CHAPTER III
REGIONAL GEOLOGY

The area known as the West Riding was an administrative division of the ancient county of Yorkshire and includes parts of the modern administrative areas of West Yorkshire, North Yorkshire, Cumbria and Lancashire. Geographically the area extends from the high ground (>600m) of the Pennines in the north and west into the lowland areas marginal to the Vale of York in the east.

These major topographic subdivisions reflect changes in the underlying geological formations (Fig. 6). The high mountainous spine of the Pennine area that crosses the West Riding from north to south, is underlain by hard, durable rocks ranging from Precambrian to Namurian (Carboniferous) in age. The lower ground to the south-east is underlain by the thick Coal Measure successions exposed in the deeply incised valleys of the Yorkshire Coalfield, extending southwards from Leeds to Sheffield. The whole of the eastern part of the West Riding is underlain by the softer, commonly reddened rocks of the Permian and Triassic successions, which are in turn, in large part, masked by a thick sequence of unconsolidated Quaternary glacial sands, gravels and lacustrine sediments extending into the Vale of York (Aitkenhead *et al.* 2002).

The area is drained by a series of easterly flowing rivers whose valleys also form the principal routeways, from west to east across the West Riding, before joining the Humber estuary.

PRECAMBRIAN SYSTEM

The oldest rocks of the West Riding are Precambrian to Cambrian (or Ordovician) metasediments, comprising a structurally complex succession of slates, coarse grits and conglomerates. They crop out only in the small inliers of Ingleton and Horton-in- Ribblesdale. These metamorphosed rocks are in general hard and durable, but their intractable nature has generally precluded their use for carved stonework. They have not so far been identified in the Anglo-Saxon carved and decorative stones of the survey area.

EARLY PALAEOZOIC (ORDOVICIAN TO DEVONIAN SYSTEMS)

Ordovician rocks outcrop as small inliers east of Howgill Fells and more extensively in the extreme northwest around Sedburgh. Historically they were exploited on a local basis for building stone, flagstones and roofing slates. The Silurian rocks were exploited for flagstones in the Ingleton and Horton-in-Ribblesdale areas and were used locally for grave stones, boundary and milestone markers. The best known of these stones were the Horton Flags which were quarried around Helwith Bridge (from the seventeenth to nineteenth centuries: Mitchell, W. 1985). The massive sandstones of the Austick Grits were also used locally for building. Stones from this succession have not so far been identified in the Anglo-Saxon carved and decorative stones of the survey area.

LATE PALAEOZOIC (CARBONIFEROUS TO PERMIAN)

CARBONIFEROUS

The Carboniferous succession of the West Riding can be divided into the traditional lower and upper divisions termed the *Dinantian* and *Silesian*. These two groups are further subdivided into three principal lithostratigraphic subdivisions — a lower unit dominated by marine, fossiliferous, limestones and mudstones — the *Carboniferous Limestone Group* (Visean and Tournasian Series); a middle unit dominated by thick, non-marine, fluvial sandstones, with subordinate mudstones — the *Millstone Grit Group* (Namurian Series); an upper division also of non-marine sandstone, mudstones, but principally characterised by the presence of thin but economically important coal seams — the *Pennine Coal Measures Group* (Westphalian and Stephanian Series).

Dinantian, Carboniferous Limestone Group (Tournasian and Visean)

The limestones that dominate this unit principally crop out in the north west of the area around Craven and Askrigg. Lithologically the limestones of these two areas show strong contrasts. In the Askrigg area the limestones are characteristically dominated by thickly bedded, coarse grained, fossiliferous limestones. These limestones formed as shallow marine reefs and inter-reef shallow seas on a geologically stable structural platform known as the Askrigg Block. In contrast, to the south of this fault bounded block, in the Craven Basin, the area has undergone considerable subsidence and a thick marine succession of deeper water limestones and mudstones, which includes small mud mounds (or reef knolls) is developed.

Stones from this limestone succession have not so far been identified in the carved sculptural stones of the survey area. They are, however, a common component of the vernacular building material in the area of their outcrop in the southern part of the Yorkshire Dales.

Silesian, Millstone Grit Group (Namurian)

This irregular block and basin topography established in the Dinantian, initially continued into the succeeding Namurian stage. At first the still rapidly subsiding basinal areas continued to be filled with thick sequences of deep-water mudstones with thin turbiditic sandstone incursions. Gradually, however, this localised subsidence slowed and the topography stabilised. In the late Namurian the now shallow basin area was completely infilled with a series of thick, coarse grained, fluvio-deltaic sandstone beds with minor mudstone and siltstone interbeds. The sandstones form the prominent, craggy escarpments that typify much of the Millstone Grit Group succession that crops out from north to south along the central part of the West Riding, extending from Masham Moor in the north to Howden Moor in the south.

The sandstones can range from fine- to very coarse-grained and are generally well cemented by natural silica cement. They contain variable amounts of feldspar grains and mica flakes. The importance of the sandstones from this group in local culture and the areas economy is difficult to understate. The siliceous nature of the sandstones lead to their pre-Roman use as quern or grind stones, as for example at Great 'Whernside' and from medieval times until the early twentieth century they provided a major sources of millstones which were distributed throughout Britain and Europe (Morey and Dunham 1953; Radley 1963–4). There are few towns, villages or rural settlements in the West Riding from any period which do not contain building stone quarried from these sandstones (e.g. Blacker 1995; 1996). Many of these sandstone beds are individually named, but in general when examined in isolation they are extremely difficult to distinguish in hand specimen one from another, because of their similar petrological character. Geologically, each of these sandstone beds form the basal part of a repetitive series of fluvial cycles which typically show an upward transition from coarse, sometimes pebbly, coarsely cross-bedded, channel sandstone into finer grained, laminated sandstones, siltstones and mudstones.

Stones from the sandstone of this succession form one of the principal sources for the Anglo-Saxon carved and decorative stones of the survey area (Fig. 8).

Silesian, Pennine Coal Measure Group (Westphalian and Stephanian)

In the West Riding the Coal Measure succession principally outcrops in the area of the Yorkshire Coalfield, which extends from Leeds in the north to Sheffield in the south, and from Halifax in the west to Castleford in the east at its widest point. Small, isolated, fault bounded outcrops of Coal Measures also occur at Ingleton (Ingleton Coalfield) and around Harrogate and Ripon. Like the Millstone Grit sandstones these sandstones have been exploited both for cultural and commercial reasons since prehistoric times, throughout the area of their outcrop.

The more general basin-wide subsidence that characterised the later part of the Namurian continued into the Westphalian. During the Westphalian, however, the high energy, coarse grained, deltaic sandstones were gradually replaced by sedimentation that characterises quiet-water, lacustrine and swamp settings in which the lush vegetation that was to eventually form the coal seams became widely established. Cyclic sedimentation is again characteristic of the basin fill, with each cycle comprising alternations of sandstones, mudstone and siltstones and completed by a coal seam development.

The working of these sandstones again dates from pre-Roman times, as at Wharncliffe near Sheffield (Wright 1988). Many of the sculptural stones examined within the survey area over the Coal Measures outcrop are likely to have a provenance from sandstone in this succession (Fig. 9).

PERMIAN

Cadeby Formation — formerly the Lower Magnesian Limestone — and Brotherton Formation — formerly the Upper Magnesian Limestone

The Magnesian Limestone (Cadeby Formation) crops out in a narrow band extending from Ripon in the north to Anston in the south. Towards the end of the Carboniferous, a marked change in climatic conditions is evident in the succeeding rock successions of both the Permian and Triassic systems. A major period of tectonic plate movements (the Variscan Orogeny) lead to a complete change in the depositional setting and environments across the area. These movements initiated a transition to more arid desert conditions characterised in the early Permian by the deposition of coarse grained, terrestrial, wadi-fill breccias and yellow sandstones of wind blown origin. The latter formed a series of low sand dunes on a then emergent Carboniferous rocky platform. These basal Permian breccias and sandstones are thin and discontinuous across the area. They are generally poorly cemented and do not provide a viable source of building or sculptural stones.

In the late Permian the depositional setting again changed dramatically, with the rock platform gradually subsiding to be flooded from the east by a highly saline sea. This 'Zechstein Sea' which extended eastwards as far as Poland, was bordered along its western shoreline by a series of carbonate (limestone) shoals and reefs. The reefs are well exposed along the whole of the late Permian outcrop in the West Riding area and form part of the geological unit known as the *Zechstein Group*. Within this group are two limestone units, the *Cadeby (Lower Magnesian Limestone)* and *Brotherton* formations *(Upper Magnesian Limestone)*, which are of particular significance as sources of building and sculptural stone in both the West and East Riding.

Mineralogically the most distinctive aspect of their composition is their magnesium carbonate-rich nature. These rocks can therefore be described as dolomitic limestones, formed by mineralogical changes that have occurred since their original deposition as calcium carbonate limestones. Lithological and petrographical variations within these dolomitic limestones are particularly important. The process of dolomitization (magnesium enrichment) is thought to have occurred some considerable time after deposition, and has resulted in a variety of mineralogical and textural (or diagenetic) changes in the limestones. In some areas the original bioclastic (fossiliferous) or ooidal fabric of the limestones is intact, but in others significant alteration has occurred to form a finely crystalline dolomite in which much of the original bioclastic or oolidal fabric has been replaced. Careful study of samples of the limestones from the area has enabled these transitions to be mapped out in some detail, allowing the provenance of worked or decorative stones from the sequence to be better established (Hart 1988).

Stones from these limestone units locally form a significant proportion of the Anglo-Saxon carved and decorative stones so far examined in the eastern part of the survey area (Fig. 10).

TRIASSIC

Sherwood Sandstone Group — formerly Keuper Sandstone — and Mercia Mudstone Group — formerly Keuper Mudstone

Arid conditions continued into the succeeding Triassic. The 'Zechstein Sea' gradually contracted to be replaced by a depositional basin criss-crossed by heavily sand-laden, fluvial channels. A thick sequence of these fluvial sandstone cycles developed as the basin gradually subsided (Sherwood Sandstone Group). In the latter part of the Triassic this sandstone deposition was replaced by an extensive area of saline playa lakes in which red mudstones were deposited, sometimes with thin evaporitic beds of halite and/or gypsum commonly developed.

Triassic sandstones from the Sherwood Sandstone Group, though generally less durable than those from the Carboniferous sandstones, have been exploited over their outcrop in parts of the Pennine area for building stone but do not occur in the decorative stones examined during this study.

JURASSIC, MIDDLE

Ravenscar Group — Saltwick Formation

One stone sculpture examined was carved from sandstone from outside the West Riding area. This sandstone was probably sourced from the Middle Jurassic Ravenscar Group strata of the North Riding which principally crop out in the North York Moors and Howardian Hills (Hemingway and Knox 1973). These sandstones accumulated in a fluvio-deltaic environment as channel deposits which, locally, have been extensively exploited since the Iron Age for quernstones, building and artefact stone (Briggs 1988; Senior 2001).

Geological Period
Triassic
Permian *(Zechstein Group)*
Carboniferous

TABLE 2
Stratigraphical divisions in western Yorkshire

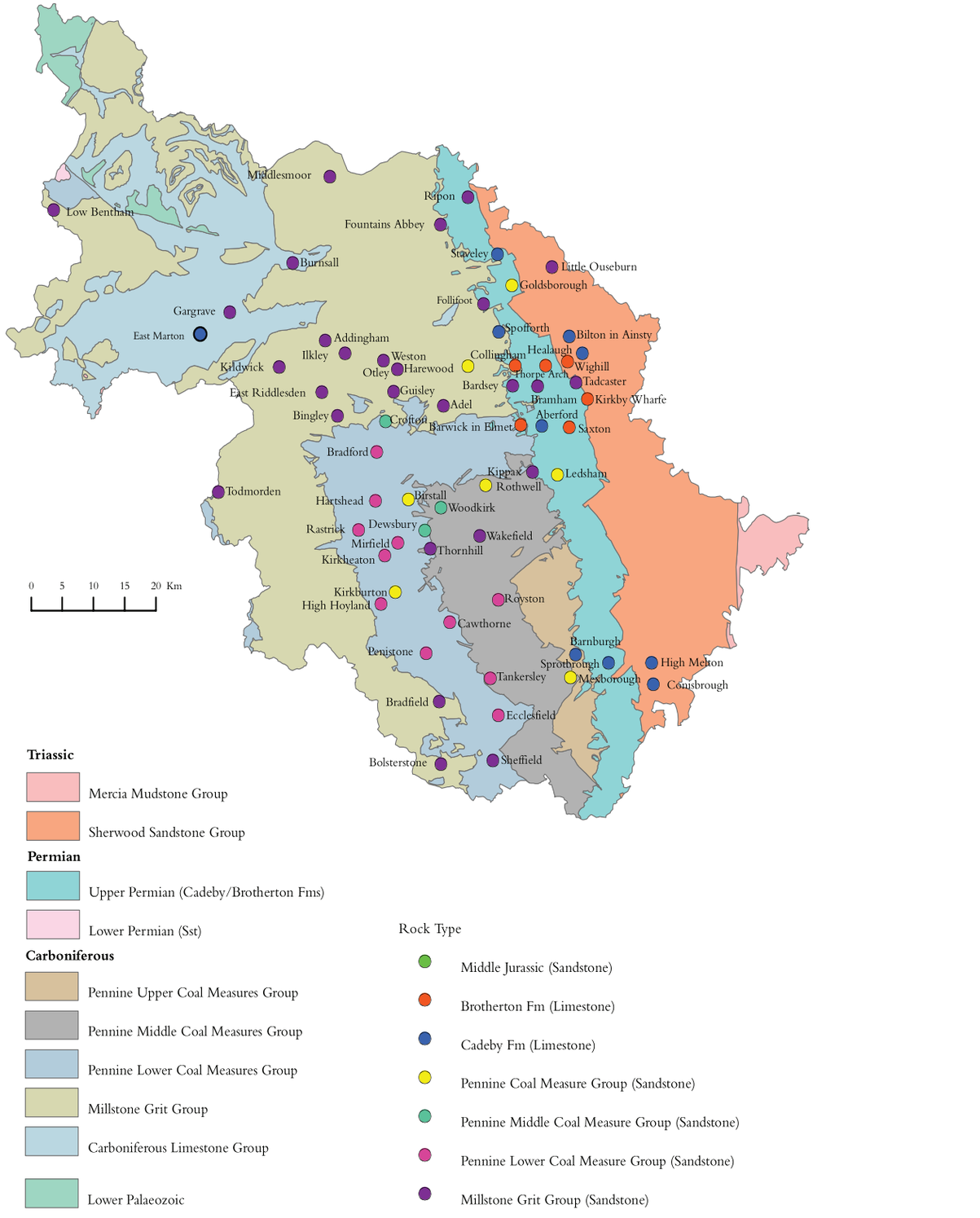

FIGURE 7
The distribution and geology of all sculptural fragments examined in western Yorkshire

STONE TYPES USED FOR THE SCULPTURES (Fig. 7)

The various stone types used for the sculptures are described below in stratigraphical order. Three stone varieties form the principal lithologies used in the Anglian sculptural stones of the West Riding — coarse grained Carboniferous Millstone Grit sandstones, finer grained Coal Measures sandstones and Permian dolomitic limestones. A single sandstone example sourced from the Middle Jurassic succession in the North Riding outside the area is also present.

GRAIN–SIZE

All of the stone samples described were examined by hand lens *in situ* and in hand specimen only. No thin sections were available to carry out a full petrographic analysis. The grain-size descriptions of both the sandstones are based on the standard Wentworth (1922) classification scheme. Sandstones are siliciclastic rocks whose grain-sizes must lie between 0.032 and 2 mm. The scheme distinguishes five sandstone categories — very fine sand < 0.125 mm, fine sand < 0.25 mm, medium sand < 0.5 mm, coarse sand < 1 mm and very coarse sand < 2 mm. Grains from 2–4 mm in size are granules, and grains > 4 mm are pebbles. This grain-size scheme is also applicable to limestone lithologies, e.g. in a coarse grained limestone the carbonate grains or crystals must predominantly lie between 0.5 and 1 mm in size. In general variations in grain-size are rarely sufficient to identify the source of a sandstone or limestone; however, on occasion the presence of quartz pebbles of a certain type can narrow down the search, e.g. some Leeds cross fragments and the East Riddlesden Hall cross-shaft (p. 148) occur near to pebbly sandstone sources in the Bramley Fall area, Rough Rock Formation (Millstone Grit Group), the source of sandstone for medieval Kirkstall Abbey.

SANDSTONE MINERALOGY

The sandstones described in the sculptures are all detrital siliciclastic rocks of Carboniferous age. Mineralogically, siliciclastic rocks are defined as those in which clastic fragments or grains derived from the weathering and breakdown of pre-existing siliceous rocks make up more than 50% of the rock. In the sculptural sandstones silicate grains make up more than 95% of the framework grains: these are dominated by quartz (translucent or white with sub-conchoidal fracture surfaces) with variable amounts of feldspar grains (opaque and variegated with distinct planar cleavage planes). Other grains commonly present include platy micas (muscovite), organic fragments and pervasive small, white patches of the clay mineral kaolinite. These framework grains are bound together by natural cements that in these sandstones are almost exclusively composed of silica (quartz). The presence of such silica cements is evident in some specimens from the sparkling crystal faces exposed at fractured surfaces in the sandstone. Note that identification and estimations of the proportions of these different mineral components, using a hand lens, is generally only feasible in the coarser grain-sizes.

LIMESTONE MINERALOGY

Limestones are defined as those rocks where calcium or magnesium carbonate minerals form more than 50% of the rock. In the sculptural stones the limestones found are all of Permian age and are composed principally of magnesium carbonate and can therefore described as dolomitic limestones. Formed as reefal limestone accumulations, which are thought originally to have been of calcium carbonate, over geological time they have undergone substantial changes to their mineralogical composition and textures by a process known as diagenesis. The limestones now commonly show only remnants of their original bioclastic or ooidal components or may be completely recrystallized, removing any trace of their original depositional components. Such textural variations can occasionally be used to determine the provenance of a limestone.

SEDIMENTARY STRUCTURES

In many of the sandstone sculptural fragments examined, traces of an original sedimentary fabric are evident: most commonly this fabric takes the form of marked layering or lamination in the sandstone. In general such sedimentary features would be avoided and more massive sandstones preferred, as they could form lines of weakness along which failure could occur during dressing and carving of the stone. Where such laminae show a low-angled relationship to the stone surface it is described as cross-bedding, which is characteristic of original deposition of the sand in a high energy, confined, channel. Pronounced cross-bedding is a noticeable feature in some of the sculptural fragments but does not generally appear to produce a weak stone. However, as cross-bedding is ubiquitous in both the sandstones of the Millstone Grit Group and in some coarser Pennine Coal Measures sandstones, which were all deposited in similar fluvial channels, as part of the major Carboniferous river system, it cannot generally be used as a provenance indicator for the quarry source.

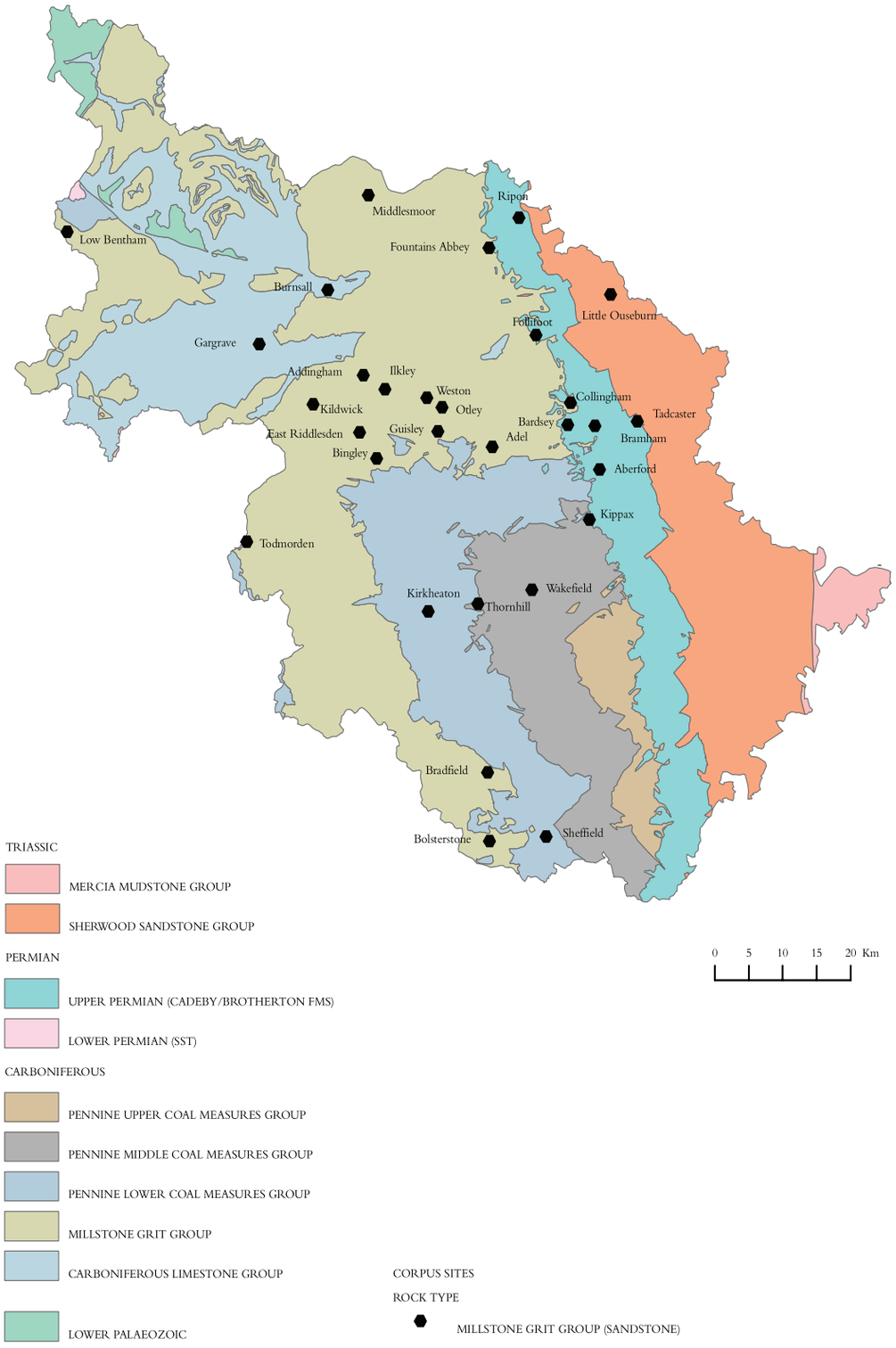

FIGURE 8
The distribution of sculptural fragments of sandstone from the Millstone Grit Group (Upper Carboniferous) succession

In contrast, where lamination occur parallel to the sculpture surface, as in pieces at Ilkley and Harewood, lines of weakness have clearly developed along the laminae (Ills. 329, 363). Parallel lamination of this type, which is also commonly associated with finer grain-sizes and micaceous or carbonaceous concentrations, would suggest quite strongly that a source in the Pennine Coal Measures Group is more likely. In more recent times parallel laminated sandstones from the Pennine Lower Coal Measures (Elland Flags) have been the principal sources of fissile sandstones for roofing or paving purposes throughout the West Riding area.

COLOUR

When freshly quarried, Carboniferous sandstones in the West Riding show a wide range of colours from grey-greens, pale yellows to variegated browns and reds. The colour variations are principally due to changes in the composition and weathering state of the iron minerals dispersed in very small proportions throughout the rock. In stone provenancing these colours could be effectively used to narrow down stone sources. The most immediate problem, however, when examining and describing the sculptural stones is the frequent discoloration of the stone surface by air-borne pollutants. Many of the fragments either still stand or clearly stood outdoors in the past and have been subsequently re-sited indoors. Consequently, it is rarely possible to determine the true colour of many of the stone surfaces examined, unless damage has occurred exposing a clean fractured surface. Only on rare occasions do the sculptural stones show a colour distinctive enough to be helpful in provenancing the quarry source. Locally, in parts of the West Riding, for example, some Carboniferous sandstones show a distinct natural reddened coloration. Examples of such reddened sandstones in sculptural pieces occur at a number of locations, e.g. Follifoot and Ripon, which may be attributable to local sources. However, some care needs to exercised when provenancing all reddened sculptural pieces as it is also clear that a number show some signs of burning which also can produce significant surface reddening in both sandstones and limestones, e.g. Barwick in Elmet (p. 93, limestone), Burnsall (p. 107, sandstone).

UPPER CARBONIFEROUS SOURCES (Figs. 8 and 9)

The stones most widely used in the sculptures of the West Riding are sandstones from the Millstone Grit (Namurian) and Pennine Coal Measures groups (Westphalian). Though broadly similar in character, sandstones from these two groups can only be distinguished petrographically by changes in grain-size, mineralogy, cementation and colour. Over much of the West Riding area the sandstones of the Millstone Grit Group (MGG) generally show coarse, often pebbly grain-size, quartzose compositions and hard siliceous cements. In contrast those from the Pennine Coal Measures Group (PCMB) have generally proved to be finer in grain-size, more feldspathic in composition and less well cemented. However, this is not invariably the case and each sculptural piece must be compared directly with local sandstone varieties before reaching a firm conclusion as to their provenance. More precise provenancing of these sandstones has been achieved in recent years by the use of heavy mineral analysis but requires access to large samples for destructive preparation, clearly a step too far in this project (Hallsworth and Chisholm 2000).

While a broad subdivision of the Carboniferous sandstone sculptural pieces is usually possible into either Millstone Grit or Pennine Coal Measures varieties, it is more difficult to relate the stones to specific local quarries or sandstone beds. Despite the proliferation of good quality sandstone for building and decorative stonework in the West Riding and their widespread use from medieval times onwards, there are few studies on early quarrying activity in the Carboniferous sandstone succession of the West Riding area (Moorhouse 1990). The principal published and unpublished studies relate to provenancing the sandstones used in Roman York which have generally been ascribed to the closest accessible outcrops in the area at Thorner (Roman *Pompocali*) where evidence of early quarrying activity has been documented.

One other feature of possible interest in provenancing the sandstones is the occurrence in some of the eastern outcrops of reddened varieties. The natural reddening is sometimes clearly associated either with their occurrence beneath reddened Permo-Triassic beds, from which the colour is subsequently derived by staining from percolating groundwaters, by contemporaneous deposition in arid, desert-like environments, or may be a consequence of iron pan concentrations within channel sandstone bodies. Alternatively it is also clear that there is evidence that some reddened sandstones may be the result of fire damage, e.g. Otley (p. 215).

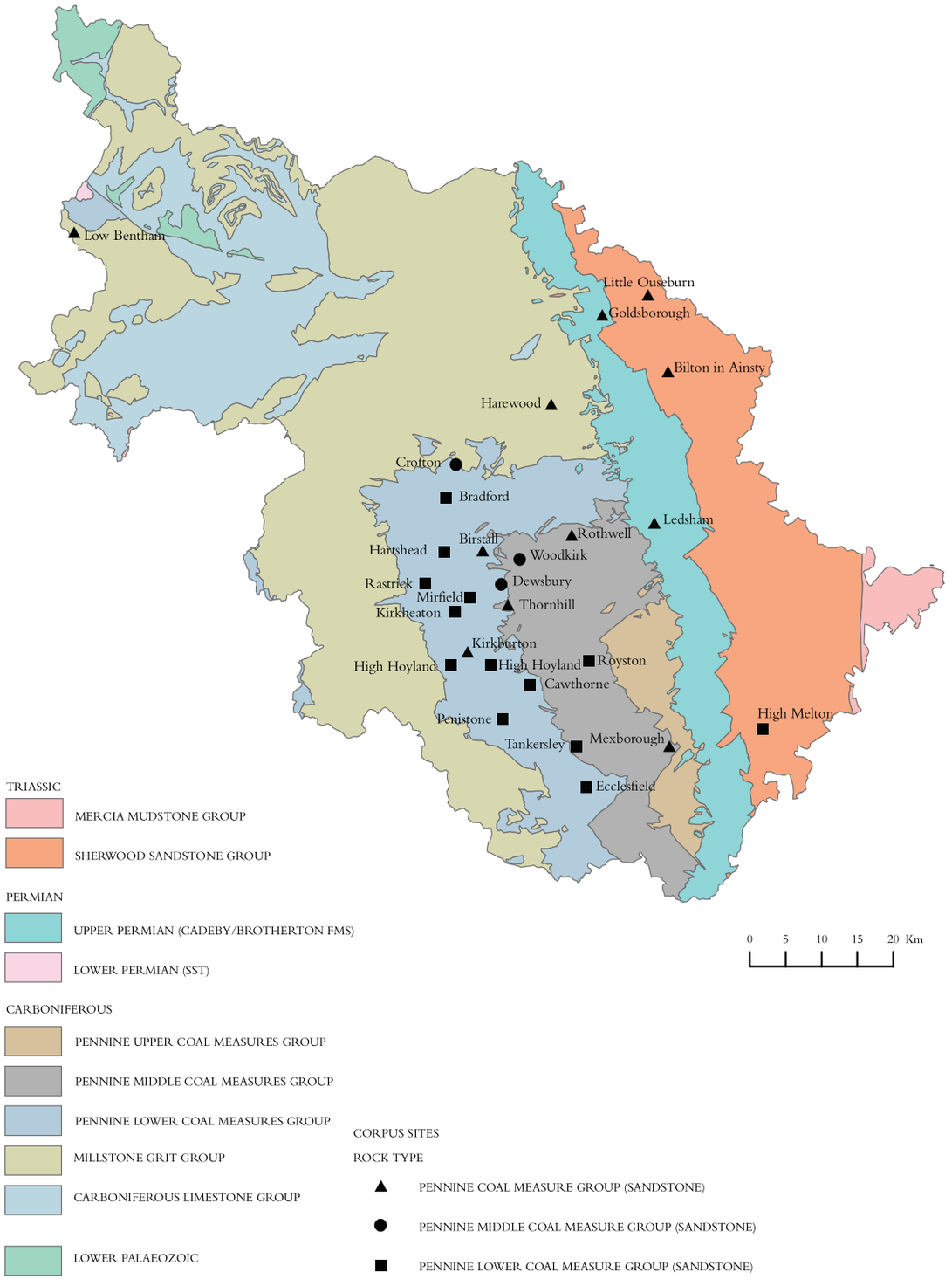

FIGURE 9
The distribution of sculptural fragments of sandstone from the Pennine Coal Measures Group (Upper Carboniferous) succession

PERMIAN DOLOMITIC LIMESTONE SOURCES (Fig. 10)

Those sculptural stones found at sites close to the outcrop of the Permian Cadeby Formation (Lower Magnesian Limestone) along the eastern margin of the West Riding area are most commonly carved from the local limestone. These dolomitic limestones were quarried extensively along the whole length of the outcrop but were particularly important, from Roman times, in the vicinity of Knaresborough–Tadcaster (Roman *Calcaria*) and in the Conisbrough–Doncaster areas. The Permian dolomitic limestones can show considerable textural variations along the outcrop. The stones from both the Tadcaster and Conisbrough areas show a range of distinctive lithologies including bioclastic, ooidal, finely crystalline and porous finely cellular textures, the latter formed by the dissolution and recrystallization of original ooidal framework.

Limestones from the Cadeby Formation were favoured by the Romans when building some of the military and civilian structures in York (*Eboracum*), Aldborough (*Isurium* — Staveley Quarry) and elsewhere. The Cadeby Formation has provided, and still provides, the main building stone for the great cathedrals of York (Jackdaw Crag Quarry, Tadcaster), Beverley (Smawse Quarry, Bramham Moor) and Southwell (Mansfield Woodhouse Quarry, Mansfield). The abbeys at Selby (Park Nook Quarry), Roche (Roche Abbey Quarry) and Welbeck, and the great Norman castle of Conisbrough, are also constructed of locally quarried Magnesian Limestone from the formation.

A second limestone formation recognised in the Permian succession is the overlying Brotherton Formation (formerly the Upper Magnesian Limestone). In general this formation is more thinly bedded in nature than the Cadeby limestones, however, there is a possibility that in some areas the beds have thickened sufficiently to provide a second source of sculptural stone. In general, however, the two limestones may be hard to differentiate in sculptural fragments.

MIDDLE JURASSIC SANDSTONE SOURCES

One sculptural stone found at Ripon (no. 1, now in the Yorkshire Museum), is the only piece that has been transported into the area from further afield. Lithologically this sandstone is consistent with a source in the Saltwick Formation of the North Riding area; however, this formation was quarried widely across its outcrop in the North York Moors, and at this stage it would be imprudent on present geological knowledge to identify a specific quarrying area as the source (Senior 2001).

SOURCING AND TRANSPORTING THE STONES

CARBONIFEROUS SOURCES

The geological succession and topography of much of the West Riding area is dominated by its numerous Carboniferous sandstone outcrops. Sources of durable sandstones for use in building, as tools or for sculptural stonework are locally plentiful in both the Millstone Grit and Coal Measures groups. In general, therefore, the present survey suggests that there is little support for sourcing the stones from a restricted number of sources, but rather that suitable stone could be widely procured from local sources. It seems more likely that the more skilful stone carvers were itinerant workers who plied their trade wherever needed without having to be overly concerned with transporting stones over long distances from specific quarrying areas.

MILLSTONE GRIT GROUP SANDSTONES (Fig. 8)

The sandstones of the Millstone Grit Group form the most durable of the stones available for sculptural work in the West Riding. Their use in many of the sculptural pieces examined shows a wide distribution across the West Riding but is particularly prominent in the area to the north of Wakefield. This is not, however, particularly enlightening as this area is also effectively the principal location of the Millstone Grit Group outcrop.

As might also be expected, there are present day concentrations of sculptural pieces along the main settlement and communications arteries, the Wharfe valley, from Ilkley and Otley to Bardsey and Kirkby Wharfe and, to the south, along the Aire valley from Kildwick in Craven to Leeds, Rothwell and Wakefield. In the areas further to the north there are a smaller number of scattered pieces at Middlesmoor, South Stainley and Ripon, and to the south at Bolsterstone and Sheffield. As yet, however, it is unclear how many of these pieces are *in situ* or could have been redistributed at some earlier period.

The Millstone Grit sandstones of the West Riding occur prominently in the Roman buildings of York, and their possible quarry sources and supply routes have been described in some detail by Buckland (1988) and Gaunt and Buckland (2002). Sources along the eastern margin of the Millstone Grit outcrop have been suggested around Thorner, where the Wharfe eventually emerges onto the Vale of York. It is generally thought that the movement of these sandstones downstream by river carriage is the most likely method of transportation. Conversely it is also likely that transportation upstream

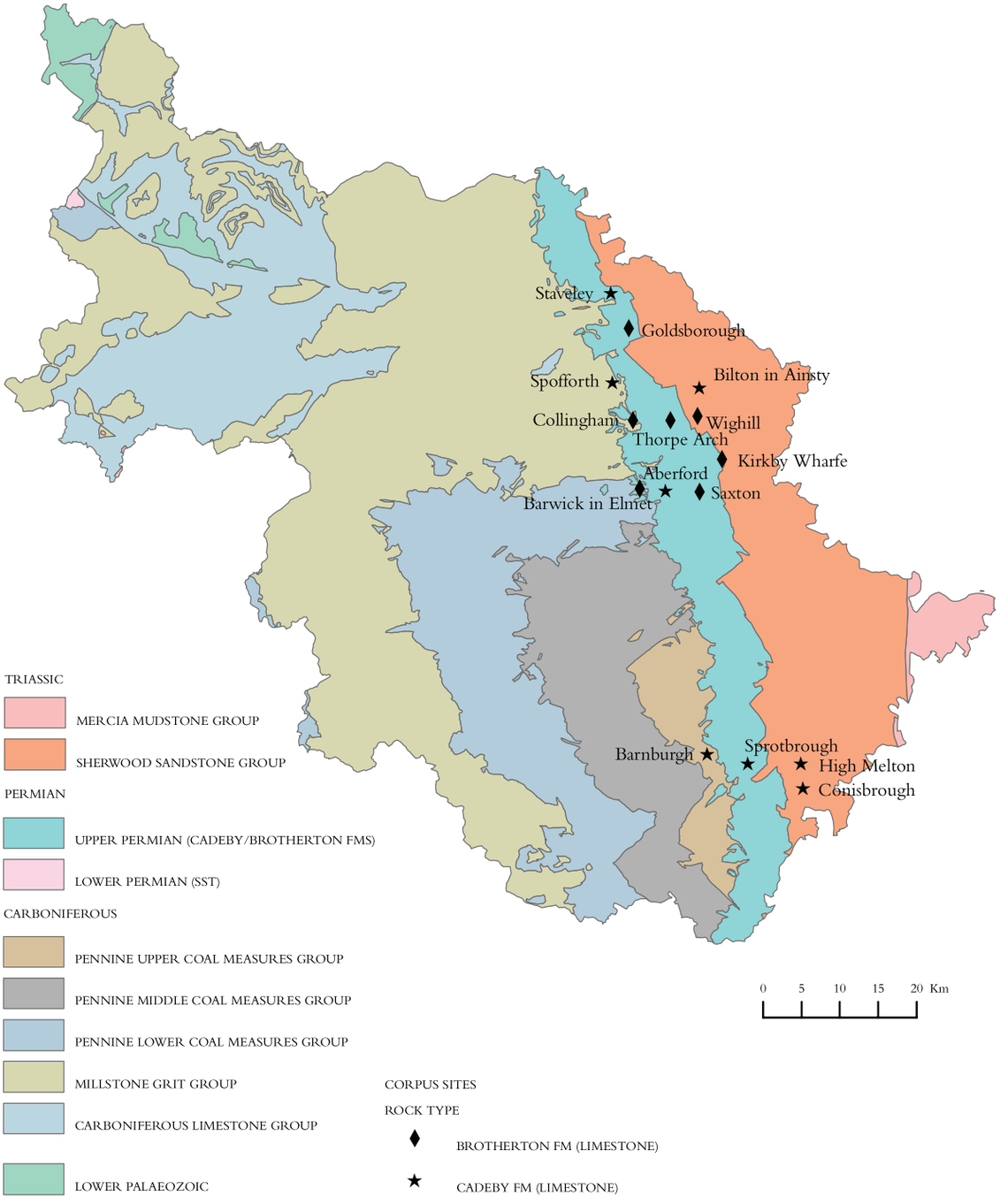

FIGURE 10
The distribution of sculptural fragments of limestone from the Cadeby and Brotherton formations (Upper Permian Zechstein Group) succession

would be logistically more difficult, and other quarry sources higher up the Wharfe and Aire valleys watercourses would probably have been used to supply stone for the Roman sites at Ilkley (*Olicana*) and Elslack (*Olenacum*). By the ninth century therefore it is likely that many of the best sandstone sources in the West Riding would have been exploited and be relatively well known to the local Anglo-Saxon population.

REUSE OF ROMAN STONE IN ANGLIAN SCULPTURE IN THE WEST RIDING

The network of Roman buildings known in the West Riding, many of which contained stone structures, provide evidence not only that good building stone was readily available, but also that a significant stone working industry must have existed in each local area. However, in the East Riding the situation was considerably different as no useful building materials crop out. Consequently, the principal centre of Roman 'occupation' at York (Roman *Eboracum*) had to import all its building materials from surrounding areas. The principal sources of building stone were quarries in the Millstone Grit sandstones and Cadeby Formation limestones of the West Riding (Gaunt and Buckland 2002). Whilst there is a wealth of evidence of the reuse of such Roman stone sources in later buildings in the East Riding (Morris 1988), there is little or no evidence that these stones were returned to the West Riding for subsequent use as building stone, or for recutting for use in its Anglian sculptures.

In the north Lincolnshire–Humberside areas a number of sites have been described where Roman stones have been reused both in buildings and in pre-Conquest crosses (Stocker with Everson 1990; Everson and Stocker 1999). In the best documented instances the reused (and therefore possibly re-cut) stones identified are Carboniferous Millstone Grit sandstones, believed to have been transported from York (*Eboracum*) (Gaunt and Buckland 2002; Senior 2001). In the West Riding no specific examples of reused Roman stones in Anglo-Saxon sculptures have so far been confirmed. This may be because many of the West Riding sculptural pieces are of a fragmentary nature and difficult to re-assemble with confidence. However, it is also perhaps because overland transportation of large stones westwards from York would have been a major logistical problem, whereas the river transportation from York gave easier access via the Ouse to the Humber–Trent navigations and their southern hinterlands.

PENNINE COAL MEASURE GROUP SANDSTONES (Fig. 9)

The finer grained sandstones of this group are recognisable in many of the Anglian sculptural stone fragments of the West Riding. Though generally less durable in character than the Millstone Grit sandstones they were commonly selected and used for the sculptural pieces found in locations throughout their outcrop area (Cawthorne, Dewsbury, Penistone etc.). Unlike the Millstone Grit sandstones, however, they rarely appear to have been transported far beyond their immediate outcrop. Where river access and a major 'market', i.e. Roman York, was available, the nature of the stones made them more sought after as flagstones rather than for decorative carved work in earlier times (Buckland 1988).

PERMIAN — CADEBY AND BROTHERTON FORMATIONS (MAGNESIAN LIMESTONES) (Fig. 10)

Unlike the Millstone Grit sandstones the sculptural limestones pieces of the Permian show a much more restricted distribution in the West Riding. There are effectively two principal concentrations, the first along the Wharfe around Collingham and Tadcaster, the second around Mexborough and Conisbrough in the south of the area. The limestones of these two principal areas show some contrasting petrographic features which suggest that in each area local quarries were used to provide the stone for sculptural work.

In the Collingham and Tadcaster sculptural limestone fragments, the limestone shows the typical finely crystalline and cellular (finely ooidal or peloidal) structure common to all the Cadeby limestones of this area. The limestone sculptural pieces of the Mexborough and Conisbrough area, which show similar cellular textures, show very few petrographic differences. Consequently, it appears that there would be little need to transport the stones far from their original quarry sources. Both areas contain suitable stones and have remained important limestone sources to the present day.