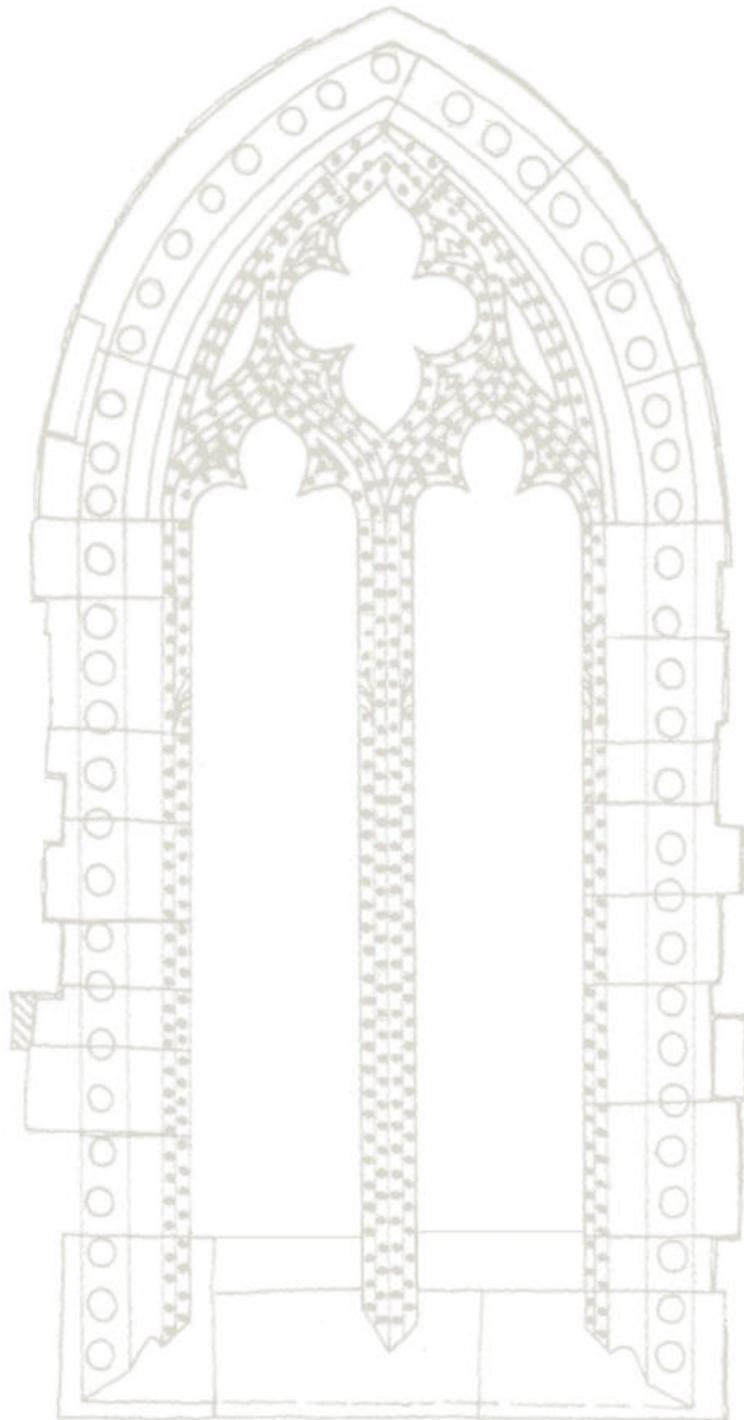


Archaeological Recording at the South-East End of
Gloucester Cathedral



ARCHAEOLOGICAL RECORDING
AT THE SOUTH EAST END
OF GLOUCESTER CATHEDRAL, 2000

**A study of the elevations of the south ambulatory and
adjacent chapels**

Steve Bagshaw

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Edited by Carolyn Heighway, Consultant Archaeologist to the Cathedral

Produced by Past Historic,

6 Church Street, King's Stanley,

Gloucestershire GL10 3HW

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Introduction

A programme of archaeological recording was undertaken during July and August 2000 whilst the south side of the eastern arm of the building was under scaffolding. The area surveyed consisted of the exterior masonry of the west wall of the south transept, the south-east chapel of the transept, the south wall of the ambulatory/tribune gallery, the south east radiating chapel, to the junction with the Lady Chapel.

The principal aims of the recording, as specified by Carolyn Heighway, Cathedral Archaeologist, were:

1. To identify the surviving Romanesque fabric, excluding 19th and 20th century repairs, in order to discern the appearance of the 11th-century south transept east chapel.
2. To assign a date to the capitals at the top of the principal wall shafts.
3. To assign a date to the blocking of the 11th-century blind arcade at gallery level in bay 5.
4. To identify reused Roman brick and tile and note its distribution in the fabric.
5. To record the masons marks at a scale of 1:1.

These aims originally applied to the south transept east chapel but have been extended to the south ambulatory / tribune and the south-east radiating chapel. A preliminary record has also been made of the petrology and origin of the building stones.

The system of notation used is based upon the thirteen photogrammetric elevation drawings that represent the W wall of the S transept (E1), south transept east chapel (E2-5), the S facing walls of the ambulatory / tribune gallery (E 6-7), the south-east radiating chapel (E8-12) and the junction with the Lady Chapel (E13) (see Figs. 1-4). Windows are numbered in descending order and from left to right on individual elevation drawings, so that, for example, the easternmost crypt level window in the S facing wall of the ambulatory would be E7 / W3.

The Romanesque Fabric

For the majority of the elevations block size and course height are sufficient to determine the junction of the 11th-century masonry with that of the 14th century.

The Romanesque blocks are smaller, rarely attaining a height of 300mm, whereas the 14th-century courses are, with a few exceptions, between 350mm and 500mm. The 11th-century blocks have a mean length of around 300mm whilst those of the 14th century that of approximately 500mm. It is therefore possible to say that for elevations 2, 3, 4, 9, 10, 11 and 12 the boundary between the 11th and 14th-century work lay between the course that includes the capitals at the top of the wall shafts and one course below.

This straight and level junction between masonry of two periods can also be traced across the corresponding bays on the north side of the building, the north-east radiating chapel and tribune gallery. In the south-west wall of this northern chapel, the 11th-century eave course has been preserved. This shows that the 11th-century wall was retained to its original height, minus the eaves, in the 14th-century raising of the gallery walls (Thompson 1977:134).

The junction between the work of these periods deviates from the pattern just described on five of the thirteen elevations; these are discussed sequentially below. Other criteria, such as comparison of mortars, variations in courses, building stone petrology and art historical evidence are used to differentiate between 11th and 14th-century masonry in elevations 5 to 8.

Four types of mortar are readily identifiable:

1. 11th century. This appears to the naked eye a characteristic pinkish brown colour speckled with inclusions of various colours. Under magnification the matrix is a pale brown with a medium, rounded to sub-rounded, quartz sand and a significant fraction of rock fragments up to 6mm in size. A small amount of crushed brick could also be identified in the samples that were examined microscopically. The mortar is poorly consolidated and crumbles easily under a blade.
2. 14th century. The colour is off-white to cream in colour, in places speckled with black inclusions. Flecks of charcoal give the mortar its speckled appearance but the majority of inclusions are oolites and limestone fragments. Where the original surface is intact the mortar remains strong and difficult to break.
3. 19th century. This is medium brown in colour, of a fine sandy texture that is soft and degraded in places. It is identified as 19th century by its association with the Combe Down Oolite / Box Ground stone (Bath stone) repairs in which grey slates are often used as levelling.
4. 19th and 20th century. A cement type mortar - uniformly grey and very hard.

It should be noted that in the areas of masonry of the south transept east chapel that have been raked out by the masons prior to repair it is possible to find evidence of 11th-

century mortar, overlaid by 14th-century mortar, itself obscured by 20th century mortar; some areas have been re-pointed at least twice since they were erected. This extensive re-pointing may be the reason that Ashwell (1985:117) accurately described the 11th and 14th century mortars but confused the dates.

Elevation 5 (Figs.1, 5, 6) contains a two-light ogee reticulated window, with ballflowers, that has been dated to 'between c. 1325-30' (Morris 1985:104), above the upper string course in the left hand bay. The right hand bay contains two bases which are all that remains of an 11th century blind arch, with a continuous roll moulding, as seen, for example, in elevation 3. The question as to the date of the destruction of this arch and the rebuilding of this area of masonry, a sequence that finds an exact parallel in elevation 8, can be initially addressed through observations of the mortars.

Figure 5 shows a detail of the left hand base of the former arch with mortar colour coded. The stone with the base moulding sits on a bed of 11th-century mortar that extends to the top and bottom on the left of the block. This mortar was traced between the stones with the half round wall shafts, immediately to the left of the base, up to the course below the 14th-century capitals; in other words the central wall shaft in elevation 5 survives in its Romanesque form to its original height.

14th century mortar can be seen plastered on the roll moulding of the base and also deep into the joints of the blocks to the right and above the moulding. The stone directly below the base is probably in situ but the other blocks on this level, that would have formed a sill to the arch, are of Bath type Great Oolite and are set in the 19th century mortar with grey slates projecting from the joints.

On the right hand side of the bay the base also survives with a similar configuration of mortars around it. The two courses above the right hand base are set in 11th-century mortar and abut the larger 14th-century blocks to their left. The precise way in which the 14th-century blocks are keyed into the uppermost 11th-century course is obscured by the iron down-pipe that runs up the wall at this point.

Therefore the right hand wall shaft exists in its Romanesque form for four courses above the string. Above this point the shaft is a 14th-century reproduction of the original 11th-century decoration as it is cut from the large 14th-century ashlar that comprise the upper two thirds of the bay (see Fig.6). The willingness of the later medieval masons to reuse and reproduce Romanesque decoration can be seen elsewhere in the cathedral and is particularly evident in the work of the mid 14th century.

The basal four or five courses of the 14th-century blocking in elevation 5 are built reusing the 11th-century blocks that, presumably, previously formed the blocking of the arch.

Quite why the blind arch was removed and the wall rebuilt to such an extent is unclear. The right hand termination of the masonry forms the angle with the east-west wall of the

tribune gallery and it was, perhaps, deemed preferable to rebuild the entire angle and walls adjacent to it. If this is the case then it would also explain the rebuilding of the upper parts of elevation 8, as it similarly forms an angle with the tribune gallery. The courses of large ashlars that run across the outer wall of the tribune gallery can be seen to continue around this angle and into elevation 5, as well as into the rebuild in elevation 8, suggesting that these areas were blocked at the time that the outer walls of the chapels and tribune gallery were raised.

Elevations 6 and 7 (Fig. 2) describe the south wall of the ambulatory / tribune gallery and are considered together. Figure 2 shows that the clear boundary between the work of the 11th and 14th centuries, seen in the two chapels, does not extend across the outer wall of the tribune gallery.

This greater extent of 14th-century rebuilding may be partially due to the windows; the small round headed windows in the south transept east chapel and the south radiating chapel were formed by opening up the 11th-century blind arches and inserting a window with tracery. This entailed no disturbance to the masonry surrounding the arch. The small round headed windows in the tribune gallery are, however, entirely 14th-century with a continuous double wave moulding. These walls were originally decorated with blind arches; these were replaced by the present windows, which would have necessitated the dismantling of the one or two of the 11th-century courses above. It should, however, be noted that the exterior skin of the tribune wall was rebuilt to a far greater degree than the interior wall.

The area of masonry between the windows, above the upper string course, on elevation 6 is assessed as being 11th-century for around nine courses above the string, although this may be overstating the survival of the 11th-century work. Here the wall has been re-pointed, in places, in both the 14th and 20th centuries. Nonetheless 11th-century mortar was seen deep in the joints between blocks of the fifth course above the string, above this point the phasing is less certain, but the relationship of the courses with the window stones suggest that they may be part of the Romanesque work.

The masonry between the round headed windows of elevations 6 and 7 can be dated with a greater degree of confidence. Here the medieval mortar is clearly visible; the limit of the 11th-century masonry has been mapped by the extent of the 11th-century mortar. The result accords well with the character of the masonry. The Romanesque work in the wall shaft survives to a height of at least six courses; possibly seven, but not more, for above this point the stones carrying the shaft are integrated into the 14th-century work.

To the left of the round headed window on elevation 7 only a small area of 11th-century masonry remains. The right hand termination of the wall marks the angle with the westernmost wall of the south east radiating chapel. Here the mortared joints are largely intact making a reliable estimate of the date on the basis of the mortars difficult.

A final point should be made on elevations 6 and 7. Because of the rounded eastern end of the 11th-century church the line of the wall turns by around eight degrees at the junction of these two elevations. Above the first string this junction is marked by a half round wall shaft. Below the string course the wall is plain and it is still possible to see vertical incisions running down each of the stones marking this change of direction. These are marks associated with manufacture, as a fixed point from which to measure the angle and thus ensure a uniform cut on the blocks. The marks would also have been used during construction as fixing marks.

The wall above the upper string in **Elevation 8** (Fig. 2) also contains the bases of a blind arch with the masonry above rebuilt, removing any further traces of the arch, as has been described for elevation 5.

The bases are judged to be in situ. A butted joint rises through the three courses above the left hand base at the point where the roll moulding of the arch has been removed. The masonry to the left of this joint is 11th century while that to the right is 14th century in date. The course above this level is haphazardly keyed into the right hand wall shaft in a manner that suggests that it is later work.

On the right hand side of elevation 8 the wall shaft showed 11th-century mortar to within one course of the capital. The stone immediately below the capital is a 19th-century Bath type replacement. Apart from the blocks carrying the wall shaft moulding little remains of the 11th-century work; the boundary between phases illustrated in figure 2 is fairly certain, there being a possibility that a few in situ blocks remain unrecognised in the bottom three courses.

Why these two blind arches, on elevations 5 and 8, were removed is unclear. There is little to suggest that they were removed in order to produce a metrical rhythm of decoration around the building at this level, and as the arches were, presumably, always blocked then their removal can not be connected with any interior decorative, or liturgical, function.

The rebuilding of the walls at these points may conceivably be the result of the structural alterations being made in the tribune gallery in the 14th century. During the 14th-century remodelling additional flyers were inserted at the interior angles of the south tribune gallery, at the junction with the south transept east gallery chapel and the south-east radiating chapel (McAleer 1986:158), bringing additional thrust down into the walls at these points. It is possible that the exterior walls were rebuilt and consolidated in order to withstand the extra thrust.

Other points on the Romanesque fabric include the dating of the segmental arch head of the lower window in elevation 4 (Fig. 1, W2/E4) as 11th, rather than 14th, century. The arch has the same profile and dimensions and it springs from the same height as the 11th-century segmental arches of the south eastern radiating chapel. But it has been

squeezed into a far narrower space so that the left hand shoulder is formed by the adjacent wall shaft. Four of the thirteen complete voussoirs have 11th-century masons marks on their faces (4/8, 4/9, 4/10, 4/11) as does the masonry abutting the arch head (4/12, 4/13). It is assumed that the window immediately to the north (W2/E5) had a similar arch before the voussoirs were removed and the surrounding masonry cut back in the 14th century.

The 14th-century fabric

The question of the date of the capitals at the top of the wall shafts has been answered, in part, in the previous section; they belong to the mid-14th-century remodelling of the eastern arm of the church. Few of the capitals have escaped replacement or repair. The surviving 14th-century capitals are those on elevation 4, south transept east gallery chapel, and that dividing elevation 6 from 7, south tribune gallery. The remainder are either 19th-century replacements of Bath type Great Oolite, or are of Lower Freestone but have indications that they too have a post-medieval date, such as conspicuously sharp arris or machine marks.

The surviving capitals are integrated into the 14th-century fabric and design. They are carved from the same pale beds of the Lower Freestone, as is the rest of the 14th-century work, and the blocks upon which they are carved extend into the surrounding ashlar wall. On the capital between elevations 3 and 4 there is a 14th-century mason's mark (4/36).

Capitals with a similar plain inverted bell shaped profile appear on top of the wall shafts of the interior of the south transept and choir, as well as in the east window of the south transept; they are dated to the 1330s and 1340s (Welander 1991:167). These capitals on the interior have hexagonal abacus while those around the exterior of the east end are square. The abacus have a wave moulding on their lower moulding. The upper edges of the abacus are all too badly weathered to certain of their precise form but they appear simple and blunt which would not be incompatible with a date of sometime in the 1330s or 1340s at Gloucester (Morris 1979:22).

The similarities in form and detail between the capitals and those found in the south aisle, and in the ballflower window in south transept east gallery chapel, may also be significant. They differ from those under consideration in that the necking is octagonal, as opposed to a simple ring, there is a lower fillet on the abacus and they are encrusted with ballflower. These ballflower capitals may have been used as a design prototype for many of the Perpendicular capitals found in the building.

The archaeological evidence suggests that the raising of the wall from the south transept east gallery chapel to the junction with the Lady Chapel (E2-13) is of a single build, at least from the level of the wall shaft capitals. This is also true for the corresponding masonry on the north side of the eastern arm. This upward extension included the north and south walls of the tribune gallery. This was, presumably, not started until after the

completion of the work in the south transept in 1337 (Hart 1863:46).

However, the extended masonry includes the heads of two ballflower windows dated by Morris (1985:104) to c.1320 (the window in the north radiating chapel), and 1325-30 (the window in the south transept east gallery chapel - E5). This implies that the windows precede, by at least fifteen years, the wall into which they are set. It therefore appears that the ballflower windows were set in their present position significantly later than the date at which they were commissioned, or carved. The windows have been altered. Richard Morris has written, in terms of design, of how the lower tracery arches are omitted in the ballflower window in the north radiating chapel (Morris 1985:104). The same arches were either omitted or removed from the ballflower window in elevation 5. The springing points remain on the medieval jambs of this window and have been reproduced on the 19th-century replacement mullion (see Figs. 6 & 7).

The stone that forms the apex of the arch has a slightly different moulding from the rest of the window (see Figs. 6 & 8). It does not quite fit and is not a later replacement which, again, suggests that the window has a complex history.

Other points connecting the decorative elements around this end of the building include: the mason's mark recorded on a stone bearing the jamb and tracery on the interior of the tribune gallery window (W1/E7) also appears on the large block that has part of the quatrefoil panel in elevation 5 (5/46). All of the tribune gallery windows, north and south, have an unusual combination of wave mouldings (see moulding profiles). The same moulding is found on the exterior of the segmental arch in the gallery window of the south radiating chapel. The voussoirs of this arch are modern replacements but the blocks forming the shoulders of the arch are original and each carry a short section of the distinctive 14th-century moulding.

Roman brick and tile

49 pieces of Roman brick were recorded and are distributed across the elevations in the following frequencies:

E1 – 3	E8 – 4
E2 – 4	E9 – 0
E3 – 0	E10 – 10
E4 – 0	E11 – 2
E5 – 2	E12 – 7
E6 – 9	E13 – 4
E7 – 4	

The greatest number occur in elevations 10 and 12, however this is related to the fact that the plaster in the splays of the crypt level windows of these elevations is crumbling away revealing the brick. If the plaster were to be stripped from the splays of the other

crypt windows it would reveal greater amounts of Roman brick. Brick occurs in similar quantities in the splays of the crypt windows on the north side of the building.

Such use of recycled Roman brick for the turning of arches in Romanesque buildings is a not uncommon, particularly in the south east of the country, although no other examples survive in Gloucestershire.

As to the question of whether the bricks are really Romano-British and not medieval in date, the consensus of opinion is that there is no evidence for the production of brick for building purposes before the second half of the 12th century (Wight 1972:25; Ryan 1997:21). Gloucestershire has no medieval tradition of building in brick.

The brick occurs only in the 11th-century work, with the exception of two pieces in elevation 6 and two in elevation 10. In elevation 6 brick is recorded in the deepened 14th-century splays of the ambulatory windows. However these splays were built reusing 11th-century materials; this is evident from the block sizes and the 11th-century masons marks on them. The brick is therefore also likely to have been released from the wall with the opening up of the splay.

In elevation 10 the two pieces of brick are used as packing at the extrados of the remodelled 14th-century window head. The 11th-century splay, or soffit, of the window survived the insertion of the pointed arch head and it can be seen to include a number of bricks. The brick must have been released from the fabric with the removal of the former round arch head to be reincorporated into the masonry, as packing, with the insertion of the new pointed arch head. Tilestones of Old Red Sandstone, Blue Lias Limestone and Stonesfield Slate (Great Oolite) are used in the same manner as the Roman brick. Such a combination, in this context, is suggestive of a Romano-British origin for the material.

Roman building materials remained available to the builders throughout the 11th-century. Brick appears both in the crypt, ambulatory and in the columns of the nave arcade where it is used to pack the vertical joints, along with Blue Lias and Old Red Sandstone slabs. This reused Roman brick and tile is absent from the westernmost bays of the Romanesque nave arcade possibly suggesting that this source of material had been exhausted during the first half of the 12th century, a situation analogous to that of York Minster (Arnold 1996:9).

Building stone

The building stones were identified with the aid of x10 and x20 hand lens and x60-x100 portable microscope. A small number of samples were taken for laboratory analysis. Identifications have been made to the level of geological formation where possible but time and resources have made it necessary for more general categories to be employed, principally for the 19th- and 20th-century work, so for example Great Oolite from the country around Bath (Combe Down Oolite, Box Ground Stone) is undifferentiated and

termed 'Bathstone'. Similarly some of 19th-century repairs to the south-east radiating chapel are designated as being of Lower Inferior Oolite as a more precise identification is not currently possible.

The various lithologies described and discussed below correspond to those illustrated on the colour coded drawings. The drawings do not describe the entire petrological assemblage as certain lithologies are represented by stones so small they are not visible on a 1:20 scale drawing, these are discussed individually in the text below and illustrated.

11th -century stone

The most commonly occurring building stone in both the 11th and 14th-century masonry is from the **Lower Freestone** Formation of the Lower Inferior Oolite Group. It is, together with other undifferentiated rock types from the Inferior Oolite Group, coded white on the petrological drawings. It is a uniformly oolitic, massive, unfossiliferous rock that, together with its relative softness on extraction, make it particularly suitable for fine detailed carving. The beds are strongly current bedded and very pale having a micritic matrix that tends to be more susceptible to weathering than the ooids, so that under magnification the latter can be seen standing proud of the surface of the rock. It outcrops along the Cotswold scarp in the Dursley area and the beds reach three metres depth at Selsley Common. The beds extend to a depth of around 5m, including the Cleeve Hill Oolite, at Leckhampton (Richardson 1904:88).

Pea Grit has not been identified on earlier surveys of building stone at the cathedral. Large blocks of Pea Grit are found in the lower courses of masonry (coded green on the original petrological drawings: here see Fig 11). The physical and chemical properties of much of the rock quarried from this formation make it particularly resistant to weathering and it has been used as a weather stone in Mid and North Gloucestershire since the twelfth century.

Pea Grit describes a variable series of coarse limestones with pisolithic layers. The type site is the Crickley, Leckhampton and Cleeve Hill section where the rock is known as 'Crickley Oncolite'. In this section the pisoliths are disc-shaped oncoliths ranging from 2-5mm and coated in micrite. The beds are buff, marly and rubbly with numerous bivalves, gastropods and echinoids and have a thickness of 2-5m (Green 1992:113). Crickley Oncolite is very probably the most weather resistant stone from the Cotswolds, as well as being a freestone. It appears in a restricted category of 12th-century contexts being used, for example, for the arcade capitals at the minster church of St. Oswald's, Gloucester, and for a number of fonts of the same date, such as Alstone and Maisemore.

It is possible to be a little more precise about the geographical origin of this stone. When dissolved in Hydrochloric acid the rock yielded a fine sub-rounded quartz fraction, feldspar and a small quantity of Zircons along with other heavy minerals. The greatest quantity of residue consisted of cryptocrystalline silica forming casts of organic structures.

It has been shown that these casts occur in beds of typical Pea Grit in the Stroud to Cleve Hill area (Wethered 1891:560); the quantity of the silica casts in the sampled stones from St. Peter's suggest that the rock originated from the Stroud/Edge areas. During a recent survey of Pea Grit exposures at former quarry sites along the Cotswold escarpment (by Arthur Price & SPB) rocks with the most similar lithology were seen at Cud Hill, near to the site of the abbey's 'Red Quar' (Price 1999:49)

Pea Grit was also used in the construction of Roman Gloucester, the remains of the Romano-British defences, preserved in the basement of the City Museum in Eastgate St, are composed of large blocks of Pea Grit and Lower Freestone. Similarly sized blocks can also be seen in the conserved remains of the Roman and medieval East Gate. It appears to have been, along with stone from the Lower Freestone formation, the major component of the Romano-British defences; a proposition which receives support from Lindsall Richardson's geological observations on the defences as encountered in King's Square (O'Neil 1958:7) and the 19th century reports of the wall, unearthed in Constitution Walk, being of 'heavy Cotswold grit-stone' (in Fullbrook-Leggatt 1947:19).

It is, therefore, probable that the Roman walls were the original source of the Pea Grit found in the lower courses of the 11th-century work, although the stones could have been reused a number of times before being incorporated in the 11th-century fabric.

It is possible to trace the extent of the Romanesque masonry around the south side of the building by following the large blocks of Pea Grit westwards from south transept east chapel. They run around the south transept and into the easternmost bays of the south aisle. Further west, in the south aisle, these large blocks of Pea Grit are scattered about the fabric having been, again, reused in the early 14th-century rebuilding.

In the few places where the original strings remain they are of Pea Grit and so it is this stone, rather than Minchinhampton Weatherstone, that was used as the principal weatherstone in the 11th-century build.

In addition to rocks from the Inferior Oolite Group there are a number of stone types that are used in subordinate positions, such as for levelling and packing joints. The stone types are briefly described and their positions in the fabric listed below.

Brownstones, from the Old Red Sandstone of the Devonian System. They occur in the building in the form of purple-grey, medium grained, well sorted micaceous sandstones. The rock may show a slight reaction to HCL, if not excessively weathered, and all the examples recorded in the Cathedral are either around 50mm to 20mm in thickness, suggesting that they are reused flag or tilestones. The closest outcrop to Gloucester is around 15km to the west in the Mitcheldean / Longhope districts (Green 1992:25) but it seems probable that the quarry was further to the south where the outcrop approaches the River Severn.

Pennant/Coal Measures Sandstone; Carboniferous; seen as a red-grey, medium-

coarse grained, moderately sorted micaceous sandstone. The nearest outcrop to Gloucester is around 20km to the west from the north of the Forest of Dean Coalfield (Trotter 1942:24).

Blue Lias Limestone: Lower Jurassic; a blue-grey, hard, splintery and finely crystalline limestone. The stone could have been quarried around Gloucester, for example at Sandhurst, Maisemore or could have been extracted from pits in the Lias Clay that forms the floor of much of the Severn Vale (Green 1992:98).

: Great Oolite; seen as a pale grey-beige, medium grained sandy limestone; the nearest outcrop to Gloucester is at High Brothridge and Brockworth Wood . Alternatively an origin near Birdlip would not be unlikely, for example at Parsons Pitch, where Ermin Way runs across the formation.

Tufa: Quarternary; the rock is precipitated from carbonate rich springs producing a light, poorly cemented, cavernous calcitic deposit that is very soft on extraction rapidly hardening to form a durable building stone which can be one third of the weight of a more conventional rock types. The nearest deposits of tufa to Gloucester are at Edgeworth and Chalford, some 13km to the south. There are two deposits on the escarpment above Leonard Stanley, however large deposits of tufa occur in the Dursley district (Goudie and Parker 1996:62) and the quantities of tufa found on Romano-British sites in the county suggest that a systematic, centralised quarrying campaign was in operation, possibly centred on Dursley (Clifford 1933:330).

All of the material described above has been recorded in quantity from Roman contexts in Gloucester. Pennant, Old Red Sandstone, Lias Limestone and Stonesfield Slate were all commonly used as roofing materials in the county (Williams 1971:109) and the fact that these rock types all occur with the dimensions of tile or flagstones suggests that the material was derived from the roofs and floors of Glevum. It has been pointed out that where Roman brick and tilestone are found incorporated into medieval structures it must be the above ground remains of Roman buildings that were being spoliated as such material rarely occurs in the footings of Roman buildings (Crummy 1981:48).

A similar suite of reused Roman brick and tilestones are found elsewhere in the 11th-century parts of the east arm of the church, as well as in the five easternmost bays of the nave together with their flanking aisles; west of this fifth bay the material is not found, suggesting that at this point the source may have been exhausted.

Non Middle Jurassic stone from 11th-century contexts

- E2** Brownstones used to pack a vertical joint in masonry midway between the strings.
- E3** Blue Lias Limestone inserted between the voussoirs of the blind arch.
- E4** Brownstones used as packing around the segmental head of the lower opening (W2/E4); Blue Lias Limestone used as packing around the head of the former blind arch, now pierced (W1/E4).
- E6** Tufa and Blue Lias Limestone and with Roman brick, used in the soffit of the splay in the westernmost crypt level window (W5/E6).

- E7** Brownstones and Stonesfield Slate used as packing around the head of the crypt level window.
- E8** Pennant tile beneath the upper string course.
- E12** Pennant tile, with Roman brick, used in and around the crypt level window (W1/E12).

14th-century stone

The ashlar are without exception of Lower Freestone with current bedding showing particularly well on the larger blocks. They show less lithological variation than the 11th-century ashlar, suggesting fewer sources.

Most of the 14th-century strings have been replaced with Bathstone but in the few places that they survive, for example in the ambulatory window in elevation 7, they are of a shelly Pea Grit. A small number of larger blocks of Pea Grit also remain in the basal courses of the parapet along with blocks of 19th century Bathstone and a coarse shelly rock from the Great Oolite, possibly Minchinhampton type weatherstone and probably also 19th century.

The distribution of stone other than that from the Middle Jurassic strata in the 14th-century fabric is similar to that of Roman brick. There is far less than in the 11th-century work and where it does occur it is associated with alterations that involved the cutting back of the 11th-century masonry releasing the stone for reuse, for example in the crypt level window on elevation 10 (Fig.9).

Non Middle Jurassic stone in 14th-century contexts

- E2/3/4** Pennant Sandstone and Stonesfield Slate used for levelling courses in the parapet.
- E5** Tufa in the soffit around the splayed head of the 14th-century window at ambulatory level (W2/E5).
- E10** Brownstones, Blue Lias Limestone and Stonesfield Slate used, with Roman brick, used as packing around the head of the crypt level window (W3/E10).

The mason's marks

Mason's marks are coded, with an elevation number followed by a mason's mark number with which it is possible to locate, using the coded elevations, the particular stone upon which the mark is inscribed.

The marks were located and traced with the aid of a raking beam from a hand held halogen spotlight and have been recorded at a scale of 1:1.

The agents of weathering have, over the 900 years since the erection of the east end, damaged the surface of the stones and removed much of the detail of many of the marks. The absence of marks in certain areas of masonry, such as below the lower string course, is due to the greater effects of weathering in these areas; elsewhere, such as in the 14th-century masonry below the parapet, where the surface tooling is clearly visible, the absence of marks must be due to factors related to the building process.

The results of this weathering have introduced a measure of uncertainty concerning the form, or type, of certain marks. More specifically the 'E' mark, a vertical stroke with three roughly equidistant horizontals running to the right, occurs with identifiable variations,

for example, there are a number of marks composed simply of the four strokes described above (eg. **4/27**). A variation on this four stroke 'E' mark has three short vertical strokes at the distal ends of the three horizontal strokes and this form, when weathered, may resemble an entirely different mark; that is the square divided by a horizontal. Where these uncertainties persist a note has been made and can be found below.

Cavities on the face of the stone affecting the marks is indicated by diagonal shading, a broken line indicates that traces of the mark remain in these areas.

E1

- 1/5-** face is very weathered, the lower diagonal is faint and impermanent.
- 1/8** some loss of definition around the upper angle, due to weathering, but the form is clear.
- 1/9** the mark takes the form of an arrow head with the stalk truncated by an area of weathering; it is unclear if, and how far, the stalk extended to the left.
- 1/11** incomplete.
- 1/12** possibly incomplete.
- 1/18** the right hand stroke is unclear-see above, note on 'E' marks.
- 1/22** weathering has removed the face around the distal ends of the horizontal strokes-see above, note on 'E' marks.
- 1/24** weathering around the upper and lower right hand strokes; this mark is probably the 'compasses' mark - eg. **2/31**.
- 1/25** faint and weathered, see note on 'E' marks.
- 1/26** possibly incomplete.

E2

- 2/4** clear example of the 'closed E' mark-see note on 'E' marks.
- 2/6** weathered-see note on 'E' marks.
- 2/10** see note on 'E' marks.
- 2/11** see note on 'E' marks.
- 2/12** see note on 'E' marks.
- 2/14** the vertical and diagonals run to the upper angle of the block.
- 2/16** see note on 'E' marks.
- 2/17** see note on 'E' marks.
- 2/22** see note on 'E' marks.
- 2/23** see note on 'E' marks.
- 2/26** see note on 'E' marks.
- 2/27** incomplete.
- 2/32** tooling marks present around the distal ends of the horizontal strokes-there was never a second, closing, down stroke, this is therefore a clear example of the 'E' mark-see note on 'E' marks.
- 2/3** see note on 'E' marks.
- 2/35** 14th-century mark

E3

- 3/2** the strokes all extend to the edge of the block in a manner that suggests that they are assembly, or fixing, marks. However these marks would be of little use in assembling the present structure and this, together with the chamfer at the upper right hand angle of the block, suggests that the block was cut for a purpose to which it was never put, or reused from an earlier structure.
- 3/4** stroke extends to the edge of a chamfered block - as **3/2**.
- 3/7** see note on 'E' marks.
- 3/10** unclear whether it is the 'E' or 'closed E' mark - see note on 'E' marks.
- 3/16** see note on 'E' marks.

E4

- 4/14** see note on 'E' marks.

- 4/8, 4/9, 4/10 & 4/11** marks on voussoirs of segmental arch.
4/23 the horizontal stroke may have extended to the left of the vertical in an area now weathered off.
4/26 the short diagonal stroke follows the line of the tooling marks and may not be part of the mark.
4/30 bottom part of the mark is weathered off; the mark is probably a double triangle.
4/33 the mark extends to the edge of the face.
4/32 & 4/33 on jambs of 14th-century window.
4/36 14th-century mark.

E5

- 5/15** script; appears to be 'Wli'; 'Wh'; or 'Wi'
5/21 the mark has been bisected by the enlargement of the window in the 14th century.
5/24 see note on 'E' marks.
5/27 the mark has been bisected when the block was cut to fit around the head of the window.

E6

- 6/14** probably incomplete.
6/15 the mark has been bisected by the re-cutting of the block-linked to its position above a window opening.
6/22 weathering has made it difficult to determine whether the mark originally had two or three strokes.
6/45 runs across two stones; it appears as if the stone has been cut in two, possibly associated with its position in a window splay.
6/51 inscription?
6/62 this is one of several marks that can be found in and around the jambs and splays of the lower windows in which the letter 'W' features.
6/70 clearly not a conventional mason's mark; the resemblance to a scratch dial is superficial as it is too small and lacks a central slot for the stick. The mark describes an angle of 33 degrees and may have been a measuring device; it appears in the area of masonry in which the scale is located.
6-75 possibly incomplete.
6/78 the mark runs to the edge of the block in a manner that suggests that the block has been re-cut at some point.
6/83 inscription.

E7

- 7/5** incomplete, the mark is probably as **7/11**
7/8 probably incomplete, possibly the remains of an 'E' mark.
7/12 unclear whether to include the broken line, the mark could be as **7/12** or alternatively as **7/16**.
7/23 the long diagonal stroke could be the remains of a tooling mark.
7/27 possibly incomplete.

E8

- 8/2** possibly incomplete.
8/3 rare example of a masons mark on an 11th-century wall shaft.

E9

- 9/8** possibly incomplete.

E10

- 10/24** incomplete.

E11

- 11/2** possibly incomplete.
11/13 possibly incomplete.
11/14 19th or 20th century mark.
11/45 & 11/46 on the roll moulding of a former 11th-century blind arch.
11/47 on tracery of 14th-century window.

E12

12/22 possibly incomplete.

12/51 possibly incomplete.

E13

13/9 incomplete, possibly as 10/22.

13/11 possibly incomplete.

13/13 incomplete.

13/14 possibly incomplete.

13/32 possibly incomplete, but similar to 13/11.

The scale

During the inspection of the stonework at the south-east end of Gloucester Cathedral, undertaken for recording the mason's marks, the spotlight revealed a series of seven equidistant incisions on the face of a block in the exterior wall of the south ambulatory, below the bottom string (Fig.10). The location number is **6/84** on the mason's marks coded drawing.

The marks were traced and recorded at a scale of 1:1. They consist of seven faint, roughly horizontal strokes ranging from 6 to 31mm in length upon a small block 250x190mm in size. The variation in the length of the marks is due to some of them being partially weathered off.

The incisions are numbered A - G in descending order, the distances between them are given below:

A-B...27.5mm

B-C...27.5mm

C-D...26.5mm

D-E...26.5mm

E-F...27.5mm

F-G...26.5mm

The marks have been inscribed with some care, showing a variation of 1mm in 27, or accurate to around 3.5%. This degree of precision would be impossible to achieve without the use of an accurate measuring instrument.

Clearly the calibrations represent inches and there are six of them. The distance between the top and bottom marks is 162mm; the average inch being 27.0mm. The upper and lower marks are both within 27mm of the edges of the block, in other words it appears as if the scale would have originally extended beyond its present six inches, probably to twelve, having been truncated by the re-cutting of the block upon which it is inscribed.

The inches, at 27mm, are slightly longer than the standard English inch of 25.4mm and would give a foot of around 324mm. If the 3.5% level of accuracy derived from the variations in the sizes of the inches is applied then a figure of 324 ± 5.6 mm results. This overstates the possible deviation from 324mm as, for example, 329.6mm is the maximum length that a foot could be at this degree of confidence, half of this 'maximum foot' would

be 164.8mm, whereas it is known that the six digits marked on the block are 162mm in length.

Having concluded that the calibrations are six inches of a foot of roughly 324mm it is then necessary to consider the possible metrological system represented by the digits, and its date.

On the date; the area of masonry that contains the block would have been built between AD1089-1100 (Hart 1863:11-12; Welander 1991:22) and the block is judged not to be intrusive (see above). However, although the block appears to be in its 11th-century position it is quite probably a reused stone taken from the ruins of Glevum. There is, then, the possibility that the scale is Romano-British rather than 11th-century in date.

These 'Gloucester inches' may have been derived from a number of metrological systems. The *pes Monetalis*, or Roman Foot, can be discounted, at 295mm it is too short. So too is the English Foot which was standardized at 304mm by the early 13th century (Grierson 1972:10). The *pes Drusianus* is a controversial unit of measurement estimated at 333mm and used, particularly in military contexts, in the Roman Western Provinces (Walthew 1982:15), although the extent of its use remains disputed as does its relationship with the so called Northern Foot of 332-333mm (Ferne 1985:252). This unit of measurement is significantly longer than the six inches of the Gloucester scale. Even at the upper limit of deviation from 324mm, at the 3.5% accuracy level, the figure of 329.6mm does not quite equal the length of the Drusian foot, and, as we have seen, the Gloucester foot would have been nearer to 324mm than 329.6mm. The units of measurement represented by the scale do not closely approximate any of the above unit nor any of the more esoteric metrological systems proposed for the early medieval period.

The lack of a datable context for the scale makes further meaningful discussion of its possible attributes of difficult, however it is hoped that the publication of the scale may stimulate further research on the metrologies of Roman and medieval Gloucester.

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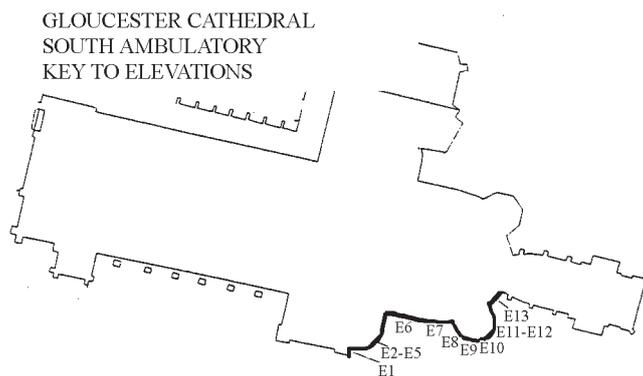


Fig.1. St. Andrew's chapel, Gloucester Cathedral.

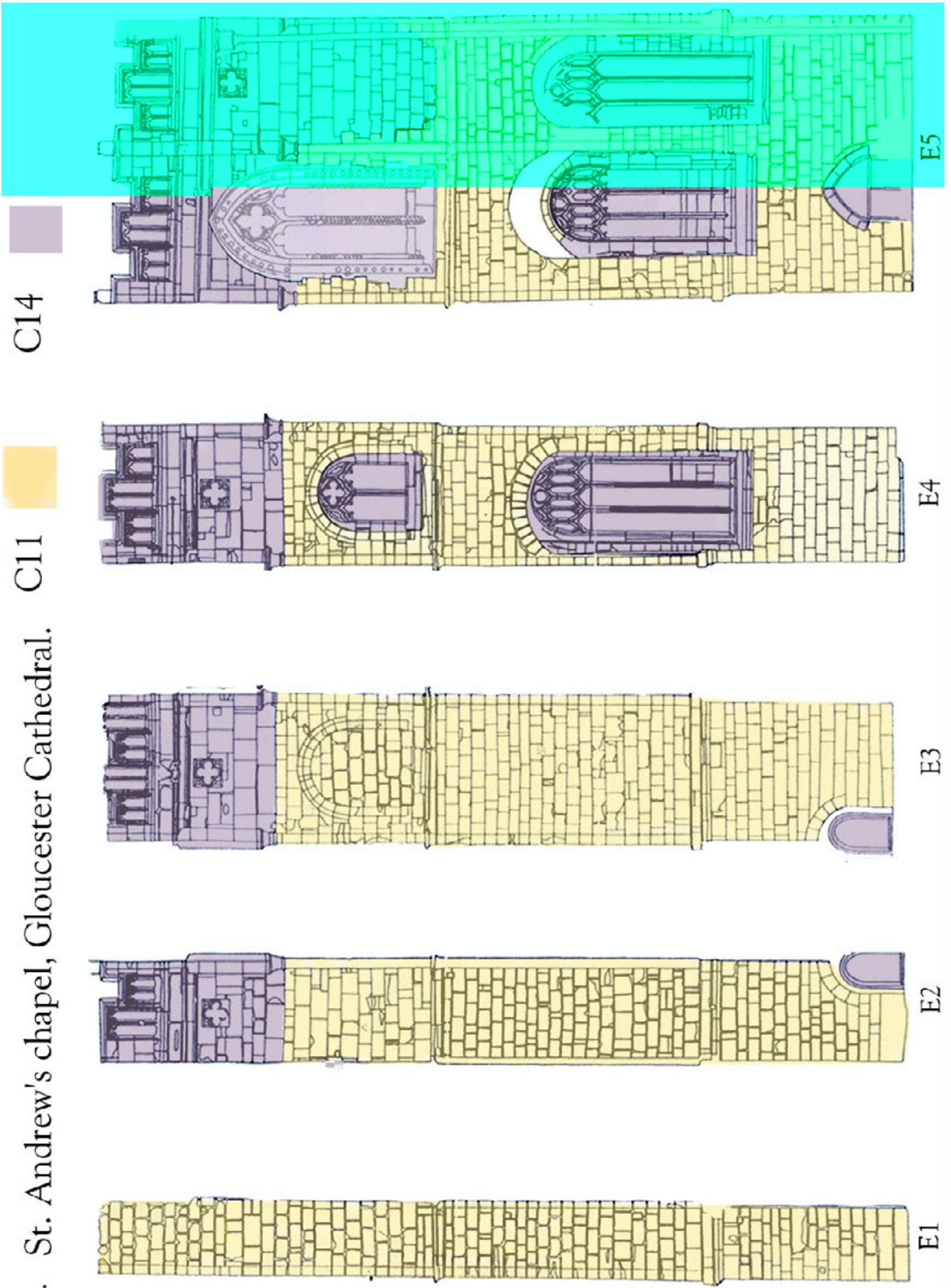


Fig.2. South Ambulatory/ Tribune and Radiating Chapel, Gloucester Cathedral

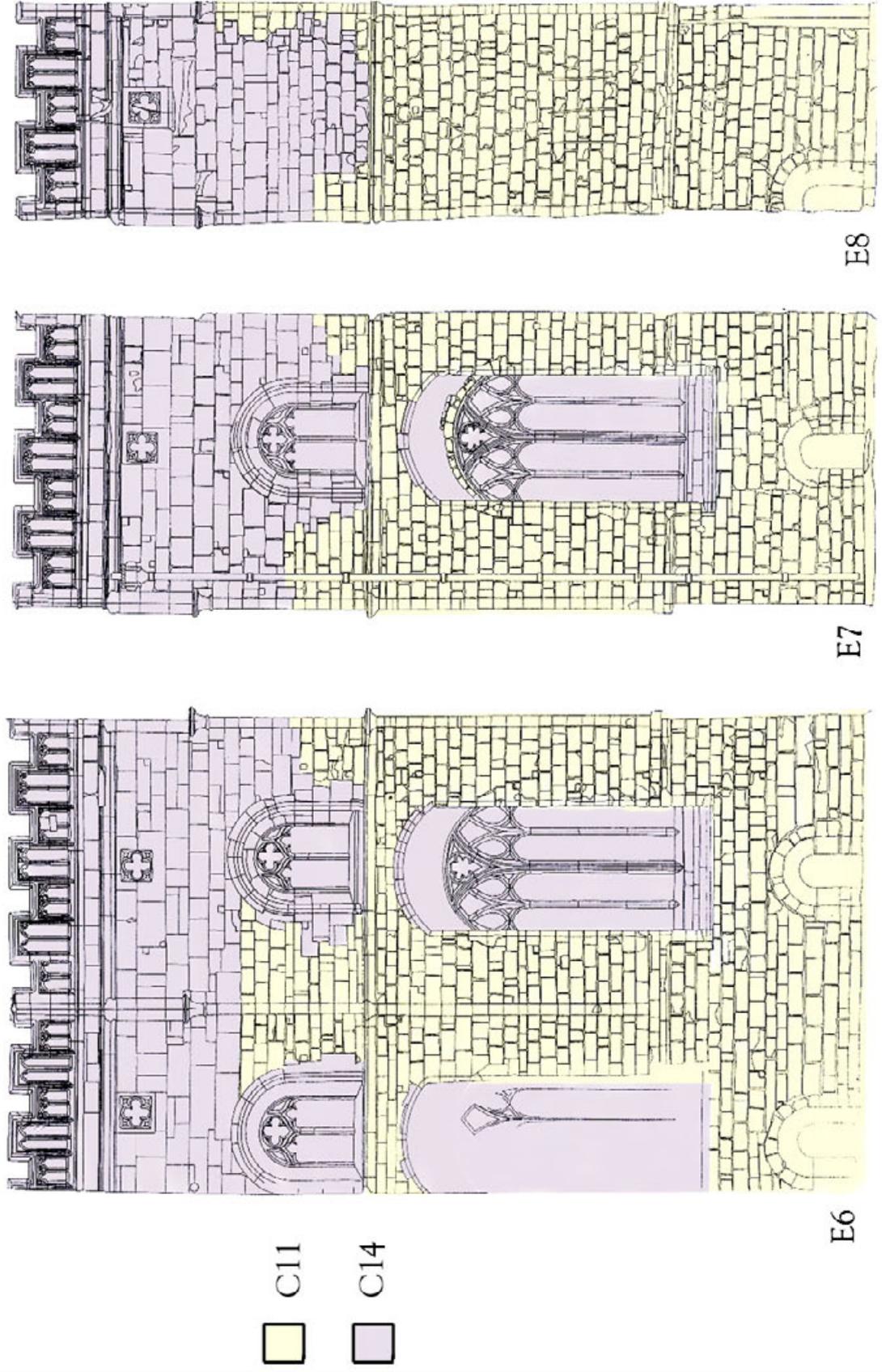


Fig.3. South Radiating Chapel and Bridge, Gloucester Cathedral

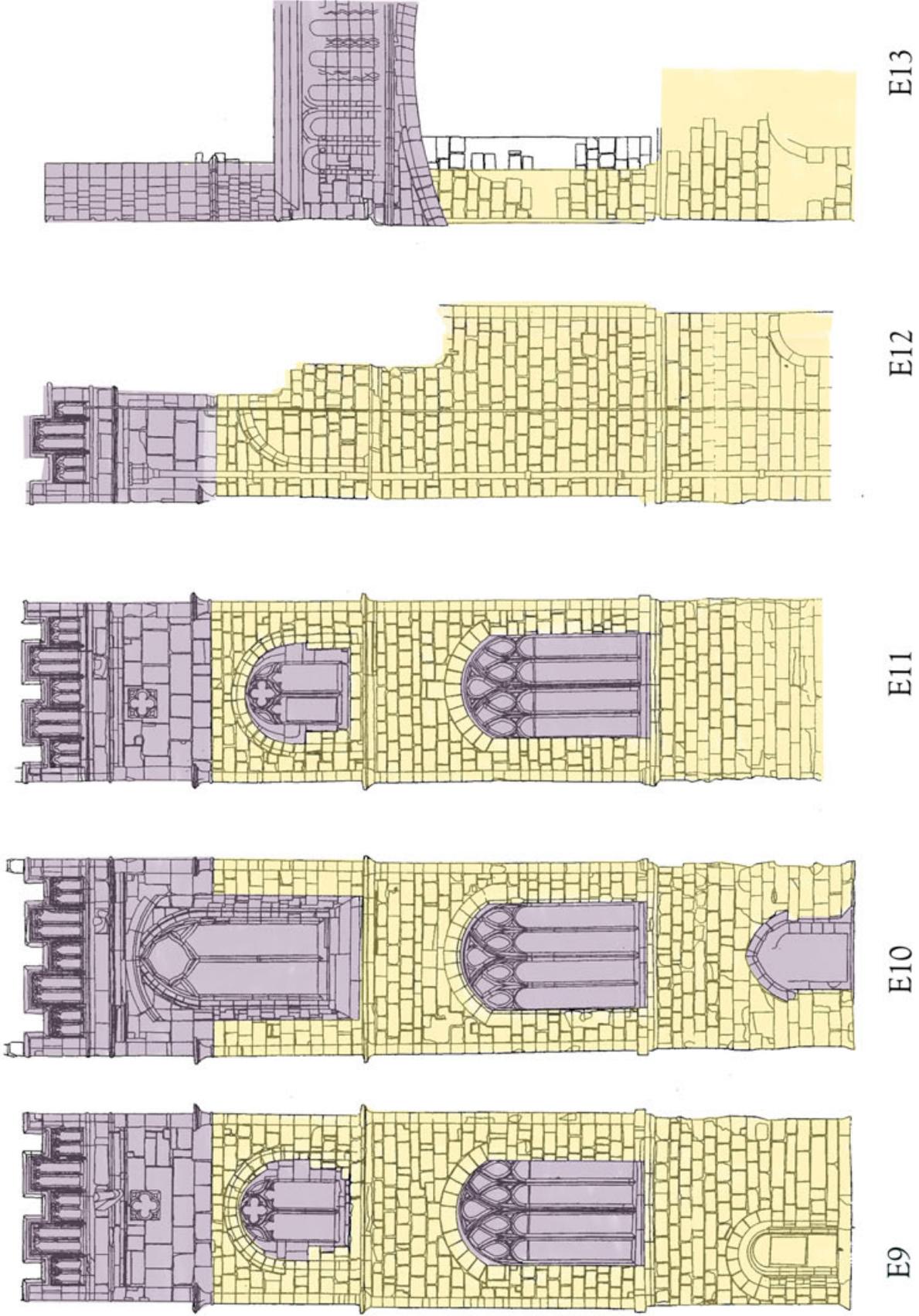


Fig. 4 Southern aspect of the eastern arm, St. Peter's Abbey, Gloucester.

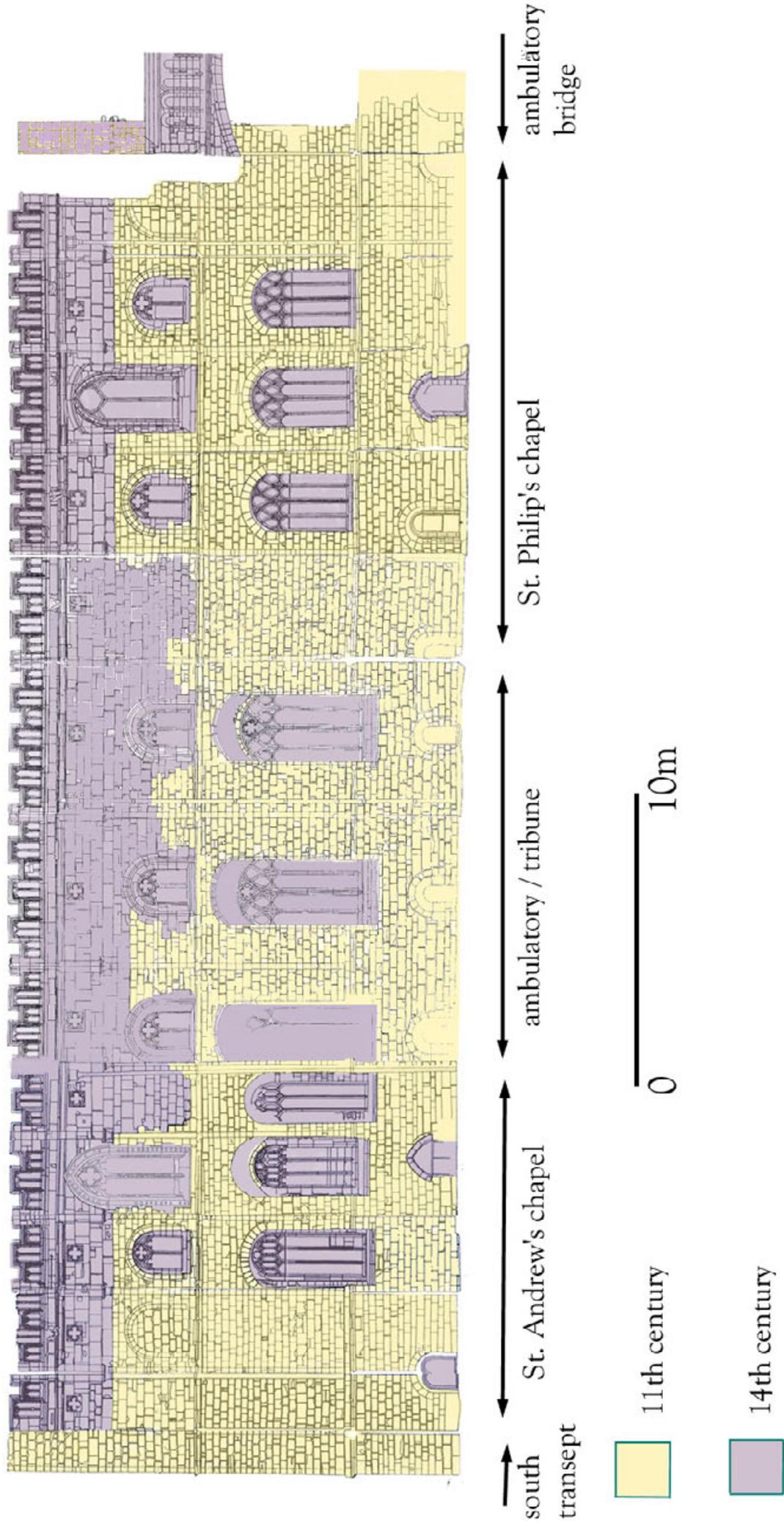


Fig 5. Detail of Elevation 5 with mortars

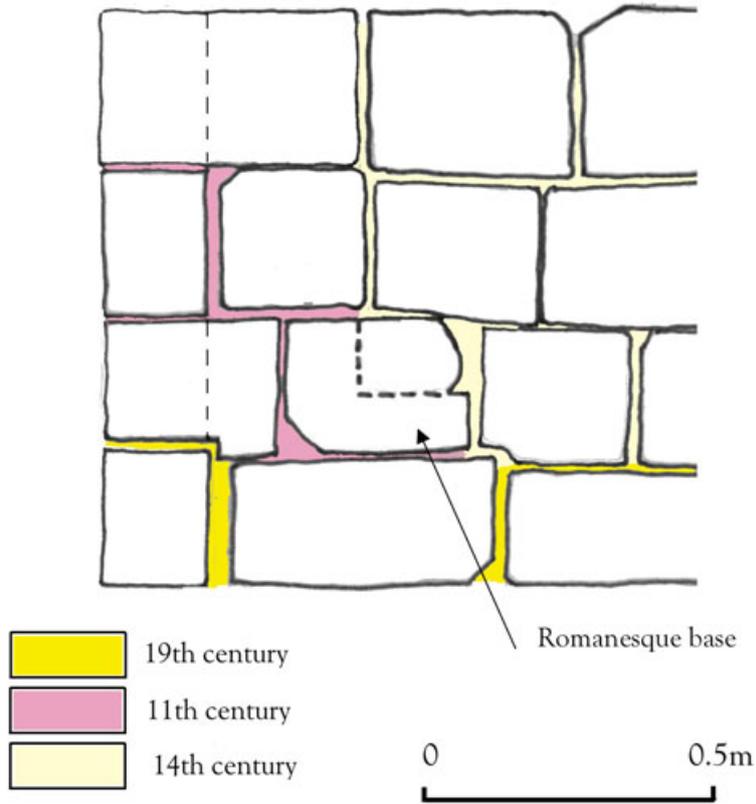


Fig. 6. Elevation 5, south transept - east gallery chapel

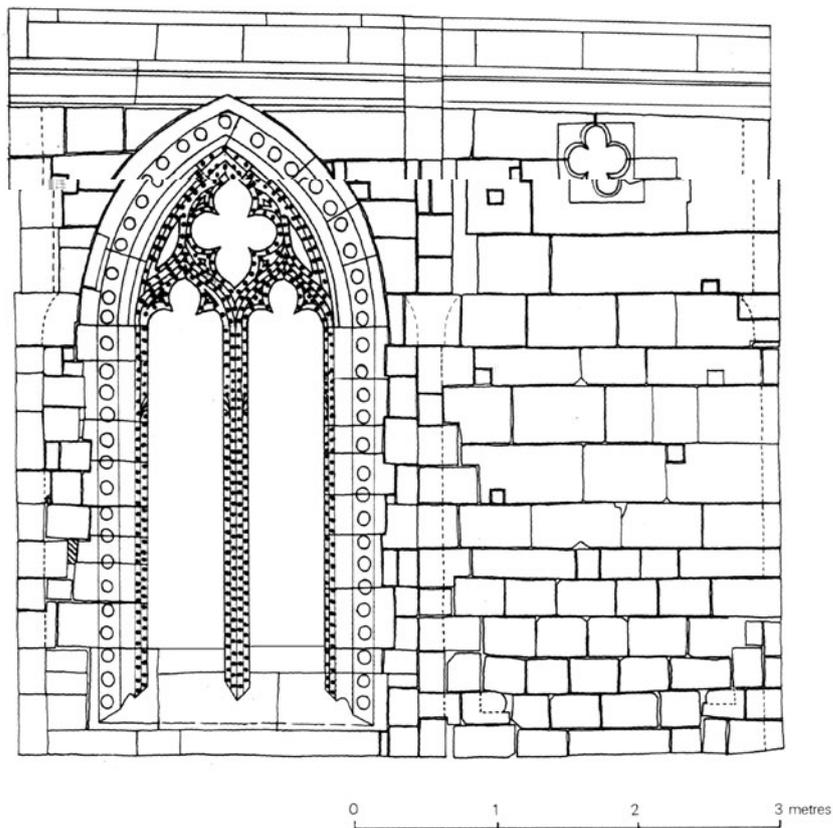
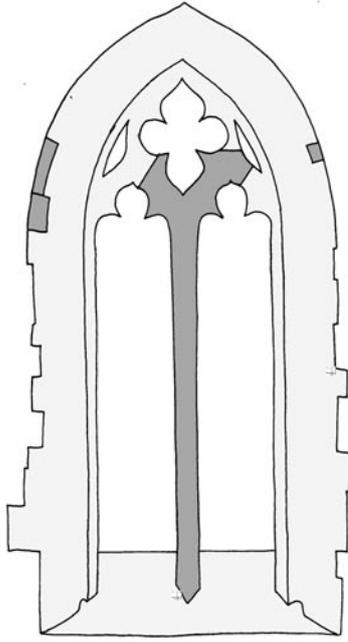


Fig. 7. Elevation 5, ballflower window: pet;rology



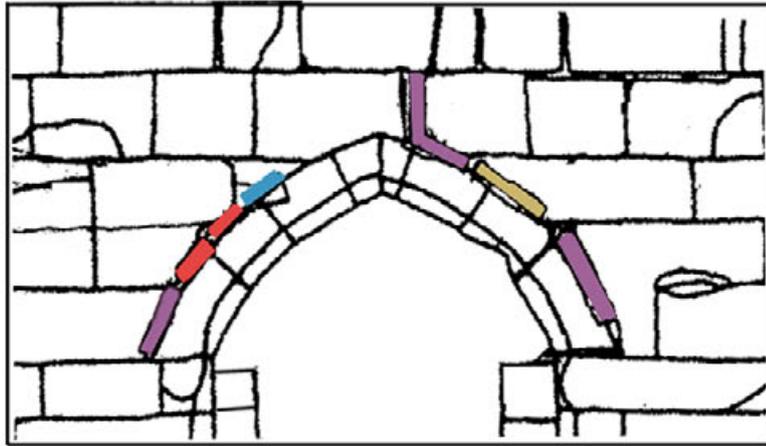
Inferior Oolite 

Bathstone 

Fig. 8. Detail of ballflower window, elevation 5.



Fig. 9: Detail of crypt level opening, Elevation 10.



Brownstones



Brick



Blue Lias Limestone

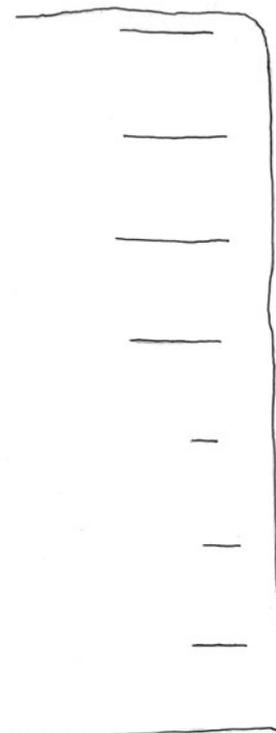
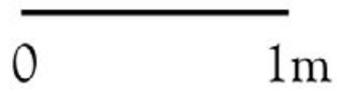


Fig. 10 6/84, the scale at 1/2

Gloucester Cathedral - South Ambulatory, Transeptal and Radiating Chapels
 Distribution of Pea Grit and Romano-British Brick

Fig. 11

