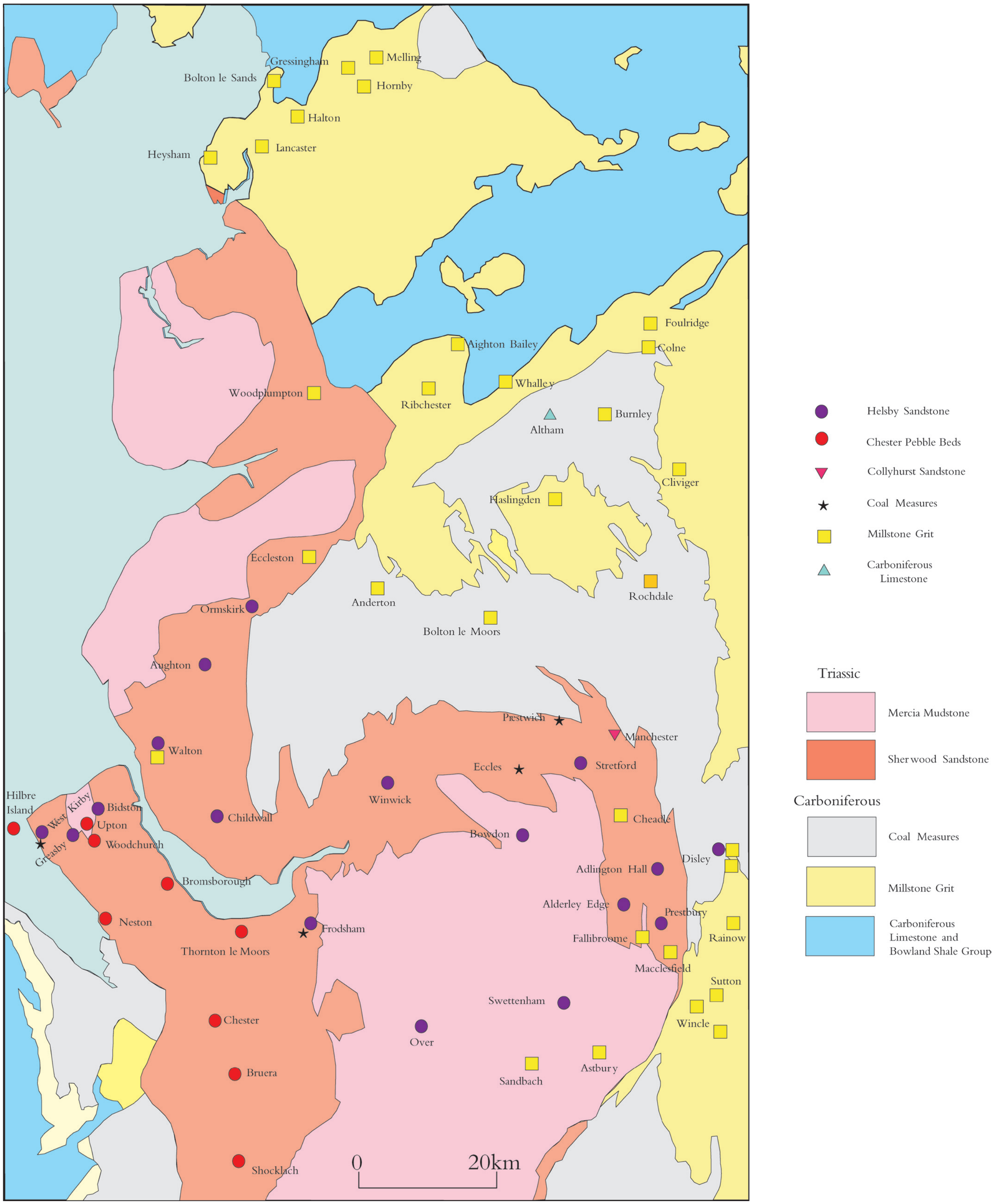

FIGURE 3
Solid geology of Cheshire and Lancashire,
with the distribution of stone types used for Anglo-Saxon sculptures in Cheshire and Lancashire

CHAPTER III
REGIONAL GEOLOGY
by C. Roger Bristow

Geographically, the counties of Lancashire and Cheshire extend from the high ground (up to 560 m OD in the north in the Forest of Bowland) of the Pennines in the east, to sea level in the west. This topographic range is largely a reflection of the underlying geology with the harder, Carboniferous, rocks forming the higher ground in the east, and the somewhat less well cemented, commonly reddened, Triassic sandstones and softer Mercia Mudstone occupying the lower ground in the west. These 'solid' rocks are in turn overlain by extensive, thick, deposits of Quaternary glacial sand and gravel, boulder clay and alluvium and peat.

Drainage of this area is dominantly by northward-flowing rivers in the south into the rivers Dee and Mersey. In the centre, the principal drainage off the Pennines is southwards before these rivers unite to flow westwards into the Mersey. In the north, the flow is predominantly westwards or south-westwards into the rivers Lune and Ribble.

The underlying 'solid' geology of Lancashire and Cheshire is indicated in Fig. 3. However, the 'solid' strata are extensively covered in 'drift' deposits (glacial deposits, alluvium and peat). Fig. 4 shows the distribution of the 'solid' strata where free from a drift cover. However, caution needs to be exercised in interpreting a map of this scale as there are small outcrops of 'solid' strata too small to show, for example in steep-sided valleys or in areas where the drift deposits are thin and patchy (e.g. around Chester).

The generalised succession of strata in the district range, which range in age from Carboniferous to Triassic, is shown in Table 2. This table shows the relationship between chronostratigraphical divisions based on geological age, and lithostratigraphical divisions (as in Fig. 3) represented in Lancashire and Cheshire.

METHODOLOGY

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 (Hilbre 2 and Whalley 9) or a heavy overgrowth of lichen (Wincle Grange 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 0mm.

The carved stones in the present area are all detrital siliciclastic sandstone (i.e. rocks in which more than 50% of the grains are clastic fragments derived from the breakdown of pre-existing siliceous rocks). All have a high percentage (95% or more) of silicate grains, of which translucent quartz is dominant. White, opaque feldspars are present in some samples, but at their maximum occurrence, only form 10% of the grains; white mica (muscovite) is present in small quantities. The grains are held together by naturally occurring cements. With one exception (Altham 1), the cement is always silica; the Altham stone has a calcareous cement (p. 000). As all the sandstones are grain supported (i.e. the constituent grains are in contact), the cement forms only a minor part of the whole rock.

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

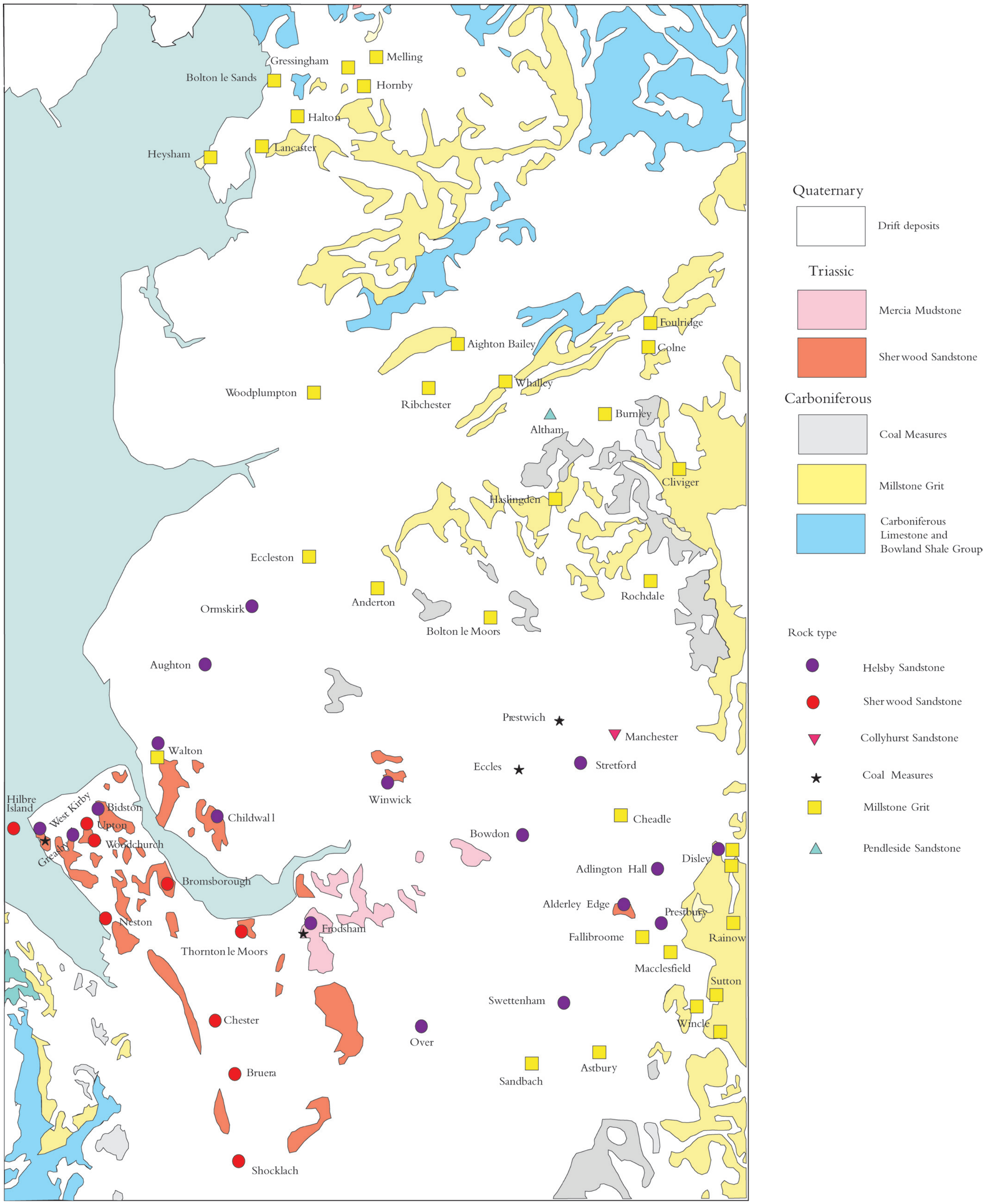

FIGURE 4
Drift geology and distribution
of Anglo-Saxon sculptured stone type used in Cheshire and Lancashire

TABLE 2
Generalized vertical section (not to scale) of the geological succession in Cheshire and Lancashire.
Stone used for Anglo-Saxon sculptures highlighted

MEMBER	FORMATION	GROUP	SYSTEM
Delamere Pebble Bed			
Thurstaston Soft Sandstone	**Helsby Sandstone**		TRIASSIC
Thurstaston Hard Sandstone			PERMIAN
	Wilmslow Sandstone		CARBONIFEROUS
	Chester Pebble Beds	Sherwood Sandstone	
	Kinnerton		
	Manchester		
	Sandstone		
	Marl		
	Collyhurst		
	Sandstone		
See Fig. 7		Coal Measures	
See Fig. 6		Millstone Grit	
Pendleside Sandstone		Bowland Carb. Shale Limst.	

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 rarely can 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; for example, the Chester Pebble Beds Formation can be too pebbly for sculptural or fine stonework.

The carved Anglo-Saxon stones are derived principally from two sources: the Millstone Grit and Sherwood Sandstone. Additionally, there is one stone (Altham 1) which can unequivocally be attributed to the locally developed Pendleside Sandstone of the Bowland Shale Group (not distinguished as a separate unit on Fig. 3); a few are questionably assigned to sandstones in the Coal Measures, and one (Manchester 1) to the Permian Collyhurst Sandstone (not distinguished separately on Fig. 3).

Without exception, all the carved Anglo-Saxon stones in the present district 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. 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. Except for Altham 1, which has a calcareous cement, all the sandstones have a siliceous 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 of the Triassic sandstones, and at the other end the light grey, yellowish grey and greyish orange Carboniferous sandstones. It is the stones in the intermediate colour ranges that are more problematical. Triassic sandstones are generally not so well cemented, slightly finer grained and slightly better sorted than the Carboniferous stones, but these last two features are not diagnostic. This problem is highlighted by the stones at Disley (Lyme Hall) where stone from two different sources appears to be present (p. 000). The stones are all of similar grain size (in the range 0.3 to 1.0 mm, but dominantly between 0.4 and 0.6 mm). The colours of nos. 2 and 3 (it was not possible to determine the colour of no. 1) are respectively pale yellowish brown (10YR 6/2) and yellowish grey (5Y 7/2), whereas no. 4 is pale red (10R 6/2). At outcrop close by is the Milnrow Sandstone of the Lower Coal Measures. This sandstone has a similar grain size to all the Lyme Hall stones, but is greyish orange (10YR 7/4) — i.e. intermediate in colour between nos. 2 and 3, and no. 4. The most obvious difference between the four stones is in the degree of cementation. No. 4 is poorly cemented — such that it has broken into several pieces and is awaiting reconstruction; the freshly exposed surfaces are very friable. In conclusion, the combination of poor cementation and colour (pale red) suggests that no. 4 is a piece of Sherwood Sandstone transported at least 14 km from the south west (Alderley Edge?), whereas the other three stones are most probably Milnrow Sandstone.

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, that it is that sandstone that is the source.

BOWLAND SHALE GROUP, LOWER BOWLAND SHALE FORMATION, PENDLESIDE SANDSTONE MEMBER

The oldest rocks, those of the Carboniferous Limestone Supergroup, crop out south-west of the area in north Wales (not considered further in this account) and in the north-east. Despite the name Carboniferous Limestone, much of the sequence, especially the basinal sequences, can be mudstone — e.g. the Bowland Shale Group (Fig. 5). Additionally, in this northern outcrop, there is a locally developed sandstone unit, the Pendleside Sandstone Member. This sandstone is calcareous and thus differs significantly from the siliceous sandstones of the Sherwood Sandstone Group and Millstone Grit. Only one example of a carved Anglo-Saxon stone, Altham 1 (p. 000), is known from this unit.

FIGURE 5
Generalised stratigraphy of the Carboniferous Limestone and Bowland Shale Group in the Clitheroe area

MILLSTONE GRIT GROUP

The succeeding Millstone Grit has a relative small crop south-west of the area in north Wales (not considered further in this account) and in the east and north-central area of Cheshire and Lancashire where it generally forms the higher ground. Like the Carboniferous Limestone, much of the Millstone Grit is composed of mudstones (Fig. 6). The intervening siliceous sandstones, where thick enough, are commonly named and can be mapped over long distances. 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 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. The many carved stones at Heysham are thought to be from the Ward's Stone Sandstone which underlies the site and into which some of the graves have been carved.

About 67% of the carved stone in the district are derived from the Millstone Grit. All the samples of Millstone Grit examined, both at outcrop (7) and the carved stones (115), consist of clast-supported, quartz sandstones. Feldspar clasts occur and vary in percentage from almost zero to 10%. In the Macclesfield area, 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, 82–93). Most are either medium- (44%) or medium- to coarse-grained (46%), with some (10%) being pebbly. Most samples (75%) are poorly sorted, 10% moderately

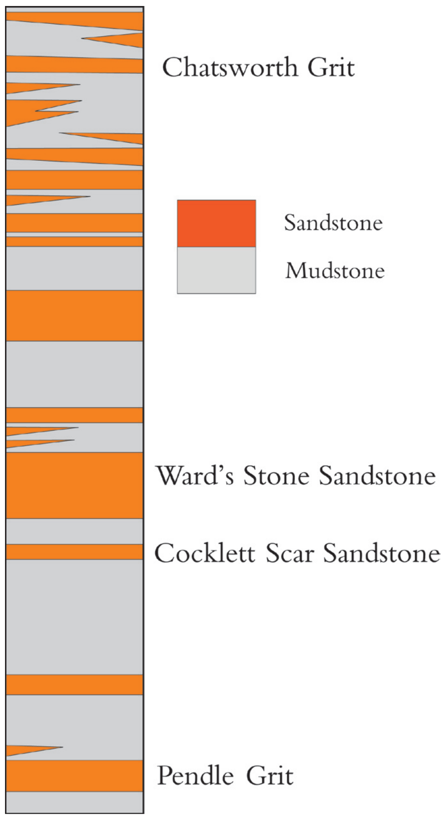

FIGURE 6
Schematic vertical section of the Millstone Grit

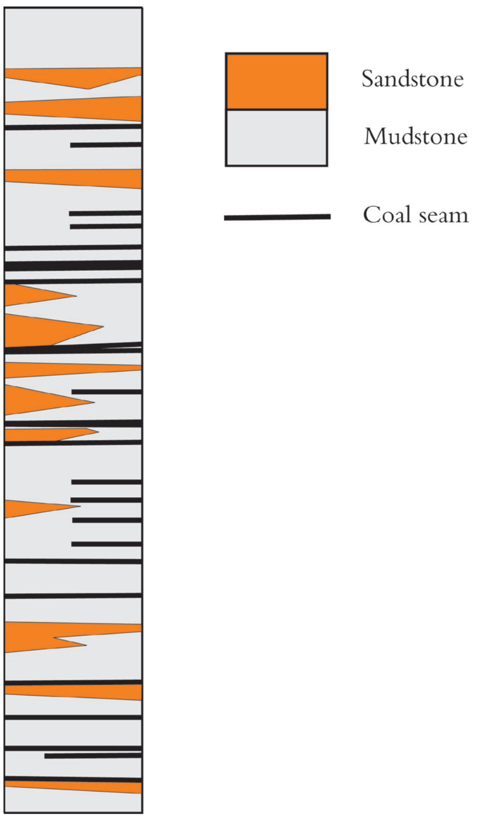

FIGURE 7
Schematic vertical section of the Coal Measures

sorted and 15% well sorted. The Millstone Grit has been extensively worked for building stone, both on a large and small scale, paving slabs and millstones.

COAL MEASURES GROUP

The succeeding Coal Measures Group underlies a roughly triangular area from just north-east of Liverpool in the west, to Burnley in the north-east and Stockport in the south. The Coal Measures consist of a variable sequence of mudstones, siltstone, sandstone, seatearth and coal, with the mudstones and siltstones predominating. Coal forms a very small percentage of the total sequence (Fig. 7). Sandstones of the Coal Measures Group are generally, but not always, of finer grain than the Millstone Grit. Only one outcrop sample from the Lower Coal Measures, the Milnrow Sandstone from Lyme Hall [SJ 965 825], has been examined. This is a poorly sorted, greyish orange (10YR 7/4), medium- (0.3 mm) to coarse-grained (0.9 mm), but mostly in the range 0.4 to 0.6 mm), clast-supported, angular to sub-angular quartz sandstone with a few white (?kaolinised) feldspar grains. Some of the carved stones at Lyme Hall (Disley 1, 2 and 3) are similar to the nearby Milnrow Sandstone at outcrop and are tentatively assigned to this unit. Other, well-sorted, fine- or fine- to medium-grained (within the range 0.1 to 0.4 mm) sandstones (Eccles 1; Prestwich 1) are also tentatively assigned to the Coal Measures, but they could be from the Millstone Grit. The hogback at West Kirby (no. 4) and the slab at Frodsham (no. 2) are two 'exotics' amongst the Wirral stones. The former is thought to be carved from Cefn Stone from the Upper Coal Measures of north Wales (Boswell, in Brownbill 1928, 21, footnote); because of similarity in colour (light olive-grey) and grain size (respectively 0.2–0.3 and 0.1–0.3 mm), Frodsham 2 could also be from this same source.

The red-bed Permo-Triassic strata rest unconformably on the Carboniferous rocks. Permian strata have only a narrow outcrop, mostly beneath drift deposits, in and around Manchester.

COLLYHURST SANDSTONE

Only one unit of Permian age, the Collyhurst Sandstone, is thought to have been used for Anglo-Saxon carved stone. The carved architectural fragment in Manchester Cathedral (Manchester 1, p. 000) matches some of the Collyhurst Sandstone blocks which have been extensively used in the building of Manchester Cathedral, and consist of yellowish brown, well-sorted, medium-grained (dominantly 0.3 mm grain size) quartz sandstone composed of sub-angular to sub-rounded clasts (the Fletcher Bank Grit (Millstone Grit) has also been used in the construction and restoration of the Cathedral (Aitkenhead *et al.* 2002, 153).

SHERWOOD SANDSTONE GROUP

The principal outcrops of the Triassic sandstones of the Sherwood Sandstone Group are in the south, particularly on the Wirral peninsula and south-south-eastwards towards Shocklach. There is, however, a large drift-covered occurrence between Liverpool, Preston and Morecombe Bay.

The Sherwood Sandstone Group comprises four formations (Fig. 8). In ascending order, these are the Kinnerton Sandstone, Chester Pebble Beds, Wilmslow Sandstone and Helsby Sandstone. Only the sandstones of the Chester Pebble Beds (formerly the Bunter Pebble Beds) and Helsby Sandstone (formerly the Keuper Basement Sandstones) formations have been used for Anglo-Saxon carved stones. The Kinnerton Sandstone (not always included in the Sherwood Sandstone Group) and the Wilmslow Sandstone 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. These two formations are not considered further in this account.

SHERWOOD SANDSTONE GROUP,
CHESTER PEBBLE BEDS FORMATION

Despite its name, the Chester Pebble Beds Formation is not everywhere pebbly. The examined carved sandstones are pale red or reddish brown, nearly all (23 out of 25) are medium-grained, but at two out of the four outcrops examined, the sandstones are coarse-grained and/or pebbly. About half the stones are well-sorted, with the remainder being moderately (25%) or poorly (25%) sorted. The Chester Pebble Beds are not as well cemented as the younger Helsby Sandstone (i.e. are friable) and consequently, where used as a building stone, have a poor weathering record. These beds were extensively used in the construction of Chester Cathedral, the stone being derived from quarries between Northgate Street and Windmill Lane. However, because of the poor weathering of the stone, extensive restoration of the Cathedral was necessary during the Victorian period (Strahan 1882). This unit was also widely worked in the Liverpool area, and Liverpool Cathedral is built out of stone from the Chester Pebble Beds.

SHERWOOD SANDSTONE GROUP,
HELSBY SANDSTONE FORMATION

The Helsby Sandstone forms a prominent escarpment south-south-eastwards from Helsby; on the Wirral, the high ground formed by this sandstone is more subdued. The sandstone is dominantly pale red or reddish brown, but in places the stone can be yellowish brown, yellowish grey or off-white. An example of the last is the Storeton stone that has been extensively quarried as a building stone (many of the buildings in Hamilton Square, Birkenhead, are built of this stone). It is also suggested that the Storeton stone was worked both by the Romans and Anglo-Saxons (Hewitt 1920, 416). However, the Storeton stone is best known for its white or pale yellow colour. No such pale coloured stone has been recognised amongst the carved Anglo-Saxon stones. The grain size is dominantly medium (85%), with the remainder being medium- to coarse-grained. Sorting varies from poor (40%), through moderate (34%) to well (26%). Some of the stones, in contrast to those of the Millstone Grit, are not well cemented and can be friable.

SOURCING AND TRANSPORTING THE STONES

From Fig. 3 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. However, as much of this area is covered by extensive drift deposits, particularly the central tract extending south-south-eastwards from Morecambe, inevitably some of the stones used for carvings must have been carried into the area (clear examples are Over (at least 10 km eastwards), Swettenham (at least 20 km) and Sandbach (at least 20 km westwards)). Other examples

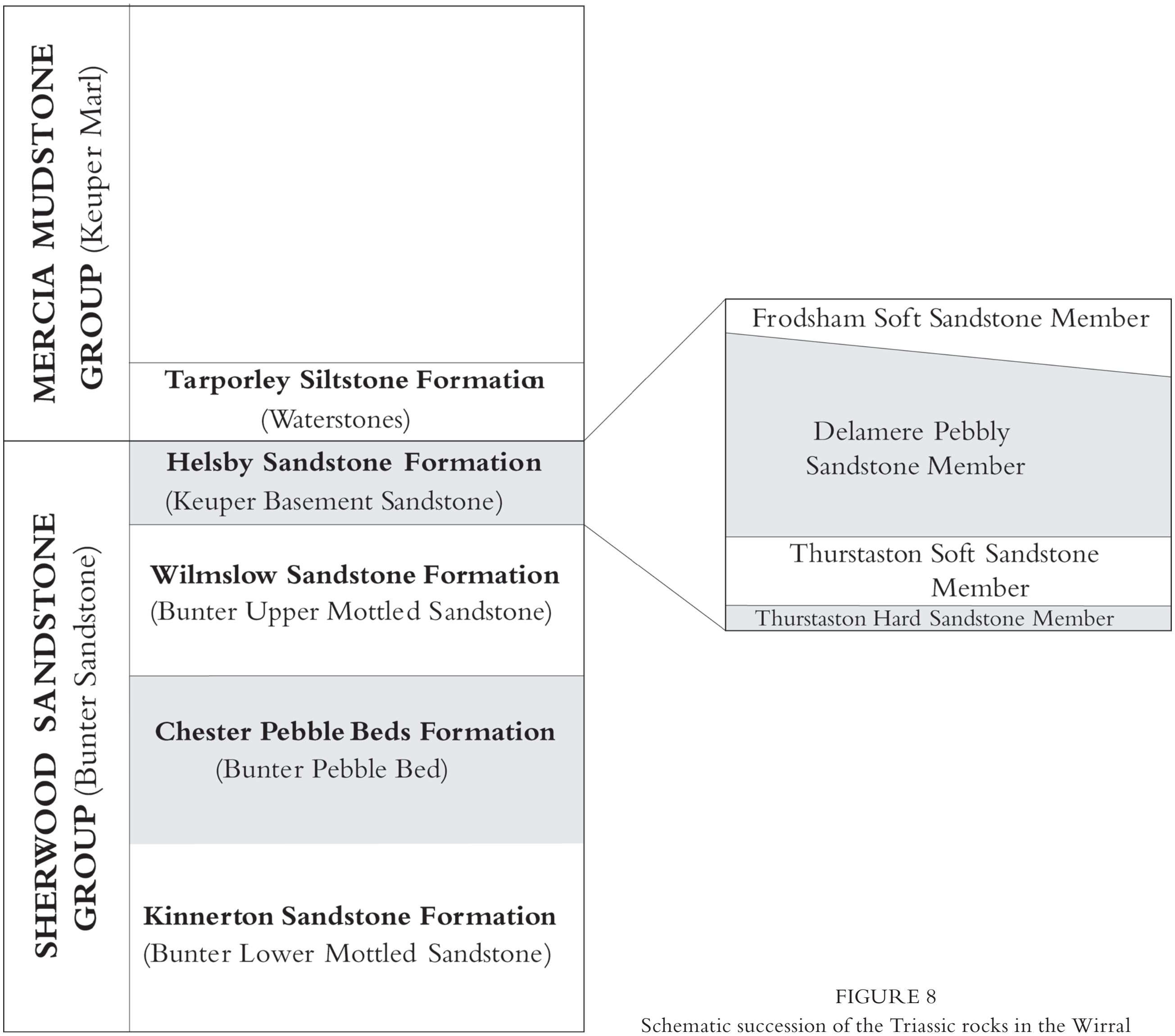

FIGURE 8
Schematic succession of the Triassic rocks in the Wirral

of transportation are the West Kirby 4 hogback (from north Wales), Frodsham 2 (possibly from north Wales or from the north side of the Mersey estuary), Altham 1 (at least 7 km south-south-westwards) and Walton 1 (at least 70 km south-westwards).

Transport of large blocks across the low-lying, poorly drained, heavy clay soils developed on the boulder clay and Mercia Mudstone may well have been by river.

REUSE OF ROMAN STONE FOR ANGLO-SAXON SCULPTURES

Although it is most likely that stone used by the Romans was re-used by the Anglo-Saxons, especially in Chester, there is no unequivocal evidence for this. Strahan (1882) refers to the Chester Pebble Beds being worked by the Romans in Chester. It is also suggested that the Storeton stone was worked by the Romans (Hewitt 1920, 416). However, Storeton stone is generally white or pale yellow colour and has not been recognised amongst the carved Anglo-Saxon stones.