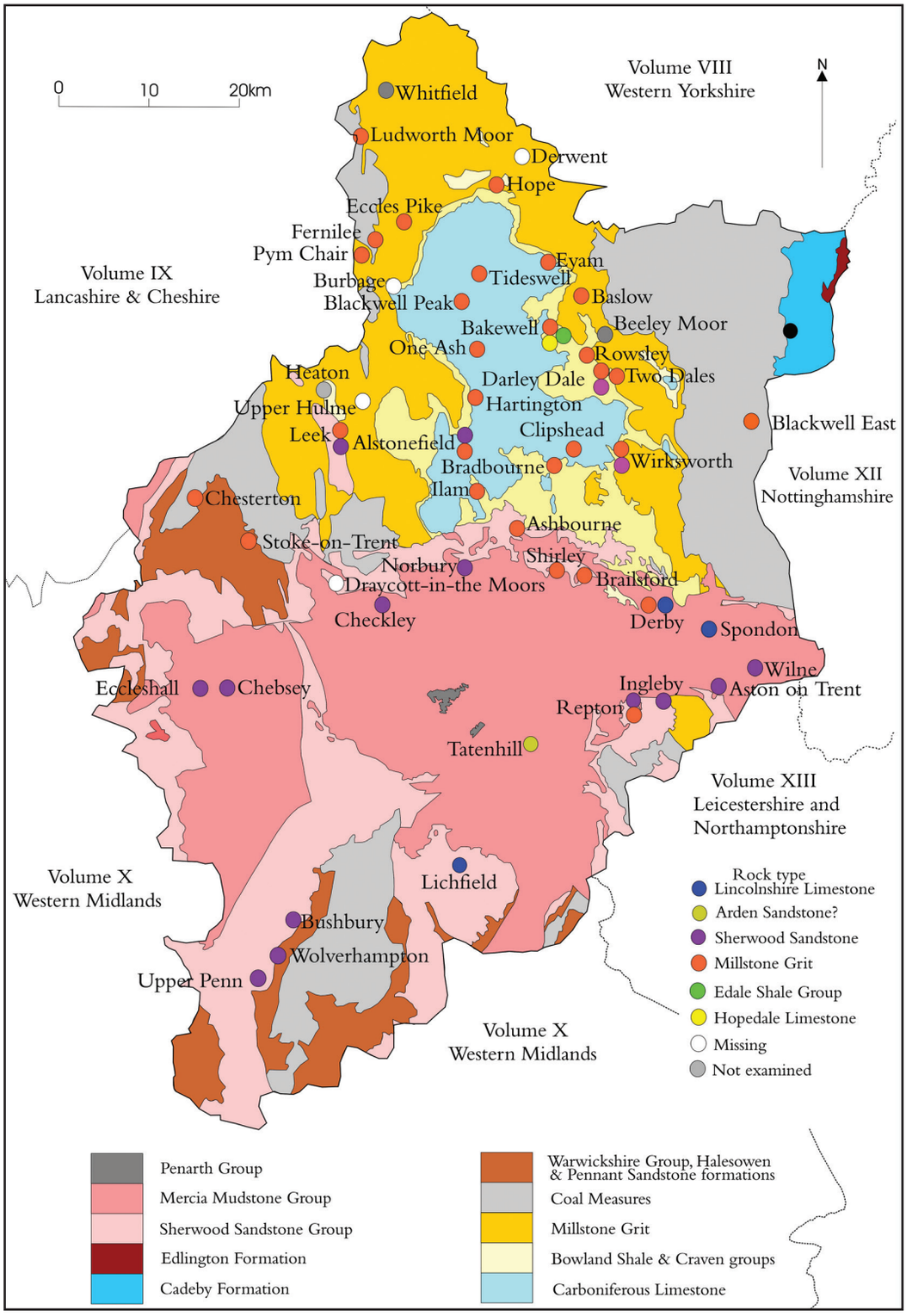

FIGURE 6
The solid geology of Derbyshire and Staffordshire, with the distribution of stone types used for Anglo-Saxon sculptures

Limestone of the Peak Limestone Group, and four oolitic limestones (Derby 3 and 10, Spondon 1 and Lichfield 1) which are from the Jurassic Lincolnshire Limestone Formation.

The majority of the carved Anglo-Saxon stones in Derbyshire and Staffordshire are quartz sandstones of fluvial origin. The constituent sandstone grains are sub-angular to sub-rounded and are mostly medium- or medium- to coarse-grained. Feldspar clasts occur and vary in percentage from almost zero to 20% (Brailsford 1). None of the carved stones sourced from Triassic strata has a significant component of very well-rounded grains typical of the widespread Triassic aeolian sandstones (Wilmslow Sandstone Formation). Except for Bakewell 31, which has a calcareous cement, nearly all the sandstones have a siliceous cement, but a few (Chebsey 1, Checkley 1 and 2) of the Sherwood Sandstone examples also have a barytes cement. As a consequence of their similarity, without stratigraphical data, the identification of the source of a sandstone can be subjective. There are, however, some general characteristics that may help to distinguish the sandstones on a broad scale. At one end of the spectrum there are the deep reds and reddish browns typical of the Triassic sandstones, and at the other end the light grey, yellowish grey, greyish orange and, in places, pink or pale red, Carboniferous sandstones. It is the stones in the intermediate colour ranges (including 'White' (a building stone term for what is generally called buff) Triassic sandstones) that are more problematical. Triassic sandstones are generally not so well cemented (either by silica or barytes), slightly finer grained and slightly better sorted than the Carboniferous stones, but these last two features are not diagnostic.

In this account, unless there is good evidence to the contrary, it is assumed that where a stone sculpture lies close to an outcrop of a similar sandstone, it is that sandstone that is the source.

GEOLOGICAL SUCCESSION

The underlying 'bedrock' geology of Derbyshire and Staffordshire is indicated in Fig. 5. However, the 'solid' strata are in places covered by superficial deposits (glacial deposits, river terrace deposits and alluvium). Glacial deposits consisting dominantly of till or boulder clay, with some spreads of gravel, occur mainly on the interfluves in the western and southern parts of the area. River Terrace Deposits, which provide an important source of gravel, are extensively developed along the rivers Trent, Derwent and Dove. Alluvium, dominantly clayey, is present along all the major river valleys.

The generalised succession of strata in the district range, which range in age from Carboniferous to Triassic, is shown in Table 1. This sets out the relationship between the major chronostratigraphical divisions based on geological age, and lithostratigraphical divisions represented in Derbyshire and Staffordshire.

In recent years, there has been a concerted effort to unify the stratigraphical nomenclature of the British Isles. As a result, many well known local names have disappeared to be replaced by one existing name that now covers a much wider area. For some geological units, where there was no existing appropriate name, a new name has been introduced. This account follows the new terminology, but for continuity, the replaced names are included in parentheses at the first mention.

CARBONIFEROUS LIMESTONE SUPERGROUP

The oldest strata in the present area are those of the Carboniferous Limestone in the core of the Peak District (part of the Derbyshire Dome). Within this area, there are two shallow-water, thickly bedded, generally massive, fossiliferous limestone sequences (on the Derbyshire and Staffordshire platforms), separated by basinal limestones and mudstones of the Widmerpool Gulf.

The Carboniferous Limestone deposits on the Derbyshire Platform (Woo Dale High) encompass a variety of lithologies, including reef limestones, coarse and fine-grained laminated limestones, bioclastic limestones, calcareous mudstones and sandstones. The Peak Limestone Group formed on a ramp on the edge of the shallow water Derbyshire Platform where there was a slope into deeper water. A variety of limestone lithologies formed on the ramp including a heterogeneous succession of mid grey, locally dark grey, fine- to coarse-grained calcarenites, with limestone clasts and coarse crinoid debris common at the base. In the vicinity of knoll-reefs, the coarsely bioclastic Eyam and/or Monsal Dale Limestones formations were laid down. Limestones from these two last formations have been widely used in buildings in Eyam, Bakewell and Ashford. It is thought that the two limestone blocks, Bakewell 19 and 20, in the porch of Bakewell Church, which immediately stand out with their dark grey colour from the rest of the stones which are of Millstone Grit, may be from the Eyam and/or Monsal Dale Limestones formations.

TABLE 1
Generalised vertical section (not to scale) of the geological succession in Derbyshire and Staffordshire; stone used for Anglo-Saxon sculptures coloured

<table>
<tr><th>BEDS</th><th>FORMATION</th><th>GROUP</th><th>SYSTEM</th></tr>
<tr><td></td><td>Westbury</td><td>Penarth</td><td rowspan="8">TRIASSIC</td></tr>
<tr><td></td><td>Blue Anchor</td><td rowspan="4">Mercia Mudstone</td></tr>
<tr><td>Tutbury</td><td>Branscombe Mudstone</td></tr>
<tr><td></td><td>Arden Sandstone</td></tr>
<tr><td></td><td>Sidmouth Mudstone</td></tr>
<tr><td></td><td>Tarporley Siltstone</td><td rowspan="4">Sherwood Sandstone</td></tr>
<tr><td></td><td>Helsby Sandstone</td></tr>
<tr><td></td><td>Wilsmslow Sst</td></tr>
<tr><td></td><td>Chester</td></tr>
<tr><td></td><td>Moira</td><td rowspan="2">Zechstein</td><td rowspan="2">PERMIAN</td></tr>
<tr><td></td><td>Edlington</td></tr>
<tr><td></td><td>Cadeby</td><td rowspan="2">Warwickshire</td><td rowspan="6">CARBONIFEROUS</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Pennine Coal Measures</td></tr>
<tr><td>Rough Rock</td><td>Rossendale</td><td rowspan="5">Millstone Grit</td></tr>
<tr><td>Chatsworth Grit</td><td rowspan="2">Marsden</td></tr>
<tr><td>Ashover Grit</td></tr>
<tr><td>Kinderscout Grit</td><td rowspan="2">Hebden</td></tr>
<tr><td>Shale Grit</td><td>Bowland Shale</td></tr>
<tr><td>Ipstones Edge Sandstones</td><td>Morridge</td><td colspan="2">Craven</td></tr>
<tr><td></td><td>Eyam/Monsal Dale Lmst</td><td>Peak Lmst.</td><td rowspan="2">Carb. Lmst. Supergp.</td></tr>
<tr><td></td><td></td><td>Carboniferous Limestone</td></tr>
</table>

BOWLAND SHALE FORMATION

At the top of the Carboniferous Limestone Supergroup and transitional to, and in part overlapping with, the overlying Millstone Grit Group is the Bowland Shale Formation of the Craven Group (formerly known as the Edale Shale Group). The Group has a relatively narrow outcrop on the west, north and east side of the Derbyshire Dome, and a broader outcrop on the south-west and south-east of the Dome. It consists dominantly of medium and dark grey mudstones with subordinate bands of limestone, ironstone, siliceous sandstone and siltstone, and calcareous siltstone and sandstone. One sandstone, the Ipstones Edge Sandstones, formerly assigned to the Craven Group, is now placed in the Millstone Grit Group. Bakewell 31, a calcareous, moderately sorted, medium-grained sandstone, may be from this Group.

MILLSTONE GRIT GROUP

The Millstone Grit Group has a wide outcrop on the west, north and east side of the Derbyshire Dome. There is a much smaller, isolated, outcrop on the county

border just east of Repton. Despite its name, much of the Millstone Grit is composed of mudstones (see Aitkenhead *et al.* 2002, figs. 16, 17). The intervening siliceous sandstones, where thick enough, are commonly named and can be mapped over long distances. They form large plateau-like surfaces on the interfluves (extensive areas of Kinderscout and Bleaklow moors are underlain by the Kinderscout Grit) and prominent craggy escarpments on the valley sides. However, because of lateral changes in lithology, or where the outcrop is broken by faulting, the continuity of any one unit is not always certain. An additional complication is that the presumed same sandstone has been given different names in different areas (see Aitkenhead *et al.* 2002, table 8, fig. 16). Because of their common, fluvio-deltaic, depositional environment and because of lateral changes along the crop, individual sandstones can rarely be distinguished from one another on lithology alone. There are, however, one or two exceptions where the carved stone source can be determined with reasonable accuracy.

About 59% of the carved stones in the district are derived from the Millstone Grit. All the samples examined (108), consist of clast-supported, quartz sandstones which are generally well cemented with silica cement. Feldspar clasts occur and vary in percentage from almost zero to 20% in Brailsford 1. In the Macclesfield area to the west, the lower sandstones usually have the lowest percentage of feldspar (>2%), whereas the higher sandstones, such as the Chatsworth Grit, have the highest (see Evans *et al.* 1968, fig. 5). Most sandstones are either medium- or medium- to coarse-grained, with a few being fine-grained and some pebbly. Most samples (57%) are poorly sorted, with 29% being moderately sorted and 13% well sorted. The colour of the Millstone Grit varies from olive grey through greyish orange to pale pinkish brown and red. The Ashover Grit used in buildings in the Kirk Ireton and Cromford areas is stained pink by downward percolating groundwater from the former overlying reddened Triassic deposits. The reddened carved stones at Wirksworth (1–4) and Bradbourne (1, 2 and 6) are probably derived from these areas.

The Millstone Grit provides some of the best and most durable building stones in the country and has been, and still is, extensively exploited. Formerly worked for building stone, paving slabs, grindstones and millstones, it is now only the first which is sought. In the High Peak, and along the Derwent and Amber valleys from Hathersage to Belper, all the named major sandstones have been extensively worked. The oldest of the Millstone Grit sandstones, the Kinderscout Grit is only developed north of the Bakewell-Baslow area. Because of its general coarseness, hardness and relatively inaccessibility it was not widely exploited. It has been used as a building stone in Eyam and some of the nearby hamlets. The Ashover Grit, because it is well bedded, fine- to medium-grained and more easily accessible than the Kinderscout Grit, has been widely exploited as a building stone—Chatsworth House, dating from 1698, is built out of Ashover Grit. The Stancliffe Darley Dale Stone, a variant of the Ashover Grit, has been worked for over 200 years; it is particularly famous for its durability and quality and was used in the building of Derby Cathedral (Aitkenhead *et al.* 2002, 154). The Chatsworth Grit, which extends along both sides of the Pennines, overall, tends to be slightly coarser than the Ashover Grit. It was widely used in building the spas and villas of Matlock. The Rough Rock was widely worked between Belper and Coxbench [SK 370435]. Stone from the last area was used for building Kedleston Hall [SK 312402], and extensively for buildings in Derby.

From just east of Repton and extending to Melbourne, a small inlier of Ashover Grit sandstones is 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 Stanton by Bridge [SK 372272] (Lott, in Everson and Stocker 2015, 16). More recently, the Ashover Grit was used to construct the bridge over the River Trent linking Stanton and Swarkestone (K. Ambrose pers. comm., 2015).

As its name implies, the Millstone Grit was much quarried for millstones both for use at home and for export. Some Derbyshire millstones were shipped from Hull to London and Holland. In addition, grindstones, widely used in the Sheffield cutlery industry, were produced until relatively recently from the Chatsworth Grit near Tansley [SK 322595] and from the Rough Rock near Derby (Aitkenhead *et al.* 2002, 155).

PENNINE COAL MEASURES

The Pennine Coal Measures crop out principally in the east of the district (Derbyshire and Nottinghamshire Coalfields). A small portion of the Lancashire-Cheshire Coalfield crops out in the north-west north of Buxton. In the west, north of Stoke on Trent, is found the North Staffordshire Coalfield. In the south, around Wolverhampton, is the Birmingham Coalfield, and in the east, small portions of the Warwickshire, Leicestershire and South Derbyshire coalfields occur.

The Coal Measures consist of a variable sequence of mudstones, siltstones, sandstones, seat earths and coals, with the mudstones and siltstones predominating. Coal forms a very small percentage of the total sequence. The thinly bedded sandstones of the Coal Measures Group are generally, but not always, of finer grain, more feldspathic and are less well cemented than the Millstone Grit, but these are not absolute criteria for separating the sandstones from these two groups. The sandstones have been widely used in colliery company buildings, as well as in the two Hardwick Halls [SK 462637], Renishaw Hall [SK 435786] and Codnor Castle [SK 433499]. However, no sculptured stone within the present area is thought to be from the Coal Measures Group, but they have been used in the adjacent county of Yorkshire (Lott in Coatsworth 2008, 24, 34), and probably in Cheshire and Lancashire (Bristow in Bailey 2010, 15), but not in Nottinghamshire (Lott in Everson and Stocker 2015, 11).

WARWICKSHIRE GROUP

The uppermost Carboniferous strata seen in the North Staffordshire Coalfield and to a lesser extent in the South Staffordshire and Warwickshire coalfields comprise interbedded sandstone, siltstone and mudstones of the Warwickshire Group; thin coals are rare. The lithologies are similar to the underlying Coal Measures, but the colours are dominantly red, brown, purple, yellow and green. No sculptured stone within the present is thought to be from the Warwickshire Group, but they have been used in the West Midlands (Bristow and Freshney, in Bryant 2012, 33–6).

ZECHSTEIN GROUP

The Cadeby Formation (formerly the Lower Magnesium Limestone), some 40 to 60 m thick, has a roughly north–south outcrop on the eastern side of the British Isles from just north of Nottingham to Hartlepool on the Yorkshire coast, and up into County Durham, with about a 16-km long outcrop in north-east Derbyshire. The dolostones or magnesium rich, dolomitic limestones are typically uniformly buff coloured, but generally weather to a cream, off-white or grey. They were widely used, mostly within the outcrop area, particularly in the colliery towns and villages, for ashlar and dressings for brick buildings. Bolsover Castle [SK 470708] was built out of stone quarried from the nearby Bolsover Moor. Stone from the Creswell area [SK 520740] appears to have been widely use as building stone and for decorative carved work in medieval buildings in north Nottinghamshire (Lott in Everson and Stocker 2015, 11, 14). Creswell Crags [SK 535741], a popular tourist destination, are formed from the limestones of the Cadeby Formation. No sculptured stone within the present area is from the Cadeby Formation, but limestone from this formation was quite widely used in the West Riding of Yorkshire (Lott in Coatsworth 2008, 32, 34).

The succeeding Edlington Formation (formerly the Middle Permian Marl) consisting largely of gypsiferous red-brown mudstones, crops out over a very limited area from just south-east of Creswell to just west of Worksop and are not considered further in this account.

SHERWOOD SANDSTONE GROUP

Strata assigned to the Sherwood Sandstone Group crop out only in the southern half of the area, where it forms an irregular, unconformable, fringe to the Carboniferous strata. The Permian Cadeby and Edlington formations are cut out beneath this unconformity in this southern area. The largest outcrops, but with extensive superficial cover in places, are in south Staffordshire. The Sherwood Sandstone Group comprises the Bunter and Lower Keuper sandstones of the old terminology.

The Group is divided into three main formations, but locally a fourth (Moira Formation), consisting typically of a sub-angular conglomerate with locally-derived clasts in a red, sandy mudstone matrix, and locally with buff sandstones interbedded with mudstones, occurs in the East Midlands. As this lithology precludes its use as a building or sculptured stone, it is not considered further in this account.

The lowest sandstone formation in the group is the Chester Formation (= Bunter Pebble Beds) and incorporating the units formerly known as the Chester Pebble Beds Formation, Kidderminster Formation, Polesworth Formation and Nottingham Castle Sandstone Formation. Despite its former name, the Chester Formation is not everywhere pebbly. In the Chester area, about half of the stones examined were pale red or reddish brown, well sorted, fine- to coarse-grained, but dominantly medium-grained (Bristow in Bailey 2010, 16). The one carved sandstone examined in the present area (Upper Penn 1) is a pale red (10R 6/2), poorly sorted, pebbly, clast-supported, quartz sandstone. The Chester Formation is not as well cemented (i.e., is friable) as the younger Helsby Sandstone and consequently, where used as a

building stone, has a poor weathering record (notably Chester Cathedral). However, the more friable nature of these sandstones has been exploited in other ways, such as the excavation of the Hermit's Cave (The Hermitage) [SK 440384] at Darley Dale which is cut into the scarp face of the formation.

Sandstones of the succeeding Wilmslow Sandstone Formation generally are cross bedded, commonly in thin units, contain a high proportion of well-rounded grains of aeolian origin and are not well cemented. Because of their poor cementation and occurrence in relatively thin beds, they have been used neither as building nor carved stones and are not considered further in this account.

The highest unit of the Sherwood Sandstone Group is the Helsby Sandstone (formerly the Keuper Basement Sandstone) and with which the Bromsgrove Sandstone and Hollington Formation are now synonymised (Ambrose *et al.* 2014). The sandstones which are mostly moderate to well sorted, vary from fine- to coarse-grained, but are dominantly medium-grained and well cemented. In north Staffordshire, the sandstones are, in places, pebbly (Chisholm *et al.* 1988). The colour is dominantly pale red or reddish brown, but in places the stone can be yellowish brown, yellowish grey or off-white, or even with a slight greenish tinge. Barytes occurs as patches and as a cement. Although generally not as well cemented as the Millstone Grit, the formation has been widely exploited as a building stone. Many buildings in Ashbourne were built of sandstone from quarries at nearby Mayfield [SK 155 455]. The sandstone quoins of Ilam Church are similar to the stone used for Ilam 1 in containing scattered well rounded pebbles and were presumably sourced locally, but not (as stated by Floyd 2015, 153) from the quarries at Hollington some 13 km south west which are the source of the extensively exploited, pebble free, Hollington Stone (a local unit within the Hollington (now renamed Helsby) Formation). Stone from quarries at Norbury to the south west were used in the church of St Mary and St Barlock and doubtless in earlier times; the carved stones of Norbury 1 and 2 were extracted locally. In the east of the area, sandstone is known to have been dug at Weston Cliff [SK 394 274] for at least 250 years between 1600 and 1860, and was the source of the stone used in St Mary the Virgin church, Weston-on-Trent, and Elvaston Castle. Almost certainly, sandstone from this riverside outcrop was exploited by the Anglo-Saxons and provided the stones at Aston-on-Trent and Wilne. Workings at Repton are documented in the thirteenth century (Thomas 2011), but of course the Helsby Sandstone in this area must have been widely exploited by the Anglo-Saxons prior to that date as a source of stone for all the Repton sculptured stones. Most of these stones are pale yellowish brown (10YR 6/2) or greyish orange (10YR 1/4), moderately sorted and fine- to medium-grained, although there is some slight variation in sorting and grain size. Several Staffordshire churches are also built of Helsby Sandstone, probably mainly sourced from quarries to the east of Burton upon Trent and around Lichfield.

MERCIA MUDSTONE GROUP

The Mercia Mudstone Group (formerly the Keuper Marl), partially covered by superficial deposits, has a wide outcrop in southern Derbyshire and Staffordshire. It is divided into five units in ascending sequence: Tarporley Siltstone Formation (formerly the Keuper Waterstones, and more recently, the Sneinton Formation), Sidmouth Mudstone, Arden Sandstone, Branscombe Mudstone (formerly the Cropwell Bishop Formation) and Blue Anchor Formation.

The Tarporley Siltstone Formation comprises some 20 to 70 m of interlaminated and interbedded reddish brown micaceous siltstones and mudstones, and grey-brown sandstones in approximately equal proportions. The sandstones are mostly very fine- to fine-grained, well sorted, and micaceous. They are typically cemented by ferroan calcite or dolomite. Sandstone beds are commonly less than 0.5 m thick, though composite units may reach over 5m thick. Most beds are tabular and laterally extensive. Locally, the sandstones have been worked for ashlar. Typical examples can be seen near Derby at Mackworth Castle [SK 313378] and Radbourne Hall [SK 286356], built in 1735, and near Ashbourne at Bradley Hall [SK 223460]. However, no sandstone from this formation has been used as a sculptured stone in Derbyshire and Staffordshire.

The succeeding Sidmouth Formation is a unit of dominantly red, less commonly green-grey, mudstones and subordinate siltstones with thick salt deposits in places. Thin beds, nodules and veins of gypsum/anhydrite are widespread. Thin beds of dolomite-cemented, very fine-grained sandstone and siltstone ('skerries') are also present, but generally they are too hard to be cut and dressed, but they have been used as walling and building stones. No stone from this source has been used as an Anglo-Saxon sculptured stone in Derbyshire or Staffordshire, but they have been recorded at one locality, South Leverton, in Nottinghamshire (Lott in Everson and Stocker 2015, 15).

The Arden Sandstone crops out over a limited area on the west side of the River Trent near Burton-on-Trent. It may be the source of the Tatenhill stone.

The succeeding Branscombe Mudstone Formation (formerly the Cropwell Bishop Formation) consisting of between 58 and 68 m of red-brown siltstone with sporadic thin, fine-grained, sandstone beds, was formerly a very important source of gypsum and alabaster (a fine-grained, massive form of gypsum). The Tutbury Gypsum, up to 8m thick, occurs in the middle of the formation. It is currently mined at Fauld near Tutbury in the west, and was formerly mined at Chellaston and Aston-on-Trent near Derby.

The earliest examples of carved alabaster in England came from the Tutbury area. A school for the carving of alabaster developed in Burton upon Trent which specialised in tombs and church monuments, and supplied many parts of Britain and Europe dating back to at least 1462. It died out in the seventeenth century, but plenty of examples remain, such as carvings in Yoxall and Breedon churches (Ambrose *et al*. 2012). They are also found in the carved doorway of the Tutbury Priory Church which dates from the latter half of the twelfth century. Further evidence of early alabaster working hereabouts comes from the monument to John de Hanbury (*c*. 1280–1300) in Hanbury (Edwards 1966; Young 1990). Prior to 1580, many of the Chellaston monuments were supplied to local churches and the main concentration of alabaster monuments is within a 50-km radius of Chellaston (Cooper, A. 1996), but there is no evidence of its use in Anglo-Saxon carvings. Despite its important use for statuary and monuments, the bulk of the gypsum was used for plaster manufacture.

The typical greenish grey siltstones and mudstones of the Blue Anchor Formation, formerly the Tea Green Marl, the highest unit of the Mercia Mudstone Group, only crop out in the west of the area around Newchurch [SK 15 23] and Agardsley Park [SK 13 27]. They have not provided any stone suitable for carving and are not considered further in this account.

PENARTH GROUP

Also in the Newchurch [SK 15 23] and Agardsley Park [SK 13 27] areas, dark grey, fossiliferous, mudstones of the overlying Westbury Formation of the Penarth Group (formerly the Rhaetic) occur. These are the youngest of the 'solid' formations to occur in Derbyshire and Staffordshire and do not provide any stone suitable for carving.

IMPORTED STONES

LINCOLNSHIRE LIMESTONE FORMATION (JURASSIC)

The Middle Jurassic Lincolnshire Limestone forms an extensive, dominantly north-south outcrop in the east of the country. The nearest outcrop to the present area is about 50 km away. The formation is lithologically very variable, but is dominated by oolitic and bioclastic limestone beds of variable thickness.

Stones at Lichfield, Spondon, Derby (3 and 10) and the many carved stones at Breedon-on-the-Hill, Leicestershire, just outside the present area, are all oolitic limestones. The Lichfield stone has been positively identified as Ancaster Stone from the Upper Lincolnshire Limestone Formation (Lott 2007). The Spondon stone closely resembles the Barnack Rag in the former Soke of Peterborough, once part of Northamptonshire. The Barnack Rag is also from the Upper Lincolnshire Limestone Formation. The two Derby stones are similar to each other and are yellowish grey (5Y 7/2), clast-supported, shelly, oolitic limestone. Although they differ in detail from many Barnack Rag stones in that the ooliths stand proud (i.e. have not fallen out to leave an 'aero-chocolate' texture), they are tentatively assigned to this unit.

SOURCING AND TRANSPORTING THE STONES

From Fig. 6 (p. 10) it can be seen that the distribution of the stones used for Anglo-Saxon carvings broadly follows the outcrop of the 'solid' strata from which they are presumed to be derived. This would suggest at first sight that most carved stones have not been transported far from their source rock.

Blackwell 1 and Tideswell 1 and 2, carved from Millstone Grit, sit on the Carboniferous Limestone and have been transported a minimum distance of 8 km over hilly terrain from the nearest Millstone Grit outcrop. Chebsey 1 and Eccleshall 1 and 2 are carved from Sherwood Sandstone, but sit on the Mercia Mudstone, and have been transported a minimum distance of 5 km over clayey ground. However, it is the 'exotics' of Lichfield 1, Derby 3 and 10, and Spondon 1 (and also Breedon-on-the-Hill, Leicestershire) which have clearly been transported over considerable distance. Lichfield 1 lies a minimum of 70km from the nearest outcrop of Lincolnshire Limestone. The River Trent has been a major transport route for centuries, and although the embarkation points are unknown, the Derby pieces could have been brought

up the River Trent and then up the River Derwent to Derby. Similarly, the Lichfield stone would have been brought up the River Trent and then the River Tame to Lichfield. The string of Anglo-Saxon remains along the banks of the River Trent in Derbyshire (Wilne 1, Aston-on-Trent 1, Stanton-by-Bridge church, Ingleby 1 and 2, and all the Repton stones) also attests to its significant role as a transport route

In this account, unless there is good evidence to the contrary, it is assumed that where a stone sculpture lies close to an outcrop of a similar sandstone, it is that sandstone that is the source.

Acknowledgements

The advice of Keith Ambrose and Colin Waters of the British Geological Survey on the geology of Derbyshire and Staffordshire has been of enormous help.

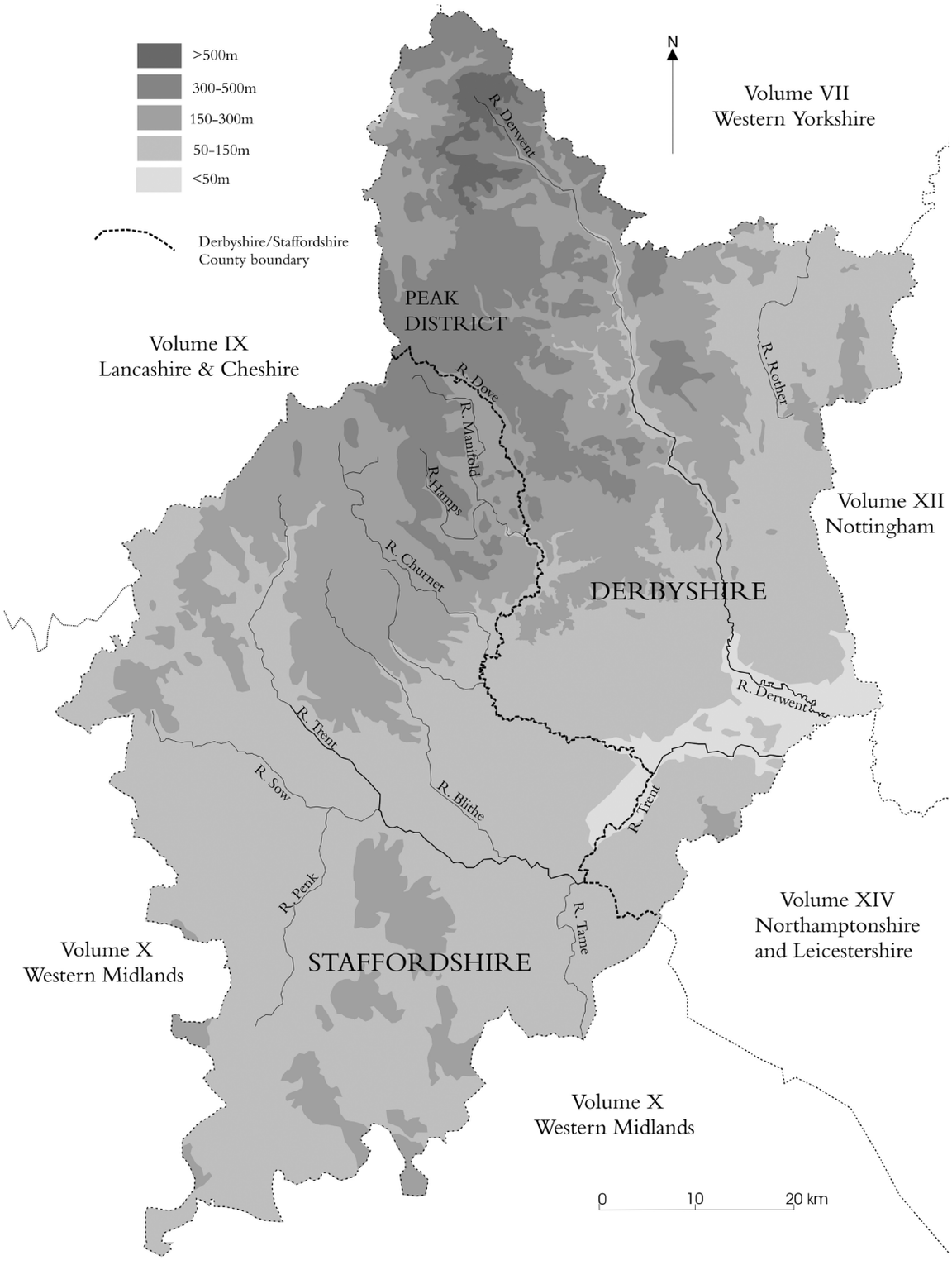

FIGURE 7
The topography of Derbyshire and Staffordshire