BRITISH GEOLOGICAL SURVEY

Natural Environment Research Council

Technical Report

(Commercial in confidence)

Report WA/93/31(C)

The geology and building stones of Lanercost Priory, Cumbria.

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1:50 000 Sheet England 18 (Brampton).

Subject Index
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The geology and building stones of Lanercost Priory, Cumbria.

by

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CONTENTS

1. INTRODUCTION

This report describes the results of a study of the building stones present in the fabric of Lanercost Priory, Brampton, Cumbria. The work was carried out by Brian Young of the British Geological Survey (BGS) Newcastle Office in March 1993 as contract No.GA/92F/9 between the Natural Environment Research Council (NERC) and Carlisle City Council.

Whereas all parts of the building accessible at the time of the investigation were examined certain parts of the structure, notably the higher parts of the walls and tower, were inaccessible. Any comments made on these are therefore based on distant observations. Lithological characteristics of the stone, eg rock type, comparative grain size, colour, reaction to 10% hydrochloric acid, block dimension, state of weathering etc. were recorded on site. Apart from a brief examination by stereomicroscope of a few small fragments of loose stone collected during the field investigation no laboratory study of the stones has been undertaken.

The descriptions presented here are based entirely on available published sources, unpublished BGS and other records, and the observations made during fieldwork in March 1993. No attempt has been made at any systematic appraisal of the structural condition of the buildings or of the ground conditions beneath them: the report is not in any sense the report of a structural survey. None of the data contained herein should be regarded as a substitute for full and appropriate structural and geotechnical investigations if any remedial or other works are contemplated.

2. SITE GEOLOGY

Lanercost Priory stands on the north bank of the River Irthing approximately 6 km NE of Brampton. The site is at the eastern edge of the Carlisle-Solway Plain, an extensive area of relatively low-lying country which extends southwards as the Vale of Eden. To the north of Lanercost rises the moorland and fell country of the Bewcastle and Spadeadam areas: to the south the Irthing and its southern tributary streams provide a relatively low-lying corridor, which between Gilsland and Haltwhistle, connects with the Tyne Gap. South of the Irthing-Tyne corridor rise the northern Pennines.

The physiographic setting of the Lanercost site clearly reflects the solid geology. The essential features of the regional geology are illustrated in Figure 1 which is a compilation of extracts of BGS 1:250 000 sheets 55°N-04°W (Borders) and 54°N-04°W (Lake District).

Although a detailed description of the area's geology is not relevant to this study a general appreciation of the main geological elements is essential to an understanding of the likely sources of stone used in the Priory. Detailed accounts of the area's geology include those by Trotter and Hollingworth (1932), Day (1970), Taylor *et al* (1971), and Jackson (1979).

The Carboniferous rocks of the earlier part of the area comprise a complex succession of mudstones, siltstones, sandstones and limestones. The sandstones and limestones are generally relatively resistant to weathering and commonly form prominent ridge features. Sandstones form striking cliffs alongside the River Irthing to the east of Lanercost. Both sandstones and limestones have been quarried, the former for building stone; the latter for lime and mortar and in places for aggregate and building stone. Mudstones have been worked for brick making near Hallbankgate. There are no active quarries in any of these rocks in the district today.

To the east and southeast of Lanercost the Carboniferous rocks are intruded locally by the Whin Sill, a more or less horizontal sheet of dolerite. This rock is particularly resistant to weathering and the sheer north-facing crags which mark its outcrop east of Greenhead provided a naturally defensive site for Hadrian's Wall for many miles to the east. The Whin Sill was formerly worked for roadstone from a handful of quarries in Cumbria and western Northumberland. Working of the Whin Sill is today restricted to the North Tyne area, eastern Northumberland and County Durham.

In the Lanercost area, and for many miles to the south, Carboniferous rocks in the east are separated from Permo-Triassic rocks in the west by a complex N-S to NNW-SSE trending set of faults known as the Pennine faults. This fault system has an aggregate westerly downthrow of several hundred metres.

The major portion of the Permo-Triassic succession of the Lanercost-Brampton area consists of a sequence of fine-grained dull red sandstones known in Cumbria as the St Bees Sandstone. This rock is well exposed in the Gelt Valley south of Brampton and in several old quarries both here and elsewhere in the Brampton area. The St Bees Sandstone has long been used as a high quality building stone. It has been quarried at a number of sites in Cumbria, including the Brampton, Carlisle, Maryport and St Bees areas. The only active quarries today are those of the St Bees area. The characteristic sombre red stone is used in many buildings including the Priory. Sandstones also of Permo-Triassic age but with rather different characteristics, and locally termed the Kirklinton Sandstones overlie the St Bees Sandstone. These rocks are well exposed in the banks of the River Irthing west of Walton: they are generally rather soft and do not appear to have been used for building stone. The St Bees Sandstone is underlain by a sequence of mudstones and siltstones known as the Eden Shales, which in the Carlisle and Kirkby Thore areas include important beds of gypsum, which are worked on a large scale for the making of plaster products in the latter area. Beneath these rocks lies the Penrith Sandstone, a coarse-grained pink sandstone which gives rise to the hilly country between Penrith and Cotehill and has long been an important Cumbrian building stone: it is still worked in quarries near Penrith.

Over much of the district these 'solid' rocks are concealed by a mantle of superficial, mainly glacial deposits, consisting mostly of boulder clay and glacial sand and gravel. The boulder clay typically consists of a compact deposit of pebbles and boulders set in a matrix that varies from a stiff clayey silt to a clayey sand. Glacial sand and gravel occupies a widespread outcrop in the Brampton area. This deposit consists of a variable sequence of sands and gravels deposited mainly from melting ice sheets.

In post-glacial times the drainage pattern seen today was established. Erosion, re-working and re-distribution of the abundant glacial debris has taken place and continues today. Adjacent to the main rivers spreads of alluvial and river terrace deposits accumulated. Lanercost Priory stands on an extensive area of River Terrace on the north bank of the River Irthing (Fig. 2).

3. BUILDING STONES

3.1 Introduction

Even the casual observer visiting Lanercost will be struck by the striking colour contrasts of the stones within the walls: dull red stone contrasts with pale grey or buff stone. This is especially noticeable in the East Front (Figure 3) the outer south walls of the Sanctuary (Figure 4), South Transept (Figure 5), Prior's House (Figure 6) and parts of the West Front (Figure 7) though a variety of stone colour is also clearly apparent elsewhere eg in the outer north wall of the Nave and North Aisle (Figure 8).

Apart from a handful of individual blocks, the entire fabric of the Priory is built of sandstone. The sandstone may be separated into two broad groups on the basis of the striking colour differences already noted. As will be discussed below these correspond with stones from two quite separate sources. The majority of the red sandstone is derived from the Permo-Triassic St Bees Sandstone: the grey to buff stone is considered here to have been obtained from one or more Carboniferous sandstone units.

The stone from which the Priory is constructed is generally well exposed, though in places inaccessible, in most of the structure. The internal walls of the present church have at some time been plastered, whitewashed or colourwashed. These walls retain a grey to brown surface coating and details of the stonework are difficult or impossible to discern.

In the following pages the major characteristics of each of these stone types, significant features displayed by the stone seen in the fabric, their use within the building, weathering characteristics etc will be described. The small number of other stones identified will be discussed. Possible sources of stone will be examined.

3.2 St Bees Sandstone

3.2.1 General description

The dull red sandstone which is prominent in the abbey fabric is derived from the St Bees Sandstone. This is the name applied in Cumbria to the thick and extensive deposit of sandstone of Permo-Triassic age which forms part of the much more extensive sandstone formation known throughout much of northwest and central England as the Sherwood Sandstone. Details of the geological succession within the Sherwood Sandstone are out of place here. Good descriptions of the St Bees Sandstone of Cumbria are those by Arthurton *et al* (1978), Arthurton and Wadge (1981), Dixon *et al* (1926), Eastwood (1930), Eastwood *et al* (1931), Rose and Dunham (1977) and Trotter and Hollingworth (1932).

Over most of its outcrop the sandstone exhibits a remarkable uniformity of lithology. It is typically a dull red to reddish brown fine- to medium-grained, well-bedded sandstone, commonly in beds or 'posts' up to 2 m thick. Small-scale cross-bedding (false-bedding of older literature) is common and disturbed or convoluted lamination is also seen in places. Whereas much of the St Bees Sandstone exhibits the characteristic dull red colour beds of pale grey to white and, locally pale yellow, sandstone also occur. In many instances the pale grey or white coloration appears to be confined to particular beds though the colour variation commonly cuts across original bedding features and in places occurs in isolated spots throughout the stone. The white bands or patches probably result from the reduction of ferric oxides in the stone or in part to the removal by leaching of much of the contained iron. Good examples of this colour variation may be seen in the St Bees Sandstone outcrop in the Gelt valley south of Brampton.

Although no samples of St Bees Sandstone from Lanercost Priory have been examined petrographically the following description compiled from published sources is likely to summarise the main features of the rock. Microscopic examination of a typical specimen of red St Bees Sandstone shows that the quartz grains which comprise the bulk of the rock are angular to subangular. A few scattered coarse, well-rounded 'millet-seed' grains occur in some specimens but these are not abundant (Arthurton and Wadge, 1981, p.83). Generally only a small amount of feldspar is present: this consists mainly of turbid orthoclase and a plagioclase (commonly andesine). White mica is common as rounded plates scattered throughout the rock in some specimens but most conspicuously concentrated on certain bedding planes. Biotite, in part replaced by hematite, has been noted in places (Ixer *et al*, p.61). Detrital minerals recorded from the St Bees Sandstone include apatite, baryte, chalcopyrite, chromite, garnet, hematite, ilmenite, maghemite, magnetite, marcasite, pyrite, rutile, tourmaline and zircon. Hematite occurs in a number of forms. It is common as detrital grains some of which contain relic magnetite (Turner and Ixer, 1977; Ixer *et al, op cit*). Turner and Ixer (*op cit*) observed hematite as authigenic grains as well as fine-grained acicular crystals. In this later form hematite constitutes the main pigment of the sandstone. Other authigenic minerals recorded from the St Bees Sandstone include anatase and baryte (Versey, 1939), and illite (Ixer *et al, op cit*). The cement is commonly ferruginous, perhaps consisting mainly of limonitic material though siliceous cements have also been observed (Rose and Dunham *loc cit*). These authors also note the occurrence of secondary overgrowths of quartz which have turned initially rounded grains into angular ones.

The generally uniform petrographic characteristics of the rock, combined with its widely spaced bedding planes, make it an excellent quality free stone. It can be obtained in large blocks and is easily sawn or dressed by other methods. Because of its comparatively fine grain size it is capable of taking finely carved detail, though Trotter and Hollingworth (1932, p.179) commented that inscriptions on tombstones may become illegible after 70 or 80 years.

3.2.2 Colour

Within Lanercost Priory the great majority of the St Bees Sandstone exhibits its characteristic dull red colour (Figures 3-9). Minor variations in this colour may be detected especially in areas of wall in which many blocks occur together and can be readily compared, eg in parts of the West Front (Figure 7), in the outer wall of the North Aisle and Nave (Figure 8) and in the outer east wall of the South Transept (Figure 9). Blocks which exhibit marked colour variation are surprisingly rare at Lanercost. The most obvious are those illustrated in Figures 11 and 12. Figure 11 shows a large block forming the lintel above the door from the South Transept to the Vestry. In this block the colour varies from the typical dull red on one side of the block to pale buff on the other. The colour does not seem to be bounded or controlled by original bedding planes. A somewhat similar colour variation from pale dull red to whitish buff is present in a carved block on the south east side of the canopy over the tomb of Sir Thomas Dacre (Figure 12). In this example the colour variation roughly follows the lamination within the stone, here laid vertically.

Inside the church the pillars and arches between the North Aisle and Nave are of a conspicuous ochreous brown colour (Figure 13-14). Close examination of this suggests that these are built entirely or almost entirely of St Bees Sandstone. A few small, recently chipped blocks within the pillars reveal that the stone is, at least in the damaged blocks, of the normal dull red colour. The overall ochreous brown tint appears to be the result of a surface wash of some form of paint which has penetrated for 1 mm or thereabouts into the stone.

3.2.3 Bedding

Where bedding in apparent it is mostly even and parallel. This is best seen where accentuated by weathering, eg in the outer east wall of the South Transept (Figure 9) and in the outer face of the east wall of the Chapel of St Catherine (Figure 10). From the size of the blocks it is clear that stone was obtained from individual beds or "posts" up to at least 0.35 m thick, (Figure 15).

Cross-bedding is conspicuous in some blocks. Figure 16 shows a block in the outerface of the east wall of the South Transept. Other examples may be seen in the west doorway of the Prior's House, in the lintels above one of the windows on the south side of the Cellarium (Figure 17), in parts of the West Front (Figure 18) and elsewhere.

Convolute lamination, seen in many blocks of St Bees Sandstone in other buildings eg Furness Abbey (Young, 1989, p.21) has not been observed in the Lanercost Priory stone.

3.2.4 Specialised uses of St Bees Sandstone

As noted elsewhere in this report the stone content of many parts of the Priory fabric reflect no preference for any particular stone type. Whereas in parts of the building the predominance of St Bees Sandstone is almost certainly a function of the availability of this stone there are instances where this stone has clearly been selected for particular purposes.

Its comparatively fine grain size compared with the other available sandstone, combined with a consistent uniformity of texture makes it the most suitable locally available stone for carved work. Most of the stone used for the detailed sculptured work, such as mouldings, arches etc is St Bees Sandstone. Fine examples of carved St Bees Sandstone within the fabric include the West Front (Figures 18 and 19), the east window of the Chapel of St Catherine (Figure 20), the windows of western range of the Cloisters (Figure 21) and the Prior's House (Figure 6) and decorative arching above Lavatorium in the south east corner of the Cloisters (Figure 22).

In a few parts of the Priory St Bees Sandstone appears also to have been selected for particular structural purposes. It is the stone employed for the vaulting in the Cellarium and for the pillars and arches between the Nave and the North Aisle (Figure 13).

Because St Bees Sandstone could be obtained as very wide blocks it is widely employed throughout the Priory for door and window lintels and sills and as component blocks of large pillars. Blocks up to 1.9 m across are present in places.

The finest example of carved St Bees Sandstone in the Priory are in several of the tombs in the Choir, Transepts and Sanctuary. The tombs of Sir Rowland de Vaux and Sir Thomas Dacre (Figure 23 and 24) both incorporate excellent examples of detailed carving int his stone. The monument of Charles James Howard is a fine example of Twentieth Century workmanship.

3.3 Carboniferous sandstone

3.3.1 General description

The presence within the fabric of a large quantity of pale grey or buff stone, which contrasts strongly with the red St Bees Sandstone, has already been noted (Figures 3-8). Whereas these stones exhibit considerable differences in colour, texture and composition they all possess features consistent with their derivation from one or more of the sandstones of Carboniferous age which crop out within a few kilometres of the Priory. No single description can be applied to these sandstones seen in the Priory fabric. In this report a small number of representative examples will be described though these may, at least in some instances, represent lithological variants derived from a single sandstone unit or formation. This is also consistent with a source in the local Carboniferous sequence where marked lithological differences may be observed within the sandstones present in a single exposure or quarry.

3.3.2 Buff to greyish-buff sandstone

A sandstone type common throughout much of the Priory is abundantly present in the lower courses of the outer walls of the Sanctuary (Figures 26 and 27) and the South Transept (Figure 28). Blocks in the east wall of the Sanctuary consist of medium-grained pale buff to greyish-buff sandstone composed of moderately well-rounded quartz grains with, in places, a few scattered flakes of white mica. There is little obvious cement in the weathered surfaces: the few blocks tested with 10% hydrochloric acid showed no reaction indicating that no carbonate cement is present. A few blocks contain fairly conspicuous "chalky" grains of kaolinised feldspar, (Figure 29) a feature common in many Carboniferous sandstones. Whereas some blocks show no obvious lamination a considerable number show relatively straight lamination and many exhibit prominent cross-lamination (Figures 26, 28, 29 and 30). Some blocks (eg Figure 29) show small rather tabular hollows which may represent weathered out mudstone or clay clasts or lenses.

A few blocks of sandstone of very similar lithology show traces of ripple cross-lamination (Figure 31).

Well preserved burrows are present in at least two blocks of sandstone of this type and are present in the rubble core of the New Chapter House walls (Figures 32 and 33).

In the long-weathered outer faces of the walls blocks of this stone typically exhibit a rather uniform dull pale buff to greyish buff coloration. Some blocks, however, display a strikingly uneven colour variation (eg Figures 29 and 30). In these instances darker brown iron oxide pigments have been preferentially concentrated along certain laminae. This is spectacularly seen in Figure 30 where the inclined cross-laminae in the upper part of the block are strongly iron-stained. The less inclined laminae in the lower part of the block are much less strongly coloured. (This block is laid upside down.)

In many examples of this stone a markedly speckled appearance is seen (Figure 34). In these instances brown iron oxide pigment has developed as discrete patches up to only a few millimetres across, perhaps nucleated around preferred mineral grains or conceivably as a result of oxidation of original iron carbonate grains, perhaps sphaerosiderite, within the stone.

A few blocks show the concentration of iron oxides as irregular bands - 'liesgang rings' - formed as reaction fronts by iron oxide precipitation within the stone, perhaps after the stone was incorporated in the structure (Figures 9 and 35).

3.3.3 Yellow sandstone

Parts of the inner walls of the Choir and North and South Transepts contain appreciable quantities of a sandstone which although in most instances appearing lithologically identical to the buff sandstone described above (3.3.2) exhibits a distinctly pale yellowish colour (Figures 36 and 37) locally with bands of darker brown coloration (Figure 37). Features such as cross-lamination are generally inconspicuous or absent in many of these blocks. Many of the blocks however have been dressed to give a smooth surface. They have not been subjected to the same degree of weathering as the blocks on the outer faces of the wall and it is suggested here that much, if not all, of this stone is very similar to the buff stone, and may share a common source.

Some very large blocks of this stone are present in the pillars of the Choir and Transepts with maximum block sizes of up to 1.2 m along the bedding and up to 0.33 m thick.

3.3.4 White sandstone

A common sandstone type within the fabric, though less abundant than the buff sandstones, is one which in weathered blocks presents a striking very pale grey or white appearance. Examples of this are present in the outer face of the south wall of the South Transept (Figures 38 and 39) and Nave (Figure 40).

This stone consists of a fine- to medium-grained white to very pale grey sandstone composed of generally sub-angular to sub-rounded quartz grains. Small patches of white kaolinite-like material in some blocks may represent altered feldspar grains. No cement is obvious and all examples tested with 10% hydrochloric acid proved to be non-calcareous. Traces of lamination, including possible cross-lamination were noted in a few blocks (eg Figure 39). Small rounded in-weathered hollows in some blocks (eg Figure 40) may represent original clay pockets, or patches of weaker or perhaps calcareous cement.

3.3.5 Reddened sandstone

Several blocks of purplish red sandstone are present, usually scattered throughout the masonry. The red colour which varies from reddish buff (Figure 41) to a more distinct purplish red (Figure 42 and 43) is quite distinct from the dull brownish red of the St Bees Sandstone. The coloration is commonly unevenly dispersed throughout the stone and appears typically to be unrelated to original sedimentary structures within the rock. Concentrations of the red pigment, almost certainly hematite, are conspicuous in a few blocks where preferred grains, clasts or nodules of ironstone or mudstone may have provided a nucleus for deposition (Figures 43 and 44). The texture and overall appearance of these stones is quite unlike that of the St Bees stone. These are typically medium-grained sandstones, in some instances with conspicuous kaolinised feldspar, of the type considered here as of Carboniferous origin.

Although generally widely scattered throughout the masonry clusters of several such blocks may be seen below the clerestory windows on the outer face of the south wall of the Sanctuary (Figure 4).

3.3.6 Specialised uses of Carboniferous sandstones

Whereas the walls of the Priory generally reflect no preference for any particular stone, the use of St Bees Sandstone, especially for carved work, has already been noted (3.2.4). In a few parts of the building Carboniferous sandstones have been carved as mouldings and arches. Examples may be seen in the pillars of the Transept and Choir (Figure 37) in the now blocked doorway at the south east corner of the Nave (Figure 45) and in the adjoining outer face of the South Transept (Figures 46 and 47). Carboniferous sandstones have locally been used for window arches eg on the West Front (Figure 48) and for the arches of the clerestory in the Sanctuary (Figure 49).

3.4 Weathering and deterioration of sandstones

The outer walls of the Priory have obviously been exposed to weathering since their erection. Since the partial destruction of parts of the structure after the Dissolution large parts of the internal walls have also suffered many years of weathering.

Very small and, perhaps in some instances, even scarcely perceptible, differences in type or quality of a stone's natural cement, its grain size and closeness of lamination, may have profound effects on its weathering characteristics, especially over a period of several centuries. The orientation of a wall and the consequent exposure to prevailing winds, sun and degree of shelter will also play an important role in the stone's durability.

Weathering perhaps makes its most obvious impact on a sedimentary rock along its original lamination or bedding. Water penetrates the rock most easily along such places which may eventually become deeply etched. A block in which such lamination is invisible in its newly dressed state may thus come to exhibit details of this fabric. This is especially true if differences, even comparatively small ones, are present in the grain size and cement of individual laminae.

Throughout the Priory good examples of lamination enhanced by preferential weathering may be seen in both the St Bees Sandstone and the Carboniferous stones (eg Figures 9, 28 and 31). The effect of deep weathering on cross-bedded St Bees Sandstone is illustrated in Figure 50. Severe deterioration of St Bees Sandstone along bedding planes is conspicuous in the arch above the east window of the North Transept. Early attempts have been made to repair this decaying stone with red-coloured cement.

Disintegration of the stone along the bedding has its most rapid effect when blocks are incorrectly laid. It is good masonry practice to lay sedimentary rocks, where possible, with bedding in its original orientation, ie horizontal and at right angles to the face of the wall. In a free-stone such as the St Bees Sandstone this is not always obvious in a newly dressed block, even to a skilled mason. Where a stone is incorrectly laid, with bedding parallel to the face of the wall it is said to be 'face-bedded'. When subjected to normal weathering such a block may weather relatively rapidly compared to its correctly laid neighbours. Such blocks may then rapidly become conspicuous hollows in otherwise smooth walls.

Several instances of 'face-bedding' in both St Bees and Carboniferous sandstones are present within the Priory. A striking example in the former stone is shown in Figure 10.

An unusual cavernous weathering of St Bees Sandstone, perhaps due to the leaching of a patchy calcareous cement, is conspicuous in a block in the south wall of the Prior's House (Figure 52).

A distinctly 'pock-marked' appearance in buff Carboniferous sandstone may be seen in a few blocks in the east wall of the Prior's House (Figure 53). These may result from the leaching of a cement, perhaps around fossil burrows or rootlets in the sandstones.

The effect of rising dampness on stone durability is well-seen in the deteriorating lower course of Carboniferous sandstone in the outer walls of the Lady Chapel (Figure 54).

3.5 Penrith Sandstone

Slabs of coarse-grained orange-pink sandstone obtained from the Permian Penrith Sandstone are present at a few places in the Priory though in almost all instances these are likely to have been incorporated in comparatively recent times.

The paving of the western end of the Nave and North Aisle are of Penrith Sandstone. St Bees Sandstone is used for this purpose at the eastern end of the church.

Penrith Sandstone paving is also present in the Transept and Choir. The flat tombstone of the child of Charles and Cecilia is of Penrith Sandstone and the tomb of Charles and Rhoda Howard also includes blocks of this stone.

3.6 Limestones

The largest blocks of limestone are used in tombs in the Choir and Sanctuary. The large tomb between the Sanctuary and Lady Chapel is capped by a slab of grey crinoidal limestone 3.8 m long, 1.42 m wide and 0.15 m thick (Figure 55). A slab of apparently very similar, if not identical limestone of similar dimensions, is present in the low platform at the base of the tomb of Sir Thomas Dacre (Figure 24).

In both instances the limestone is covered with a film of surface grime and details of its texture and composition are impossible to determine. Both slabs may originally have been polished.

Two limestone blocks or boulders are present in the rubble core of the walls at the southern end of the Dormitory block (Figures 56 and 57) and in the rubble core of the wall exposed at the south east corner of the Prior's House (Figure 58).

3.7 Other stones

Comparatively few other stone types are present within the fabric.

A cobble of what may be a microgranite is present in the rubble fill of the east wall of the Dormitory (Figure 59). Cobbles of greywacke sandstone occur near here (Figure 60), in the exposed rubble core of the south wall of the Cellarium (Figure 61), in the doorway of the door from the South Transept to the Vestry (Figure 62), and in the south east corner of the Prior's House (Figure 58) where in addition fragments of laminated siltstone, almost certainly of Carboniferous age and old brick are present.

The tombs of Charles Wentworth George Howard and Christopher Edward Howard are of polished pink granite. The sources are not known but the granites appear to be different.

3.8 Sources of stone

No records are known to exist to indicate the sites of quarries which supplied stone at any stage during the construction of the Priory. As has been outlined above two principal types of stone comprise the bulk of the fabric. The relative proportion of these stones, the St Bees Sandstone and Carboniferous sandstones, within the buildings have not been determined but large quantities of both have been employed. Apart from the relatively few instances of specialised uses of stone noted the buildings give the clear impression of being constructed from whichever stone came most easily to hand. Even within masonry erected during one period of building stone has either been obtained from two or more sources simultaneously to give the random pattern of stone distribution noted in places (eg Figures 7, 8, 9 and 10) or supplies of stone from these sources may have alternated to give the large areas composed of predominantly single stone types seen elsewhere (eg Figures 3, 4, 47 and 49).

From a consideration of the geological setting of Lanercost it is clear that both the St Bees Sandstone and Carboniferous sandstones could be obtained in abundance within a few kilometres of the site. Numerous abandoned quarries in both stone types exist in the neighbourhood, some of which are known to have been worked as long ago as Roman times. Roman quarry sites in Carboniferous sandstone are known at Combcrag Wood, approximately 4 km east of Lanercost and in the St Bees Sandstone in the Gelt Valley, south of Brampton.

A considerable amount of stone used in the Priory was undoubtedly specially quarried and shaped, probably on site, to produce the large slabs and blocks used for pillars, lintels, sills and carved mouldings. This is especially so for the St Bees Sandstone, though some Carboniferous stone has been similarly treated. The lithological characteristics of none of the sandstone are sufficiently diagnostic to indicate a precise quarry site. Indeed the features of both the St Bees and Carboniferous sandstones are capable only of indicating their broad geological provenance.

Lanercost stands a little over 1 km south of the course of Hadrian's Wall. The wall is known elsewhere to have provided a convenient source of ready-formed blocks for local building, probably almost since its abandonment. The Priory walls contain a large proportion of stones with the characteristic square outline typical of much of the masonry of Hadrian's Wall. Carboniferous sandstones, which closely resemble those in the Priory form the main constituents of the surviving portion of wall to the north east of Lanercost. One block with a Roman inscription (Figure 63) is present in the east wall of the Western Range of the Cloisters. St Bees Sandstone is a major component of the ruinous stretches of wall which remain to the north west of the Priory. It is therefore likely, or indeed probable, that Hadrian's Wall provided one local quarry for stone during one or more phases of construction of the Priory.

The limestones used for tombs are of Carboniferous age and could well have been obtained from within a few kilometres of the site.

The few cobbles and blocks of greywacke sandstone, limestone and ?microgranite within the rubble fill of the walls is likely to have been obtained on site from the superficial or drift deposits.

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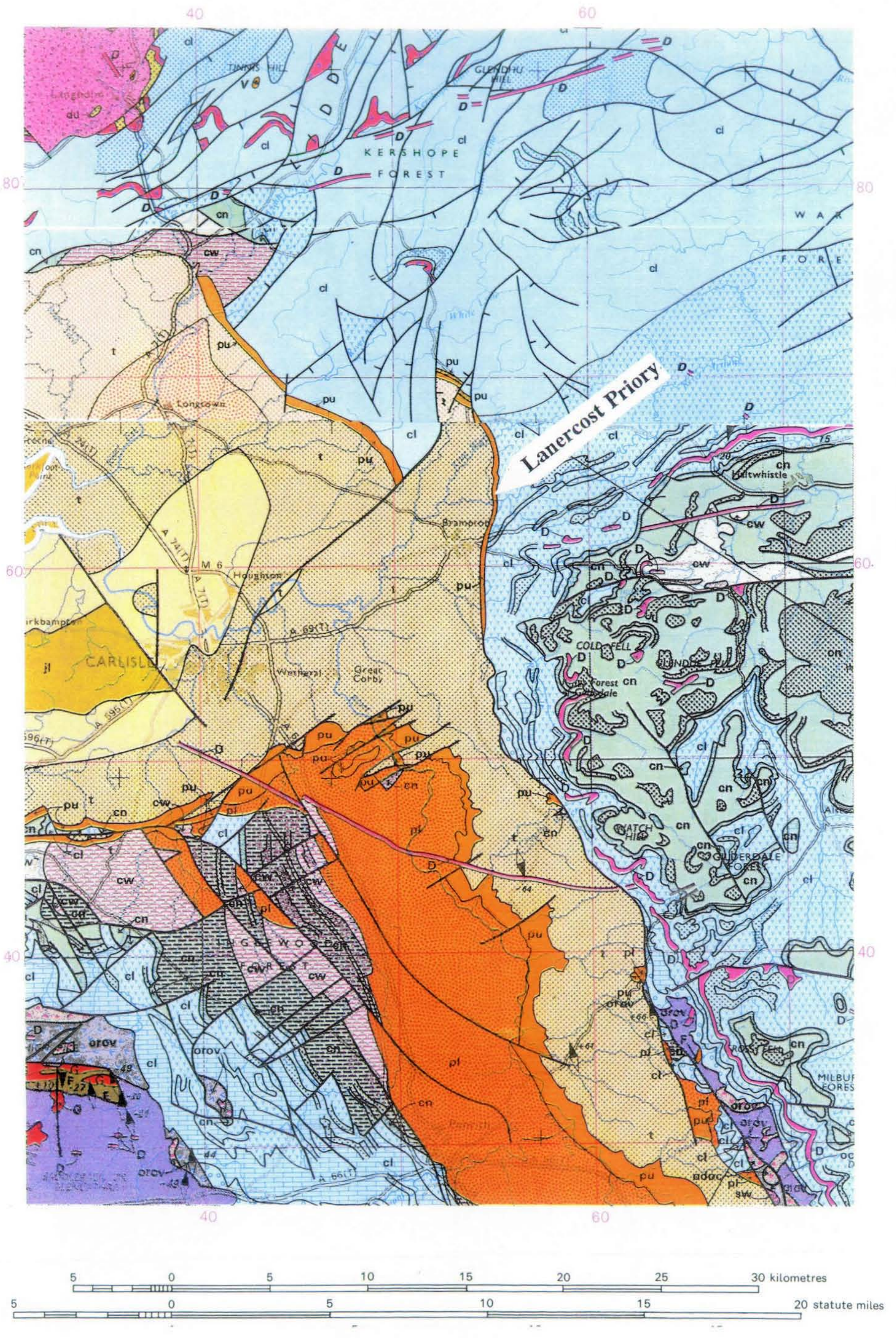
Figure 1. Geological setting of Lanercost Priory. Compilation of extracts of BGS 1:250 000 sheets 55°N-04°W (Borders) and 54°04°W (Lake District).

Figure 2. Geology of Lanercost site. Extract of BGS 1:50 000 sheet 18 (Brampton) Drift.

Figure 1.



Lanercost Priory
KERSHOPE
FOREST
CARLISLE
Longtown
Houghton
Brampton
Wetheral
Haltwhistle
COLD FELL
M 6
40
60
80
30 kilometres
20 statute miles

EXPLANATION OF COLOURS, LITHOLOGICAL ORNAMENT & SYMBOLS

SEDIMENTARY ROCKS

jl	Lower	JURASSIC
t		TRIASSIC
pt	Undivided	PERMIAN & TRIASSIC
pu	Upper	PERMIAN
pl	Lower	PERMIAN
cw	Westphalian	CARBONIFEROUS
cn	Namurian	CARBONIFEROUS
cl	Dinantian	CARBONIFEROUS
dw	Downton	DEVONIAN
su	Ludlow	SILURIAN
sw	Wenlock	SILURIAN
sl	Llandovery	SILURIAN
oa	Ashgill	ORDOVICIAN
oc	Caradoc	ORDOVICIAN
od	Llandeilo	ORDOVICIAN
ov	Llanvirn	ORDOVICIAN
or	Arenig	ORDOVICIAN

LITHOLOGICAL ORNAMENT

- Yoredale facies
- Sandstone
- Dune-bedded sandstone
- Greywacke
- Conglomerate
- Reddened beds
- Limestone
- Lava
- Tuff

IGNEOUS ROCKS

Extrusive

Lavas	Basic	in Carboniferous
Tuffs, undivided	Mainly intermediate	in Ordovician
Rhyolite lavas	Acid	in Ordovician
Andesite lavas	Intermediate	in Ordovician
Basalt lavas	Basic	in Ordovician

Intrusive

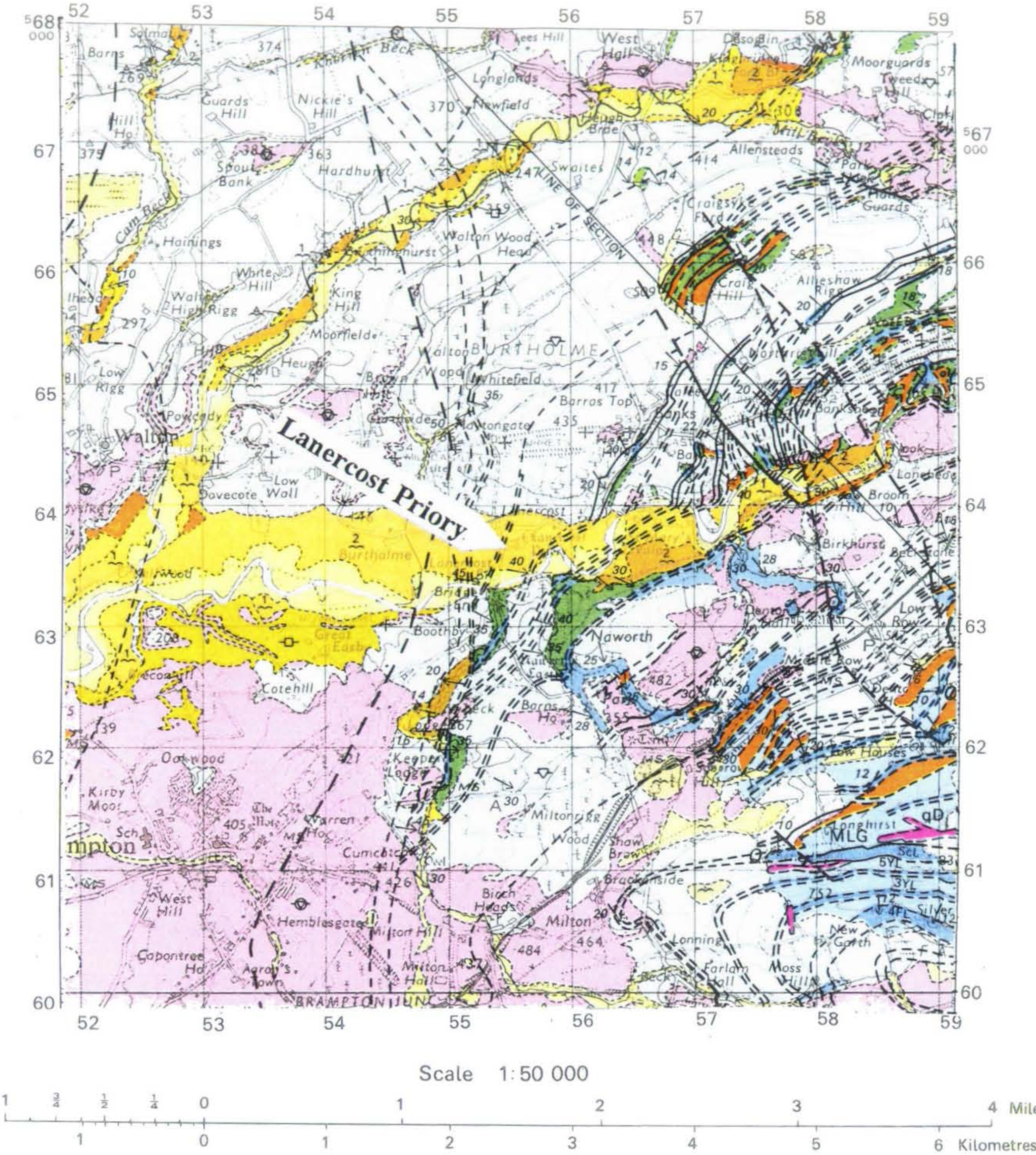
G	Coarse-grained	Acid
F	Fine-grained	Acid
P	Fine-grained	Intermediate
E	Coarse-grained	Basic
D	Fine-grained	Basic

Geological boundary, solid

Fault at surface

45 *Mean direction of the stable natural remanent magnetization relative to local bedding. The orientation of the "compass" symbol indicates magnetic declination, the solid tip being north-seeking and located at the point of measurement. The inclination is given in degrees, positive downwards from the horizontal.*

Figure 2.



Lanercost Priory
LINE OF SECTION
Scale 1: 50 000
Miles
Kilometres

EXPLANATION OF GEOLOGICAL SYMBOLS AND COLOURS

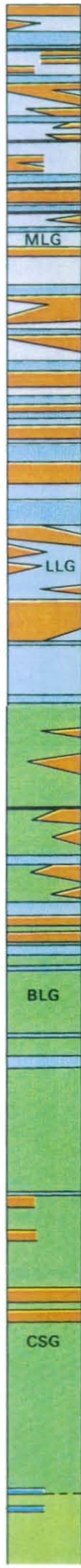
RECENT AND PLEISTOCENE (Not drawn to scale)

- Peat
- Alluvium
- First Terrace (in two stages, undivided) Chiefly loam
- Second Terrace (in two stages, undivided) Loam or Gravel
- Third Terrace (in two stages, undivided) Chiefly gravel
- Alluvial Fan Gravel and loam
- Moraine
- Laminated Clay
- Sand and Gravel
- Boulder Clay

PERMIAN AND TRIASSIC

- Stanwix Shales } Mercia Mudstones
- Kirklinton Sandstone
- St Bees Sandstone } Sherwood Sandstones
- St Bees Shales (Eden Shales)
- D- Bed Gypsum
- B- Bed Gypsum
- Basal Conglomerate (Brockram)
- Penrith Sandstone

CARBONIFEROUS



MIDDLE LIMESTONE GROUP

- Base of Great Limestone (GL)
- Sandstone
- Four Fathom Limestone (4FL)
- COAL
- Sandstone
- Three Yard Limestone (3YL)
- Sandstone
- Five Yard Limestone (5YL)
- COAL
- Scar Limestone (ScL)
- COAL
- Sandstone
- Limestone
- COAL
- Sandstone
- Limestone
- Sandstone
- Tyne Bottom Limestone (TBL)
- Sandstone
- Jew Limestone (JL)
- Sandstone
- Greengate Well Limestone (GWL)
- Sandstone
- Bankhouses Limestone (BL) = Smiddy Limestone (SmL)

LOWER LIMESTONE GROUP

- Sandstone
- Low Tipalt Limestone (LTL)
- Sandstone
- Limestone } Melmerby Scar Limestone (MSL)
- Sandstone } Melmerby Scar Limestone (MSL)
- Denton Mill Limestone (DL) } Melmerby Scar Limestone (MSL)
- Sandstone
- Sandstone
- Limestone
- Naworth Limestone (NL)

BIRDOSWALD LIMESTONE GROUP

- Sandstone
- Sandstone
- THIRLWALL COAL (ThC)
- Sandstone
- Sandstone
- Limestone
- Sandstone
- Leahill Limestone (LhL)
- Sandstone
- Sandstone
- Appletree Limestone (AL)
- Limestone
- Limestone
- Millerhill Limestone (ML)
- Lanercost Limestone (LanL)

CRAIGHILL SANDSTONE GROUP

- Sandstone
- Sandstone
- Limestone

FELL SANDSTONE GROUP

- Limestone

Quartz Dolerite

GENERALIZED VERTICAL SECTIONS

Scale 1:5 000

Figure 3.	Eastern end of Sanctuary. St Bees Sandstone (red) and Carboniferous sandstone (grey to buff).
Figure 4.	South wall of Sanctuary and Chapel of St Catherine. St Bees Sandstone (red) and Carboniferous sandstone (mainly grey to buff). Note the reddened Carboniferous sandstone blocks (arrowed) beneath Clerestory window.
Figure 5.	South wall of South Transept. St Bees Sandstone (red) and Carboniferous sandstone (grey to buff).

Figure 3.

Figure 4.

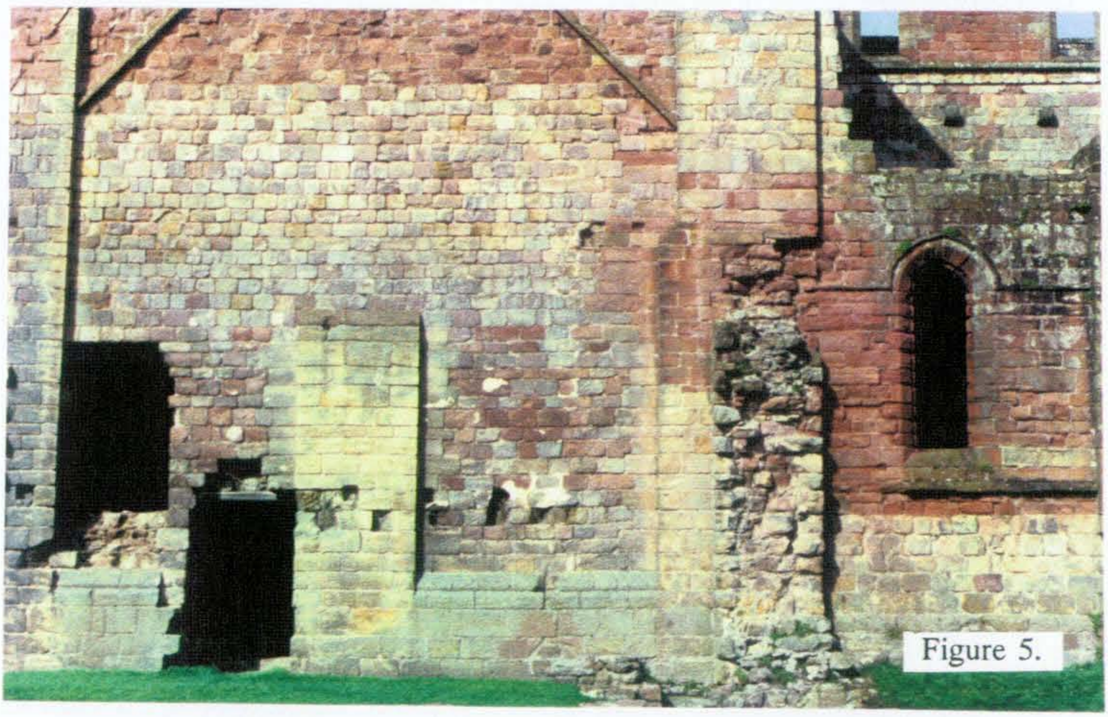


Figure 5.

Figure 6. East wall of Prior's House. Mainly Carboniferous sandstone (grey to buff) with St Bees Sandstone (red) quoins and windows.

Figure 7. South corner of West Front. Simultaneous use of St Bees and Carboniferous sandstone.

Figure 8. North wall of Nave and North Transept. Simultaneous use of St Bees and Carboniferous sandstone.

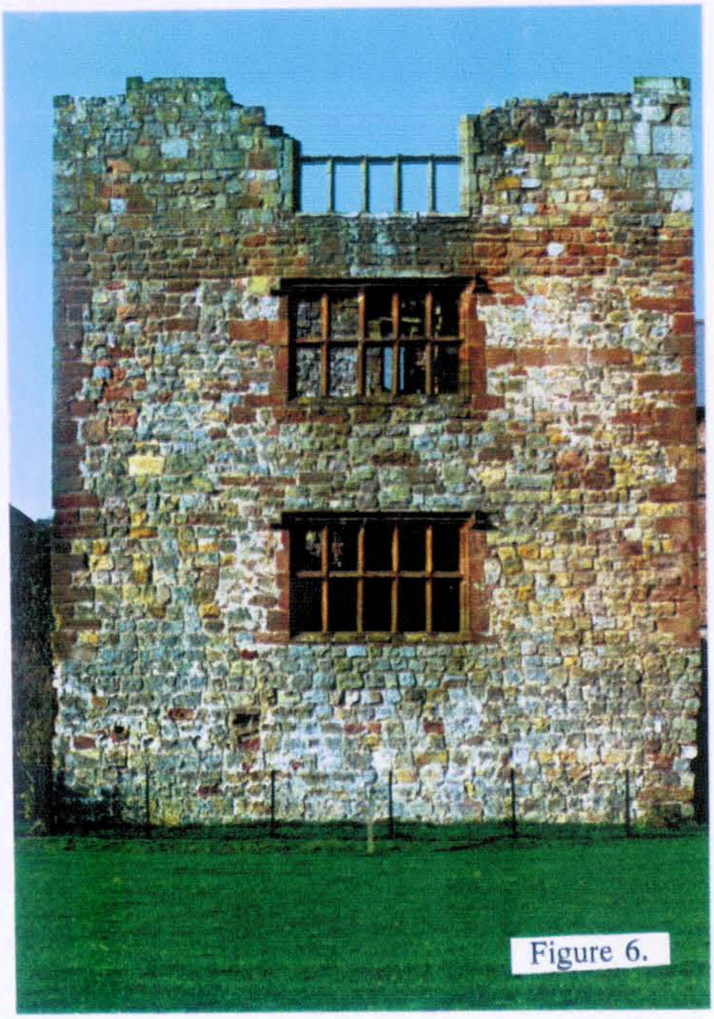


Figure 6.

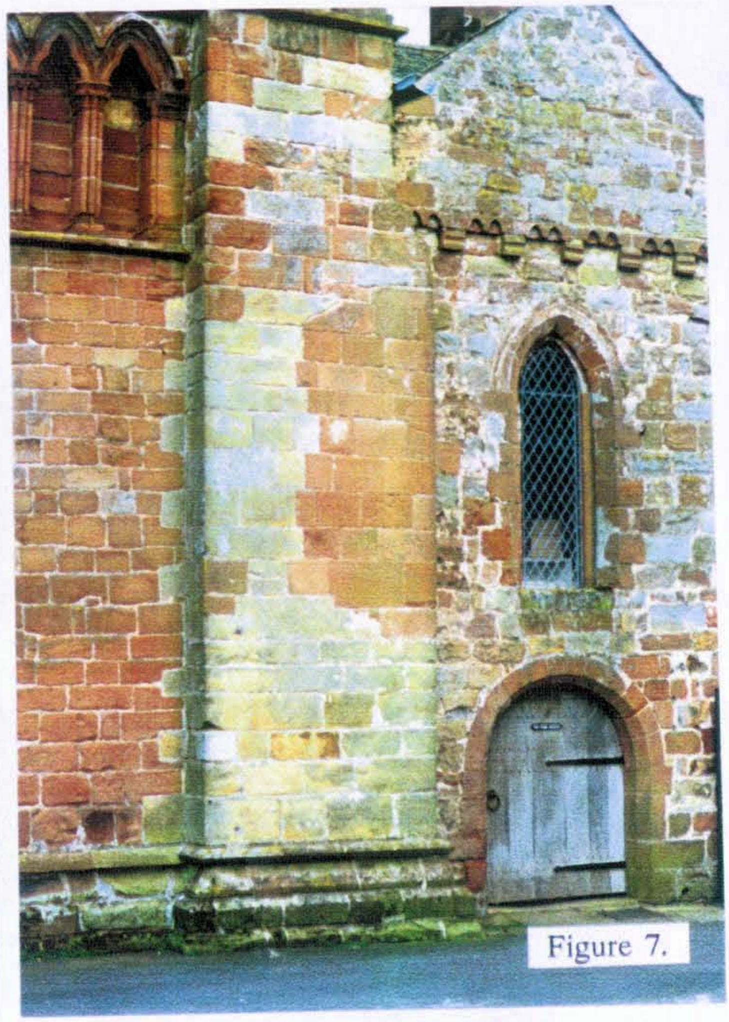


Figure 7.

Figure 8.

Figure 9. East wall of South Transept. Minor colour variations in St. Bees Sandstones (red). Note also varying intensity of weathering along lamination in this stone. Liesgang rings are conspicuous in a quoin of yellowish brown Carboniferous sandstone near the base of the wall.

Figure 10. East face of wall of Chapel of St Catherine. Parallel lamination in St Bees Sandstone (block A). The lower block (B) is 'face-bedded' and is considerably in-weathered.

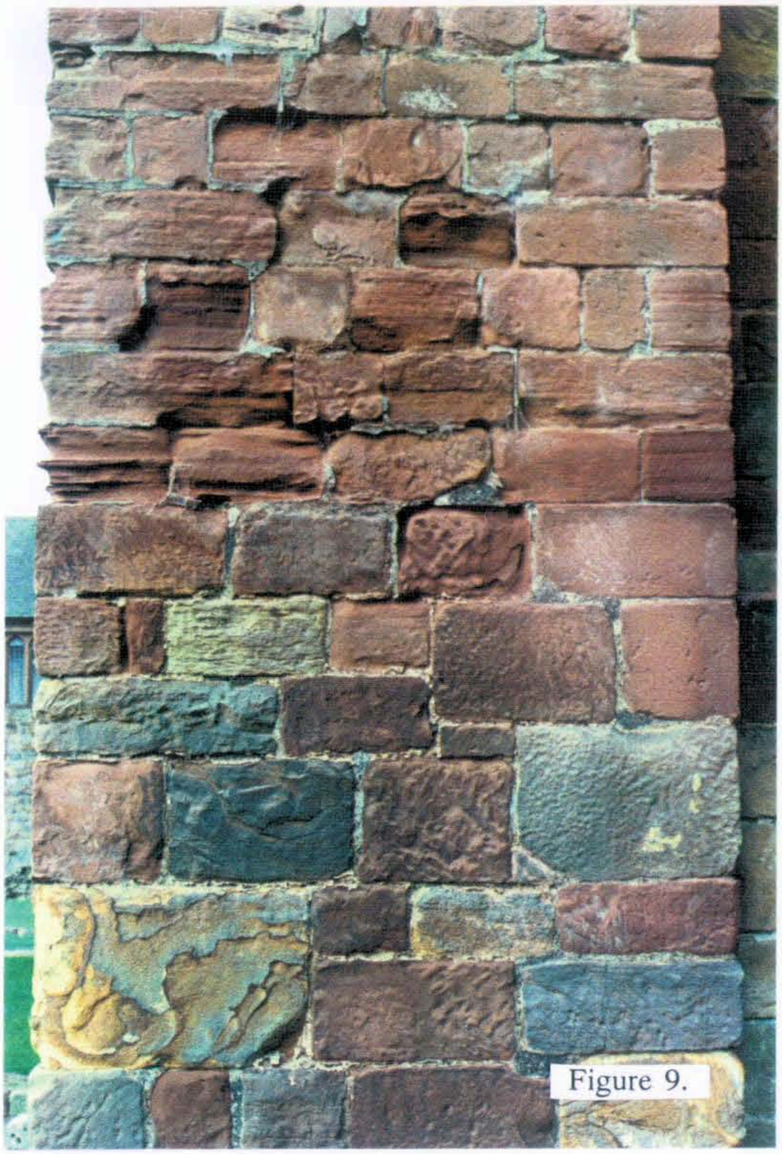


Figure 9.

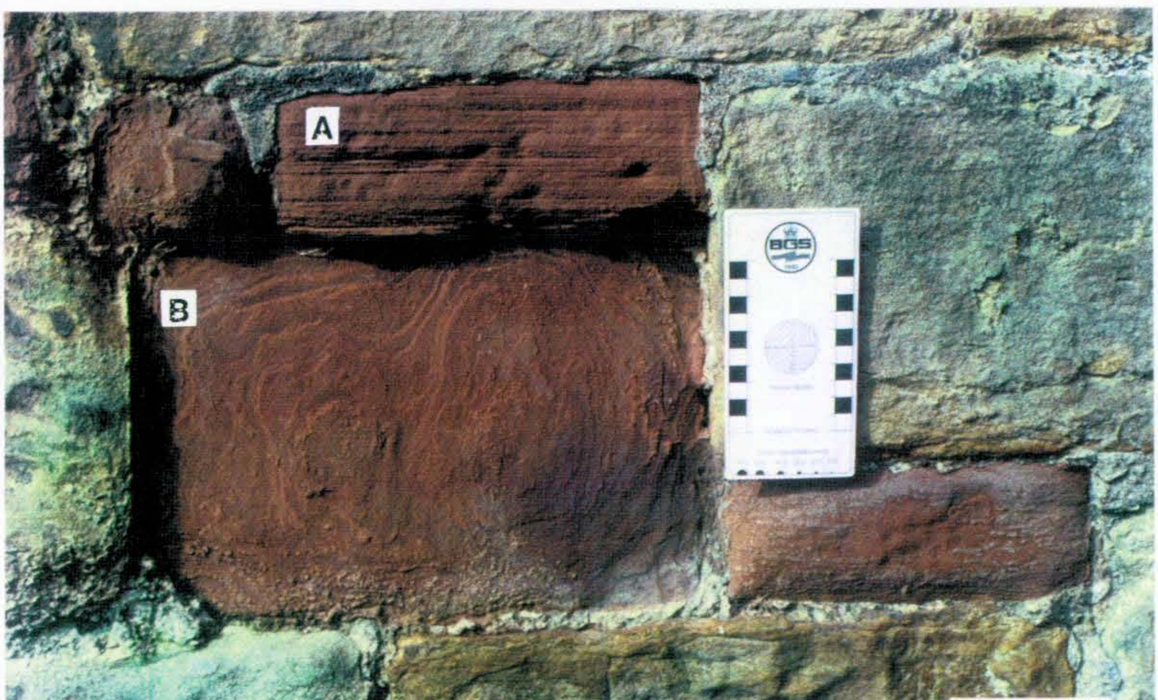


Figure 10.

Figure 11. North side of doorway from South Transept to Vestry. Colour variation in St Bees Sandstone lintel.

Figure 12. South east side of canopy over tomb of Sir Thomas Dacre. Colour variation in St Bees Sandstone.

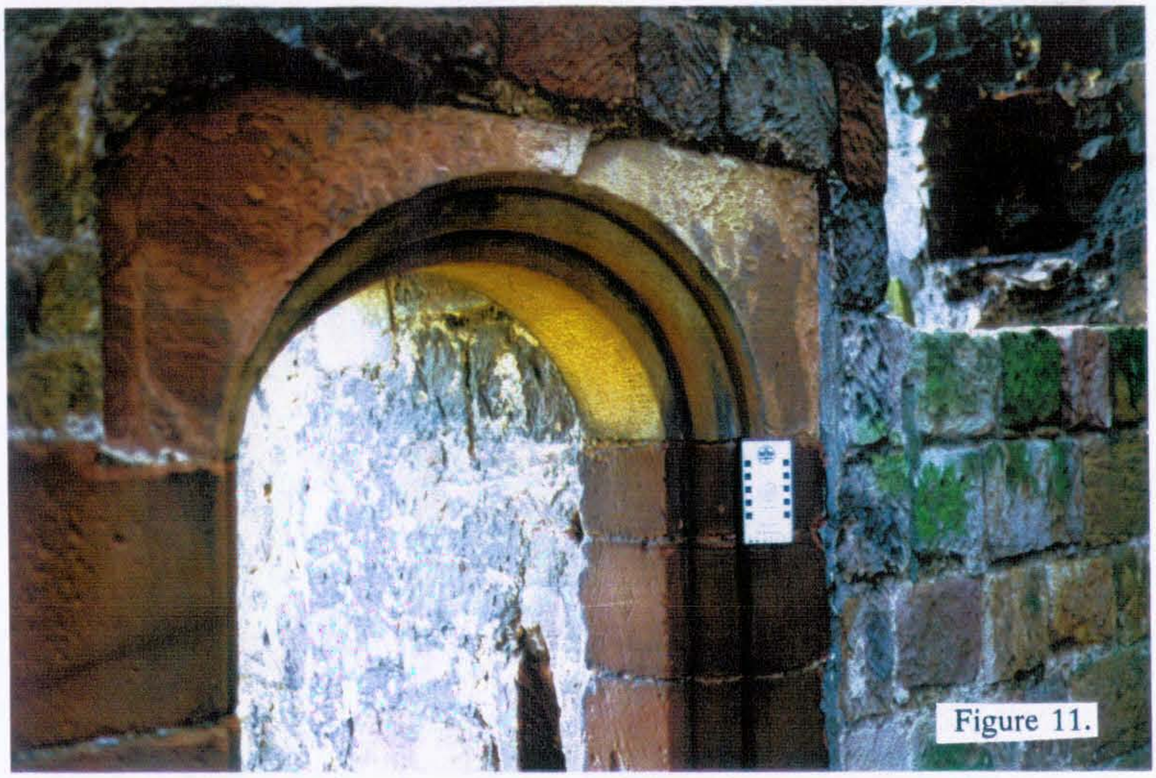


Figure 11.

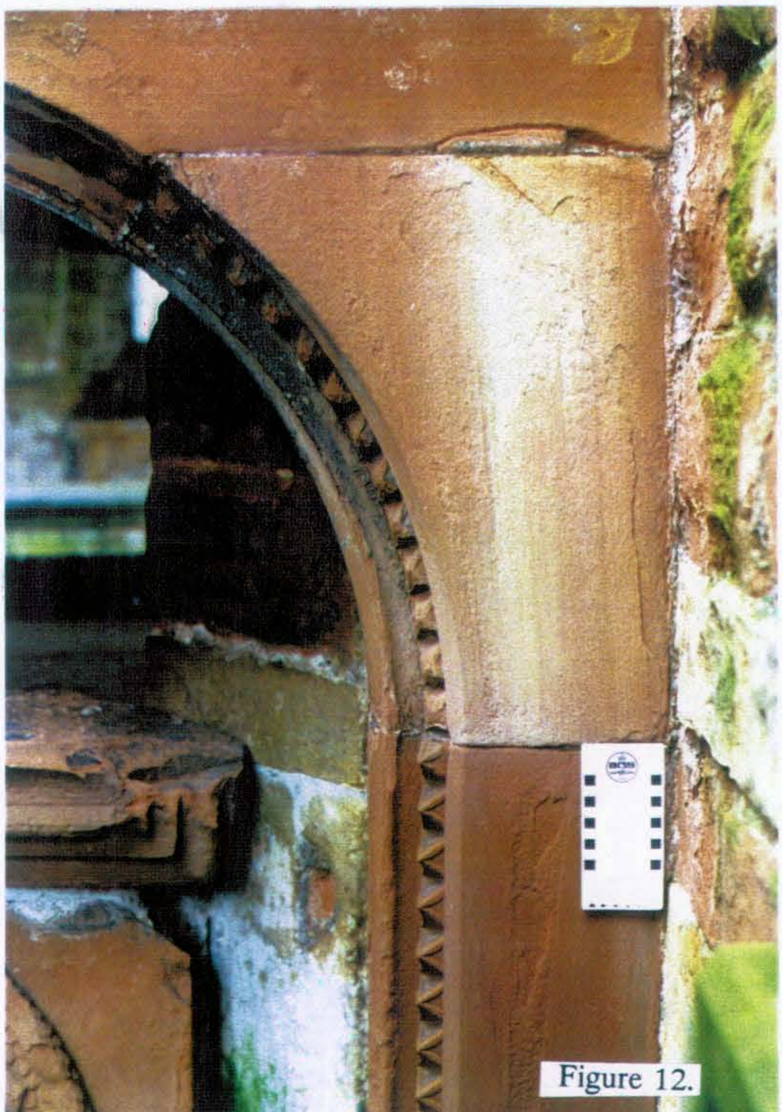


Figure 12.

Figure 13. Nave and North Aisle. Pillars and arches of colour-washed St Bees Sandstone.

Figure 14. Pillar between Nave and North Aisle. Detail of colour-washed St Bees Sandstone.

Figure 15. Pillar between Choir and South Transept. Large dressed blocks of St Bees Sandstone.

Figure 13.

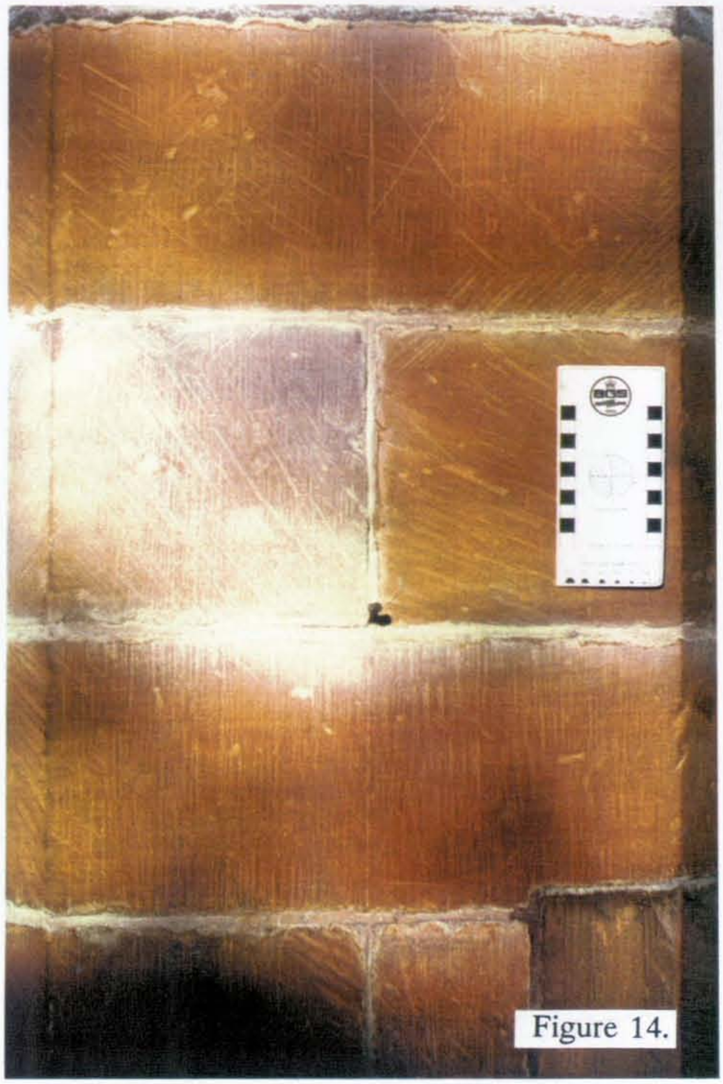


Figure 14.

Figure 15.

Figure 16. East wall of South Transept. Cross-bedding in St Bees Sandstone.

Figure 17. South wall of Cellarium. Cross-bedding in lintel of St Bees Sandstone. Remainder of wall of Carboniferous sandstone.

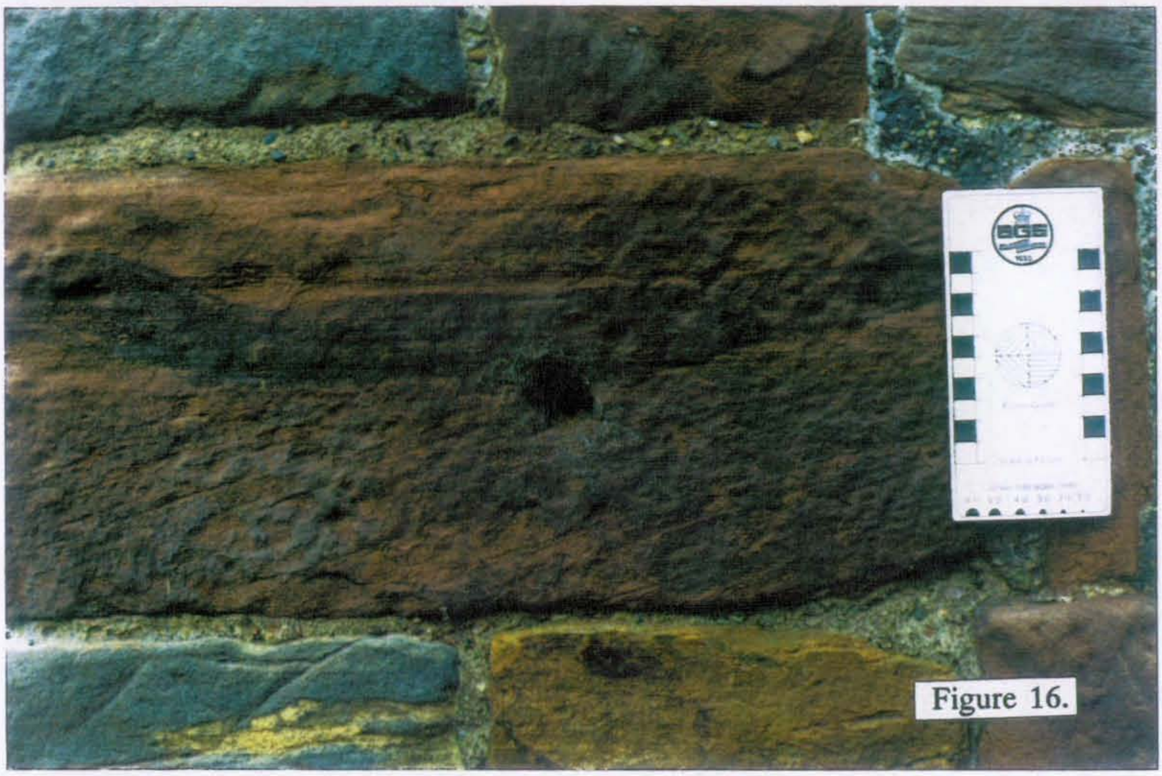


Figure 16.

Figure 17.

Figure 18. West Front. Carved St Bees Sandstone.

Figure 19. West Front. Carved St Bees Sandstone.

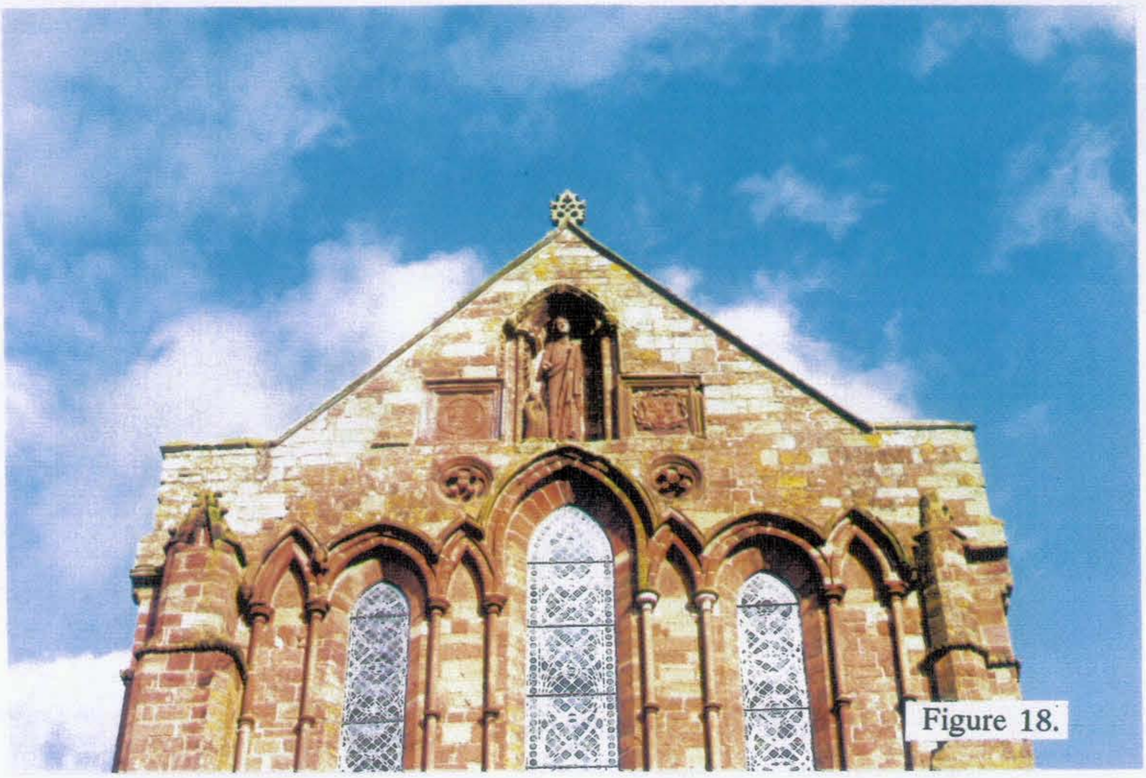


Figure 18.

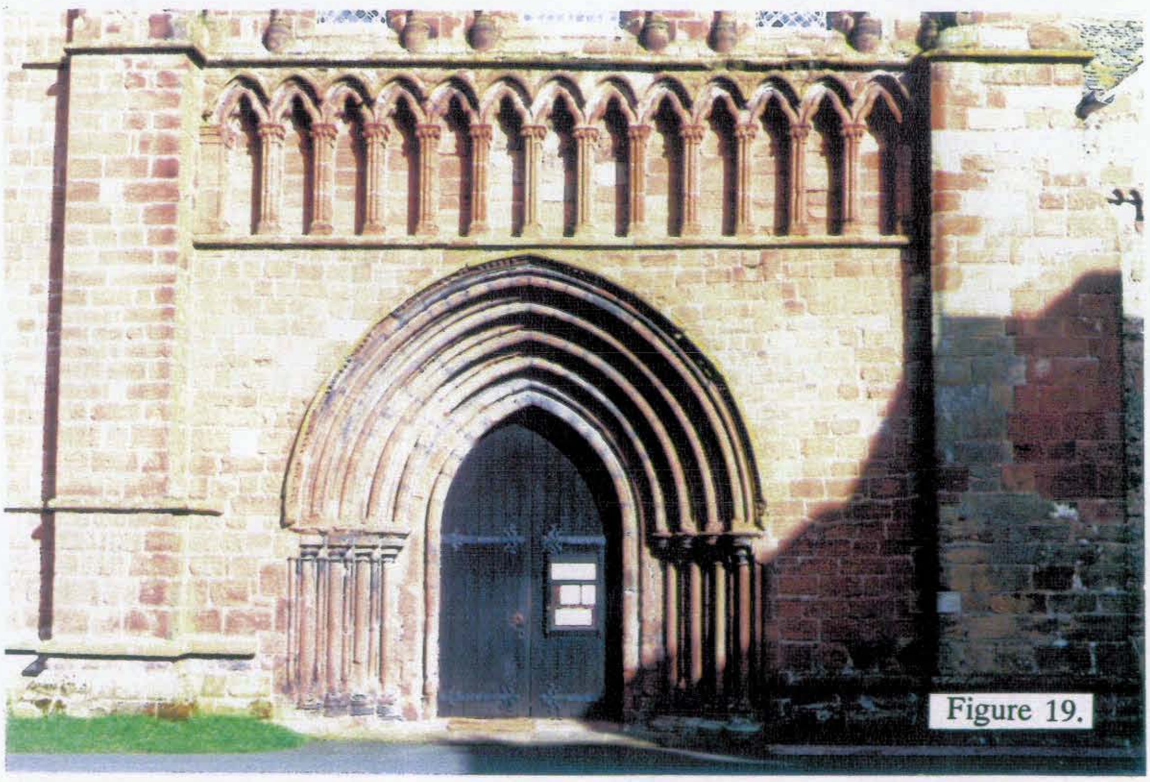


Figure 19.

Figure 20.	East window, Chapel of St Catherine. Carved St Bees Sandstone.
Figure 21.	West range of Cloisters. Windows and doorway of St Bees Sandstone. Remainder of wall mainly Carboniferous sandstone.
Figure 22.	Arching above Lavatorium. Carved St Bees Sandstone.

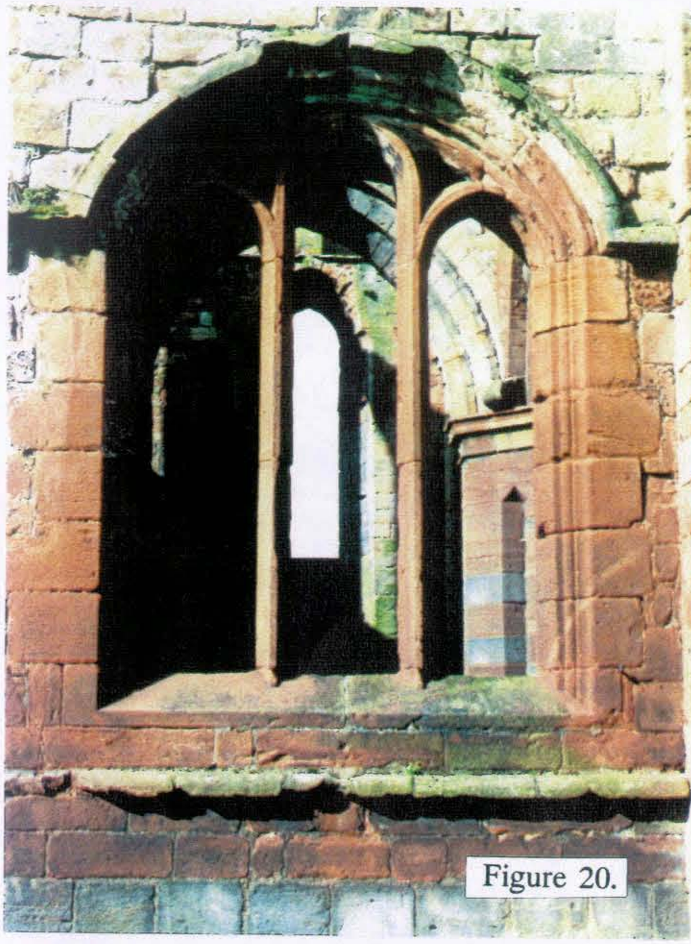


Figure 20.


Figure 22.


Figure 21.

Carved St Bees Sandstone

Figure 23. South face of tomb of Sir Thomas Dacre.

Figure 24. North face of tomb of Sir Thomas Dacre. Large dressed slab of grey limestone at foot of tomb.

Figure 25. Monument to Charles James Howard.

Figure 23.

Figure 24.

Figure 25.

Carboniferous sandstone

Figure 26. East wall of Sanctuary.

Figure 27. South wall of Sanctuary.

Figure 28. West wall of South Transept.


Figure 26.

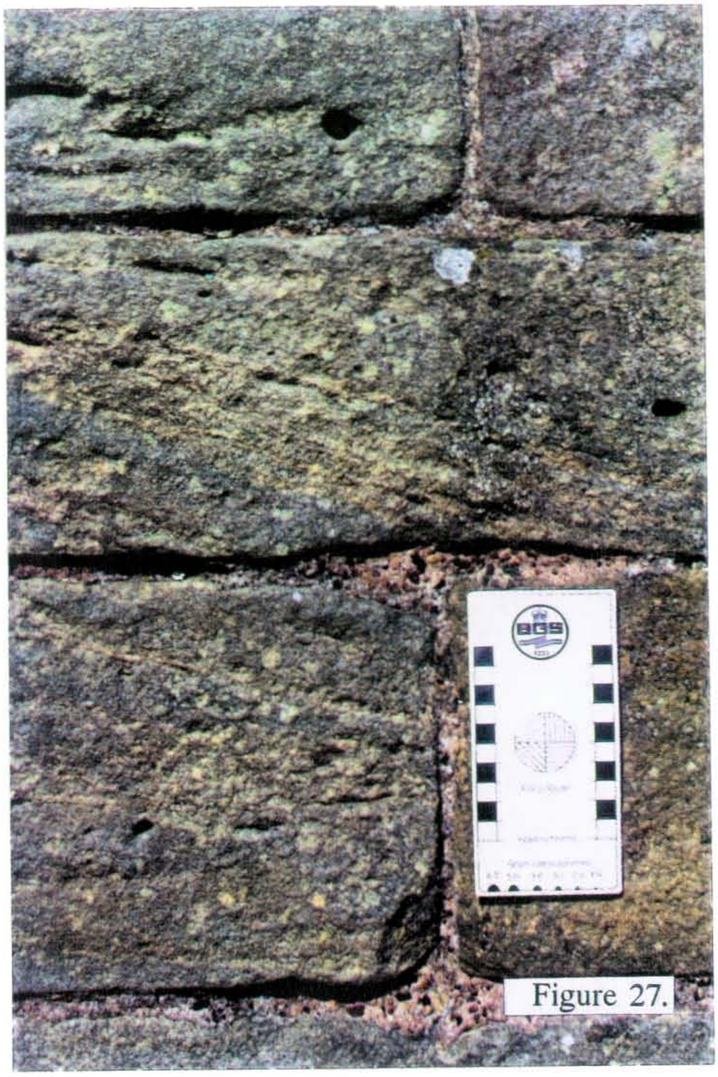


Figure 27.


Figure 28.

Figure 29. East wall of Sanctuary. Cross-bedding in Carboniferous sandstone accentuated by brown iron-oxides. A few grains of off-white kaolinised feldspar may be seen in places.

Figure 30. North wall of Lady Chapel. Cross-bedding in Carboniferous sandstone accentuated by brown iron-oxides. This block is inverted.

Figure 31. East wall of South Transept. Weathered ripple cross-lamination in Carboniferous sandstone.

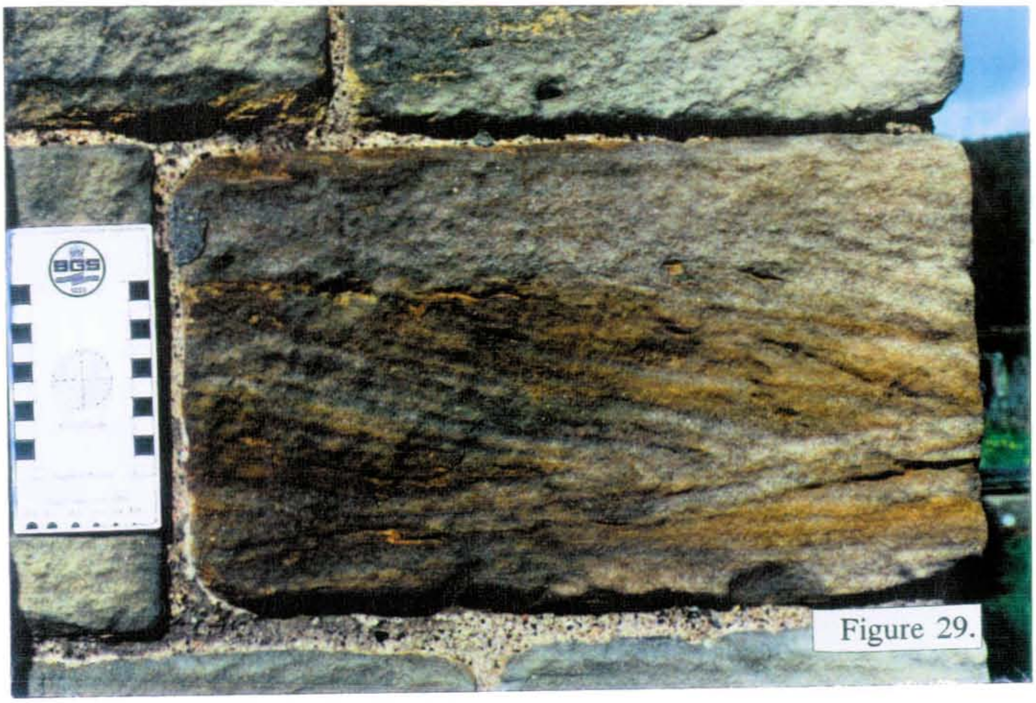


Figure 29.

Figure 30.

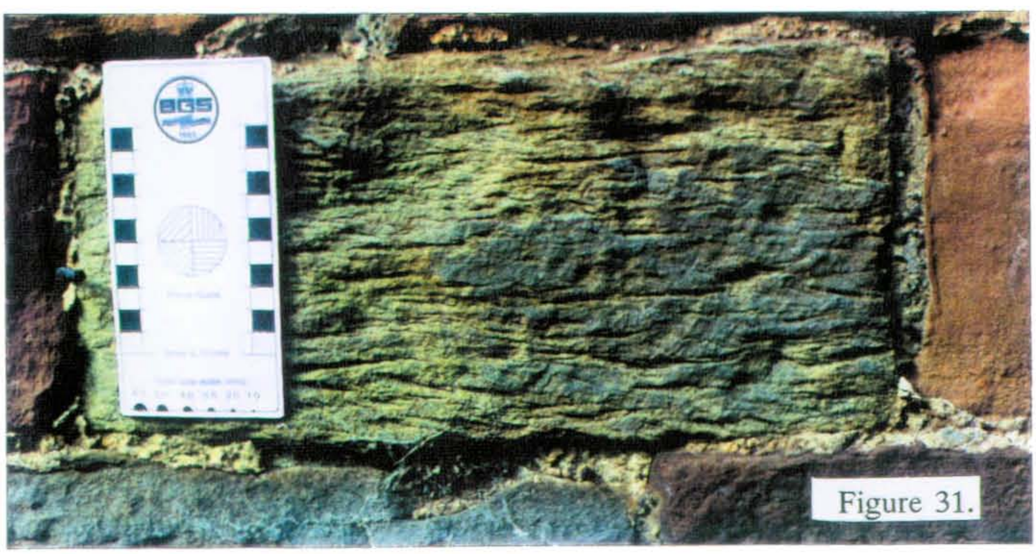


Figure 31.

Worm burrows in Carboniferous sandstone

Figure 32.

In rubble core of New Chapter House walls.

Figure 33.

Figure 34. South wall of Nave. Brown-speckled Carboniferous sandstone.

Figure 35. South east corner of South Transept. Liesgang rings of brown iron-oxide in Carboniferous sandstone.

Figure 34.

Figure 35.

Figure 36. Pillar in North Transept. Yellow Carboniferous sandstone.

Figure 37. Pillar in North Transept. Dressed blocks of yellow Carboniferous sandstone with some St Bees Sandstone.

Figure 36.

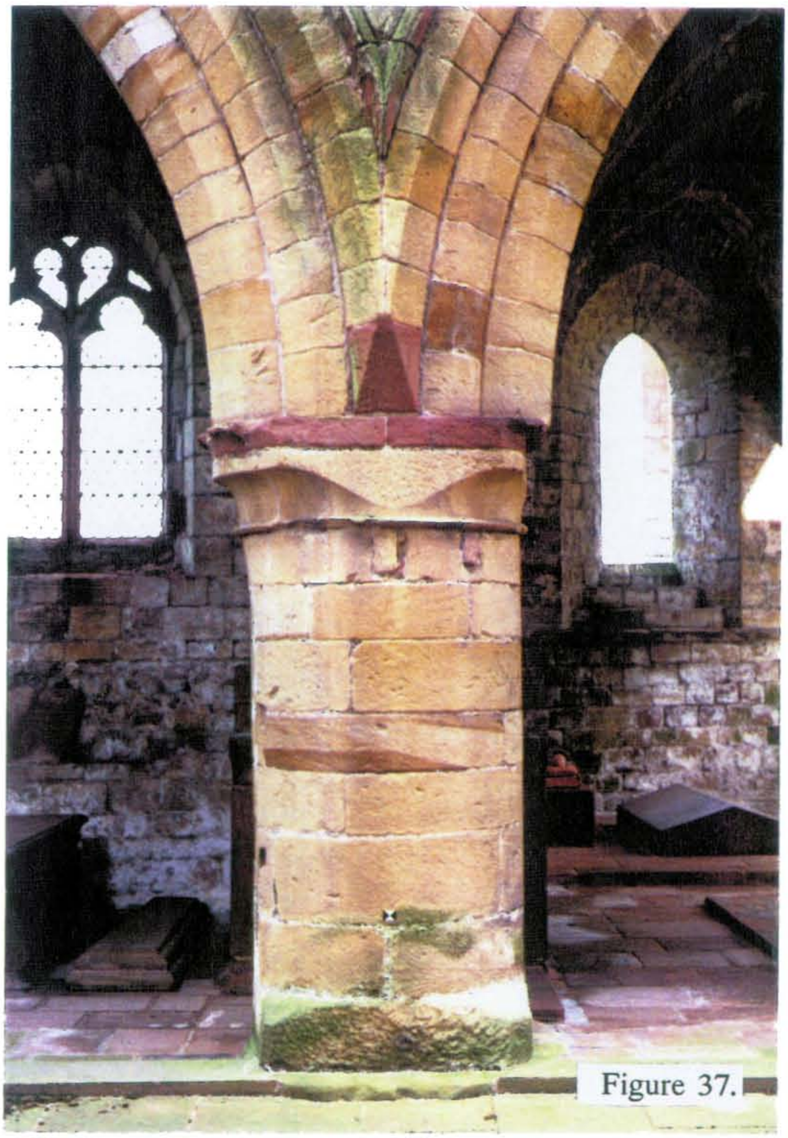


Figure 37.

White Carboniferous sandstone

Figure 38 and 39. South wall of South Transept. Squared blocks, possibly derived from Hadrian's Wall. Traces of cross-bedding may be seen in the lower left-hand block in Figure 39.

Figure 40. South wall of Nave. Small in-weathered hollows.

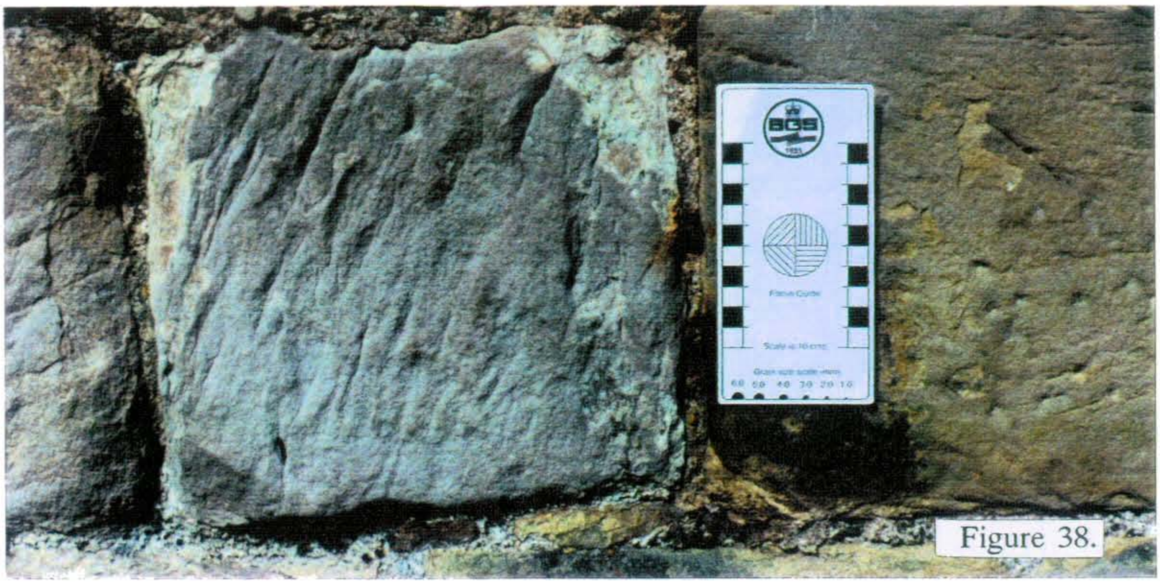


Figure 38.

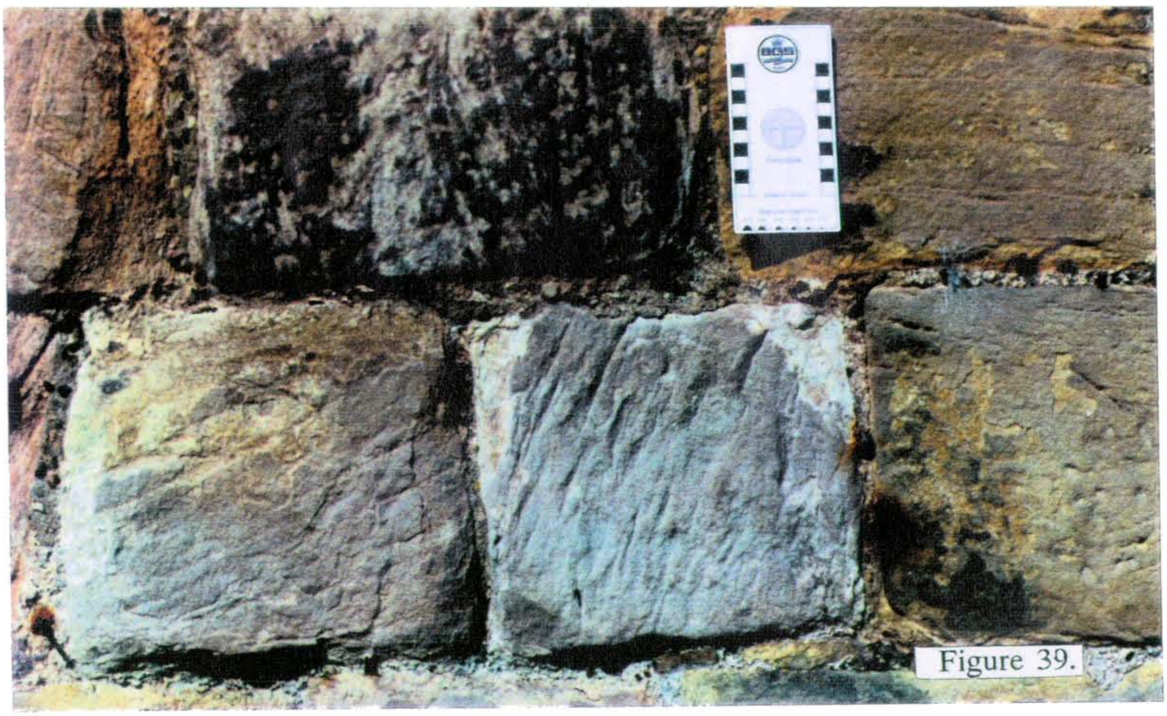


Figure 39.

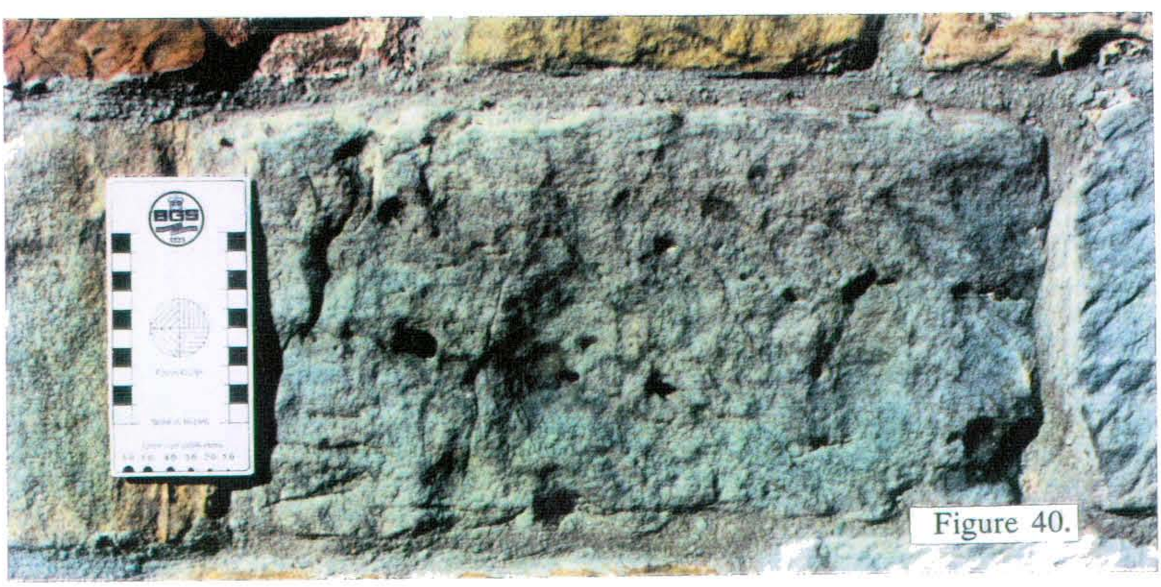


Figure 40.

Reddened Carboniferous sandstone

Figure 41. West wall of South Transept.

Figure 42. South wall of South Transept.

Figure 41.

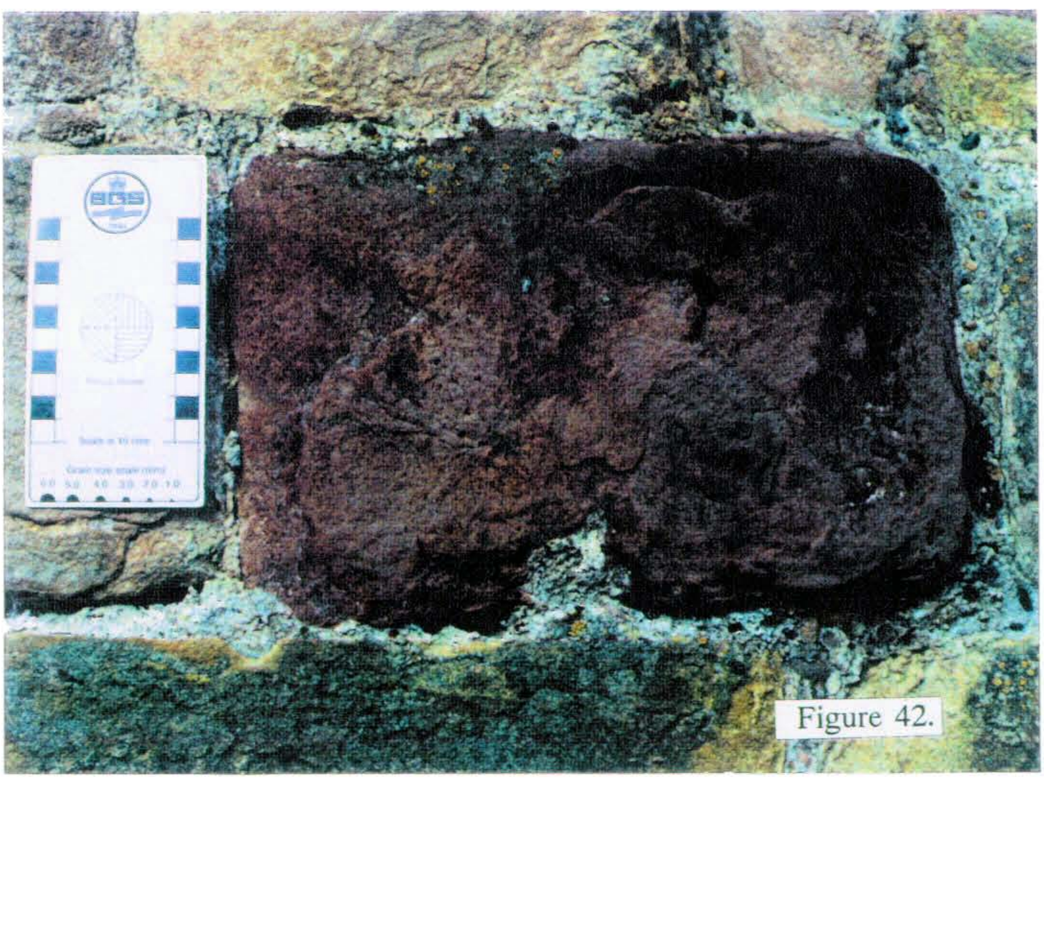


Figure 42.

Reddened Carboniferous sandstone

Figure 43. South wall of Nave. Spots of ?hematite-rich pigment.

Figure 44. Rubble core of wall, New Chapter House. Intense patchy ?hematite pigmentation.

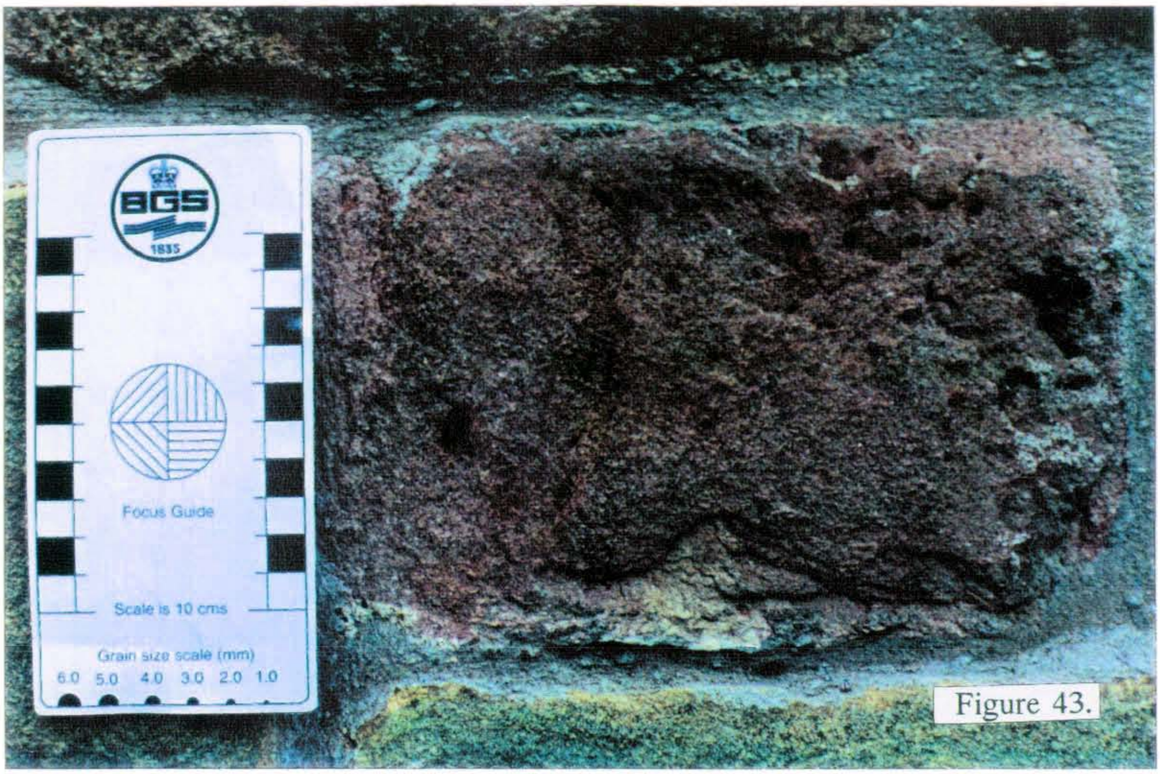


Figure 43.

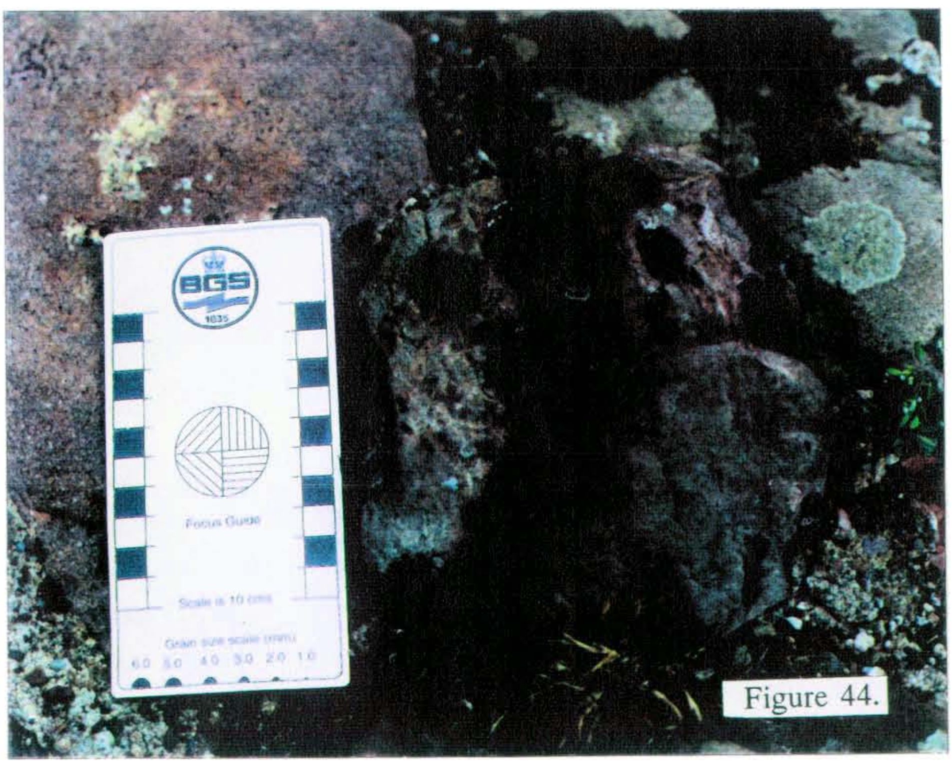


Figure 44.

Carved Carboniferous sandstone

Figure 45. South wall of Nave, doorway. The modern masonry blocking the archway is St Bees Sandstone.

Figure 46. Arch above doorway, west wall of South Transept.

Figure 47. West wall of South Transept.

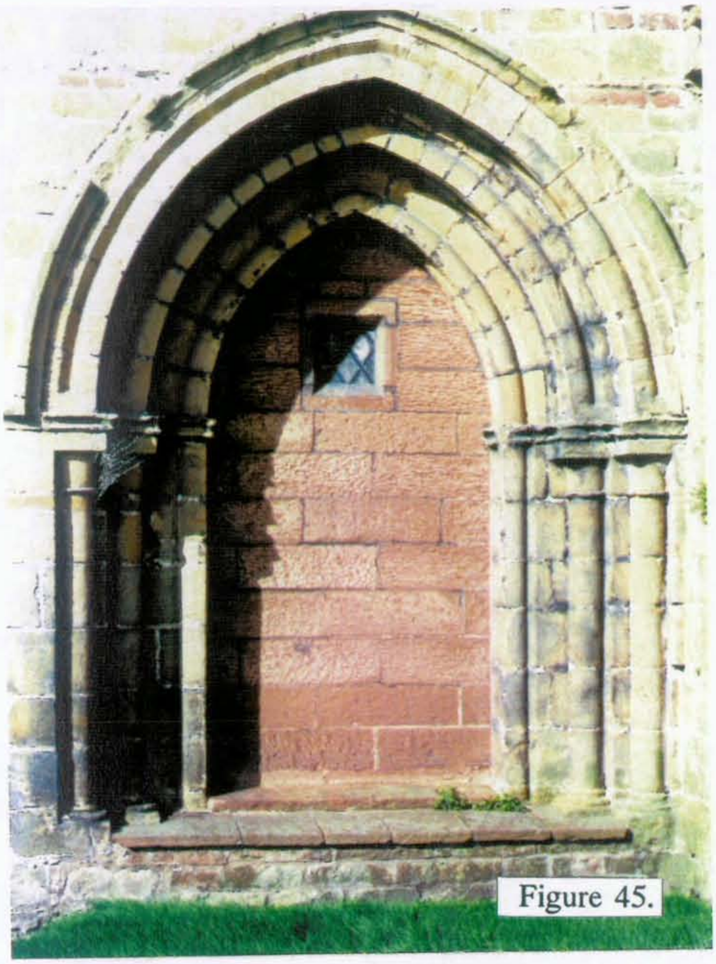


Figure 45.

Figure 46.

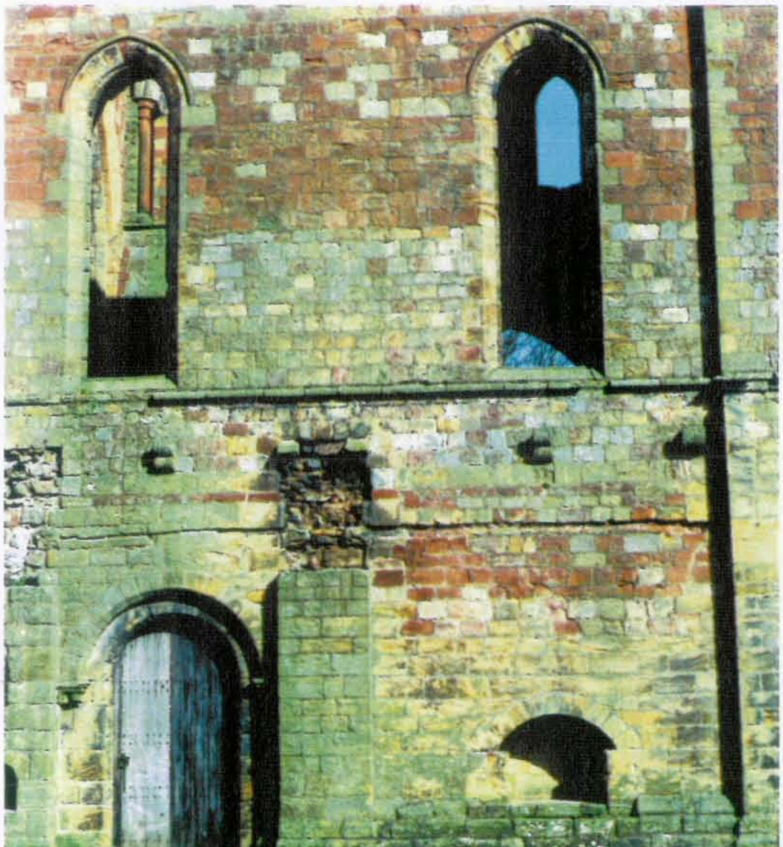


Figure 47.

Carved Carboniferous sandstone

Figure 48. Window in north side of West Front. The red masonry is St Bees Sandstone.

Figure 49. North side of Sanctuary. Arching in Clerestory is of Carboniferous sandstone. The red masonry in the lower walls is St Bees Sandstone.

Figure 48.

Figure 49.

Figure 50. West Front. Deeply weathered cross-bedded St Bees Sandstone.

Figure 51. East window of north Transept. Marked deterioration in St Bees Sandstone in top of arch with patchy repairs in red cement.

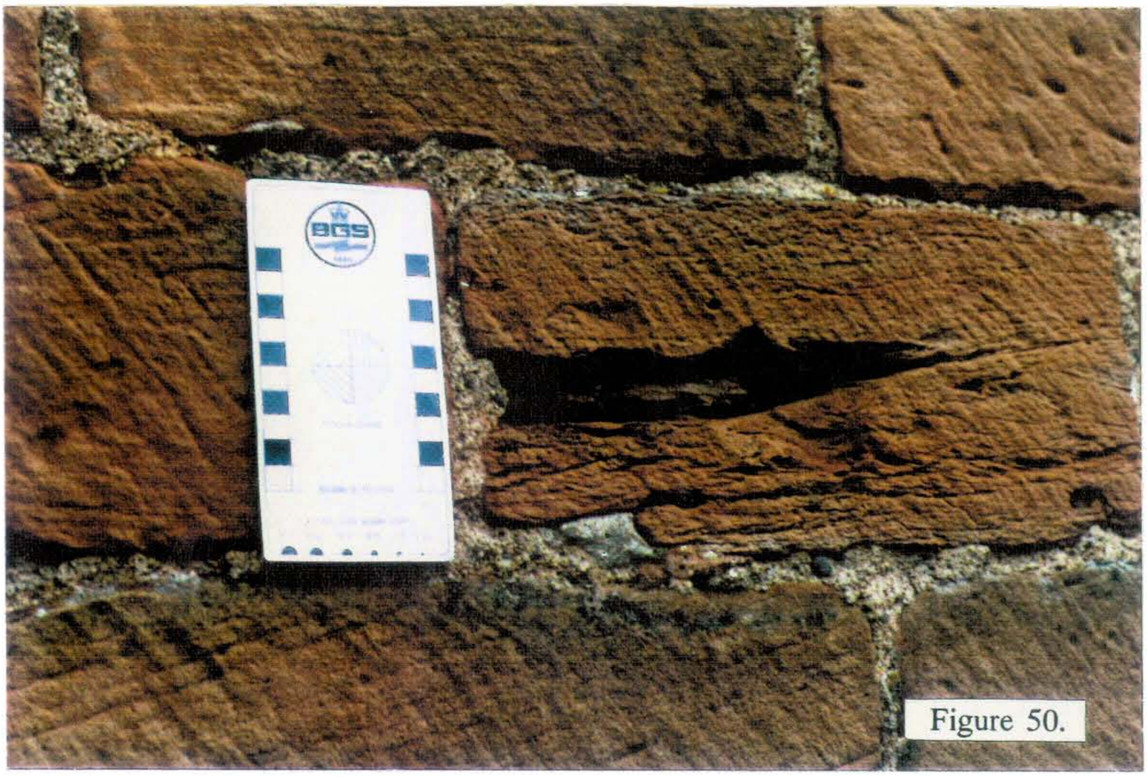


Figure 50.

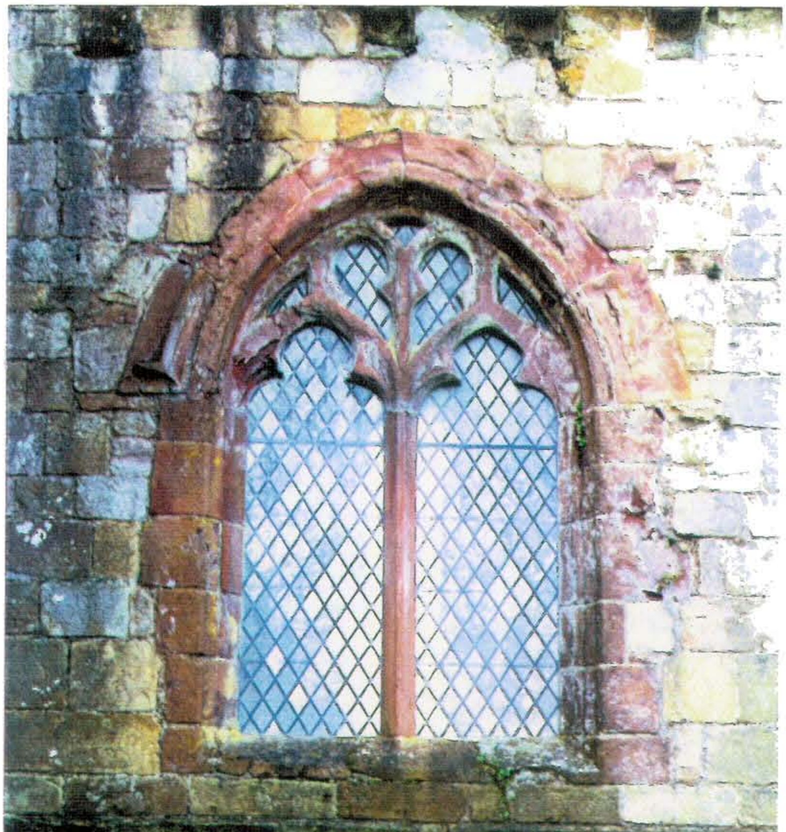


Figure 51.

Figure 52. South wall of Prior's House. Cavernous weathering of St Bees Sandstone.

Figure 53. East wall of Prior's House. 'Pock-marked' Carboniferous sandstone.

Figure 54. North wall of Lady Chapel. Deterioration of foundation courses of Carboniferous sandstone.

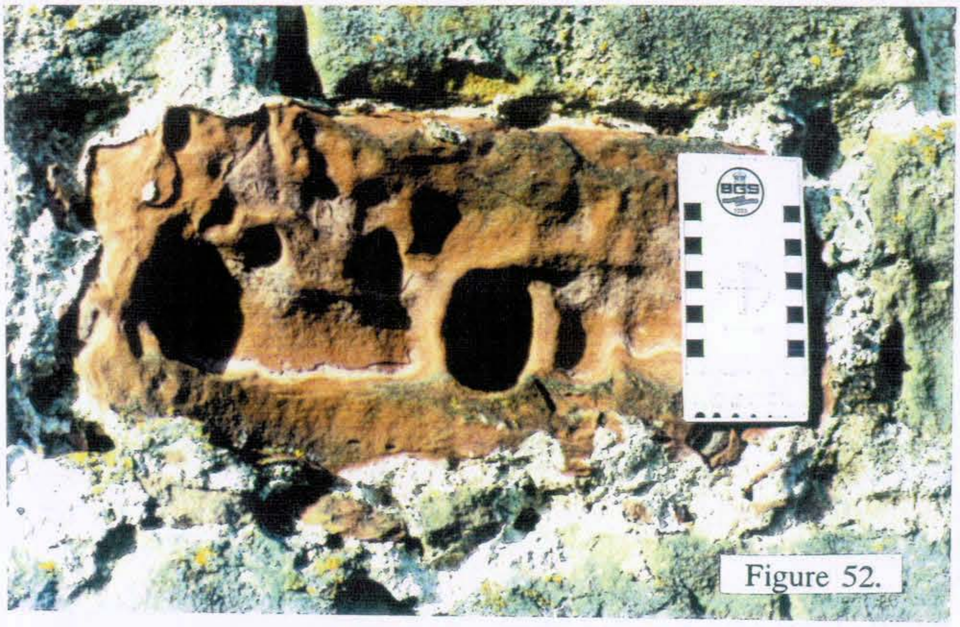


Figure 52.

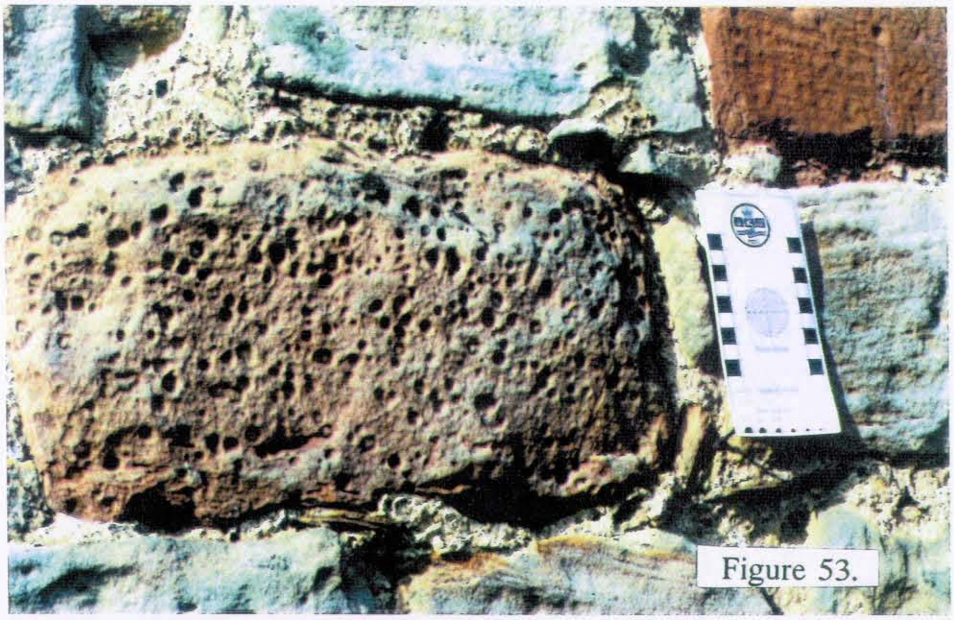


Figure 53.

Figure 54.

Figure 55. Tomb between Sanctuary and Lady Chapel. Carboniferous sandstone capped with large dressed limestone slab.

Figure 56. Rubble core of walls, southern end of Dormitory. Brown limestone cobble.

Figure 57. Rubble core of wall, southern end of Dormitory. Grey limestone cobble.

Figure 55.

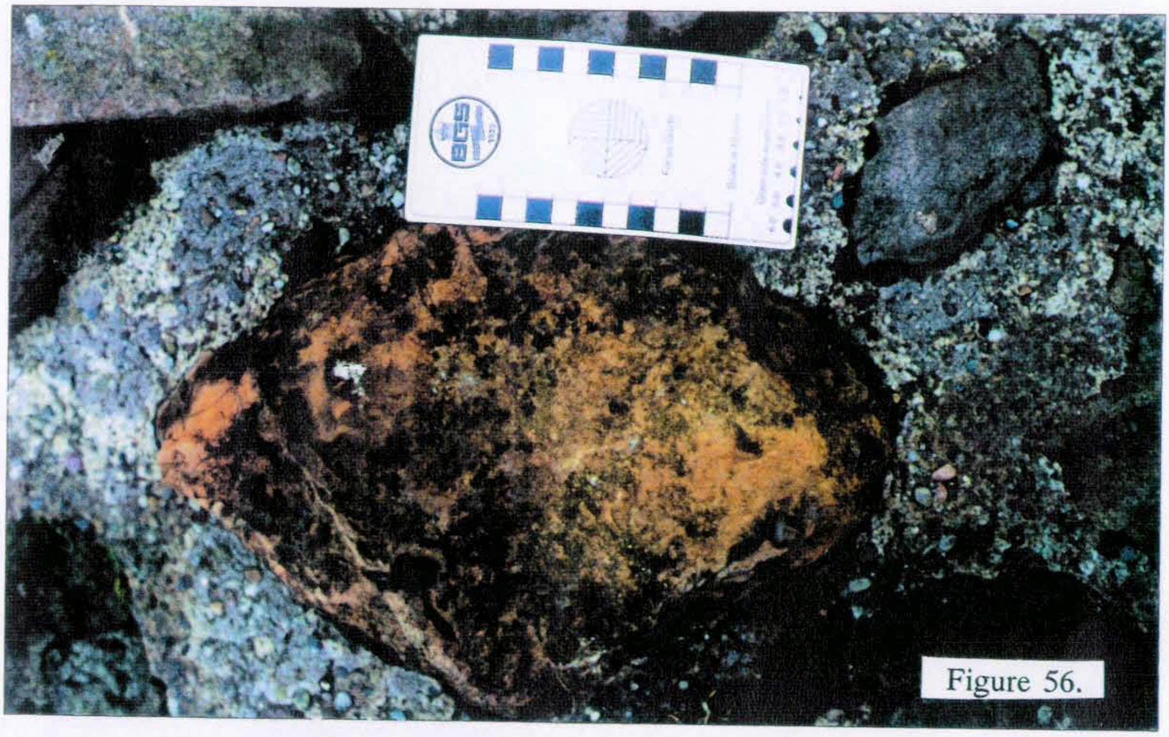


Figure 56.

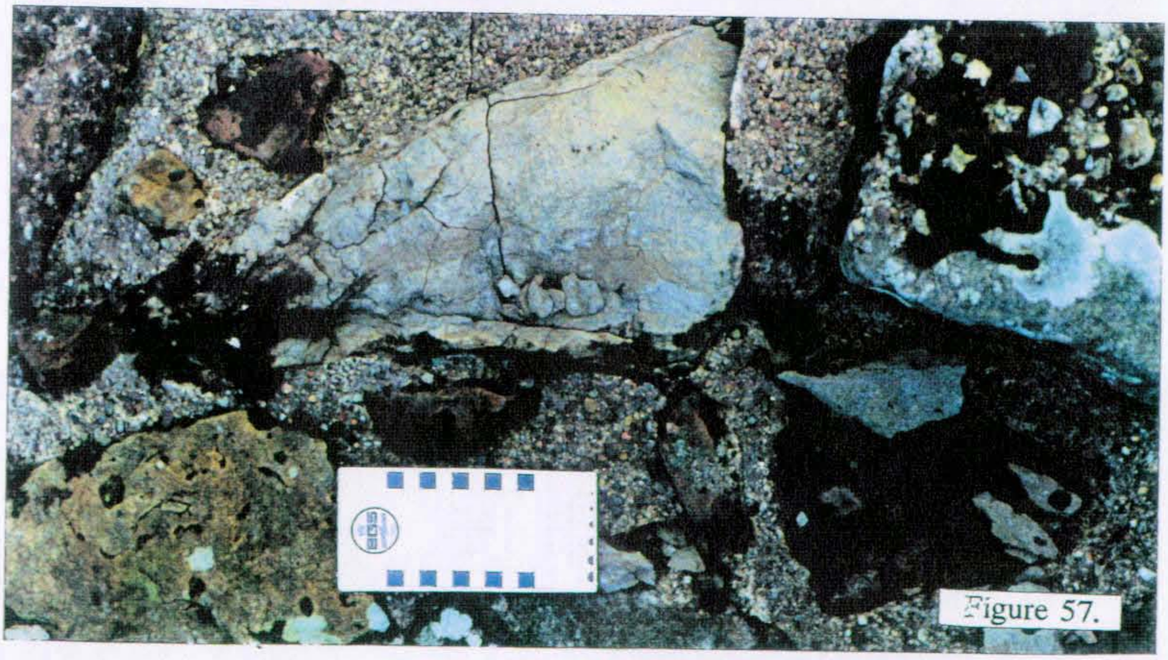


Figure 57.

Figure 58. South east corner of Prior's House. Rubble core contains St Bees Sandstone, Carboniferous sandstone, grey limestone, siltstone, greywacke sandstone and brick.

Figure 59. East wall of Dormitory. Cobble of ?microgranite in rubble core.

Figure 60. East wall of Dormitory. Cobble of greywacke sandstone in rubble core.

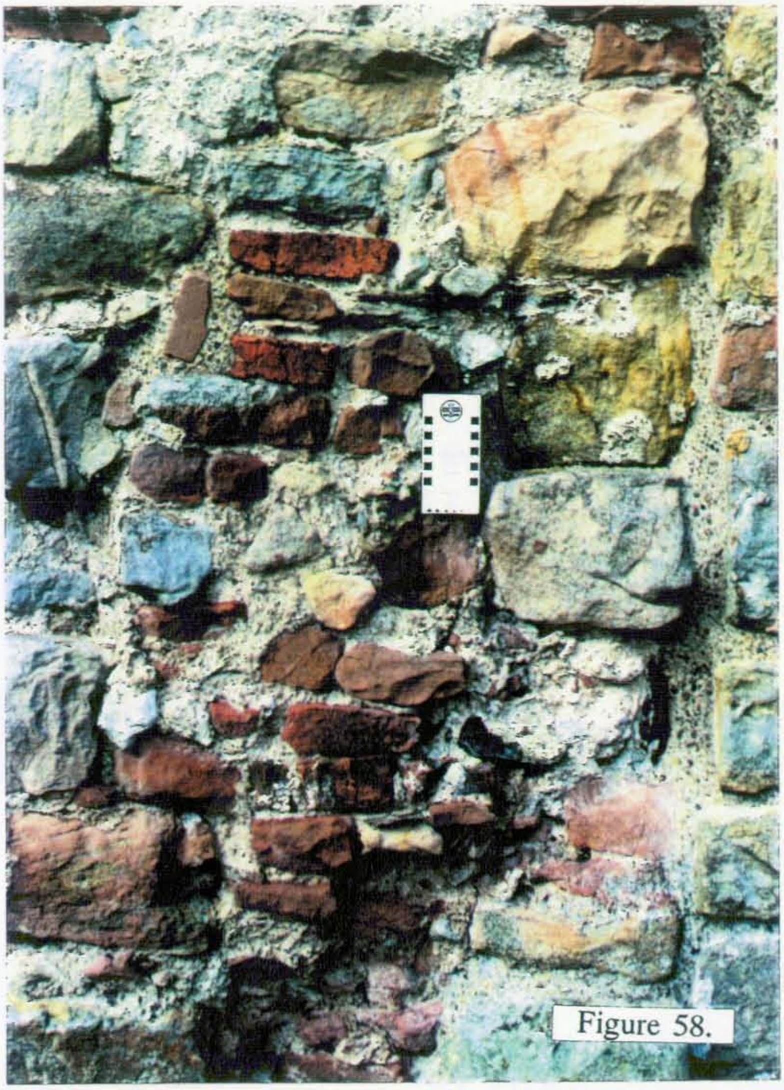


Figure 58.

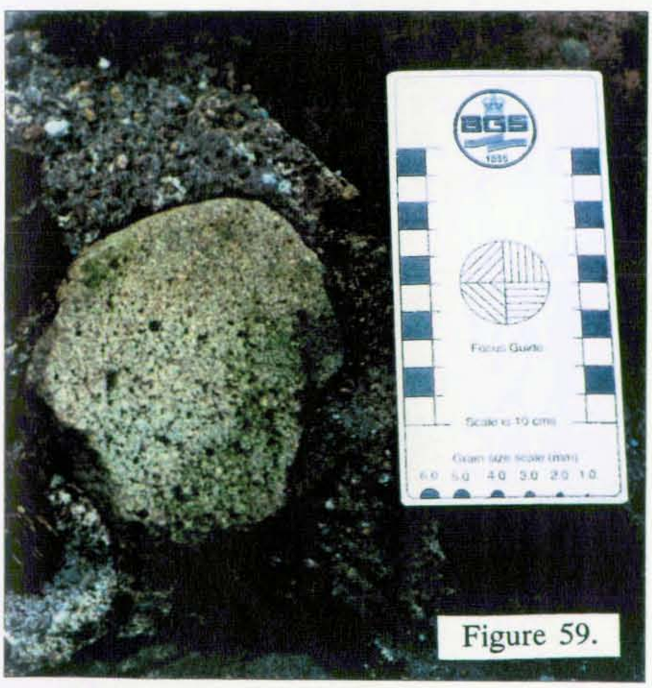


Figure 59.

Figure 60.

Figure 61. South wall of Cellarium. Greywacke sandstone cobbles in rubble core.

Figure 62. Doorway from South Transept to Vestry. Cobble of coarse greywacke sandstone.

Figure 63. East wall of Western Range of Cloisters. Block of Carboniferous sandstone with Roman inscription. Lintel beneath is also of Carboniferous sandstone.

Figure 61.

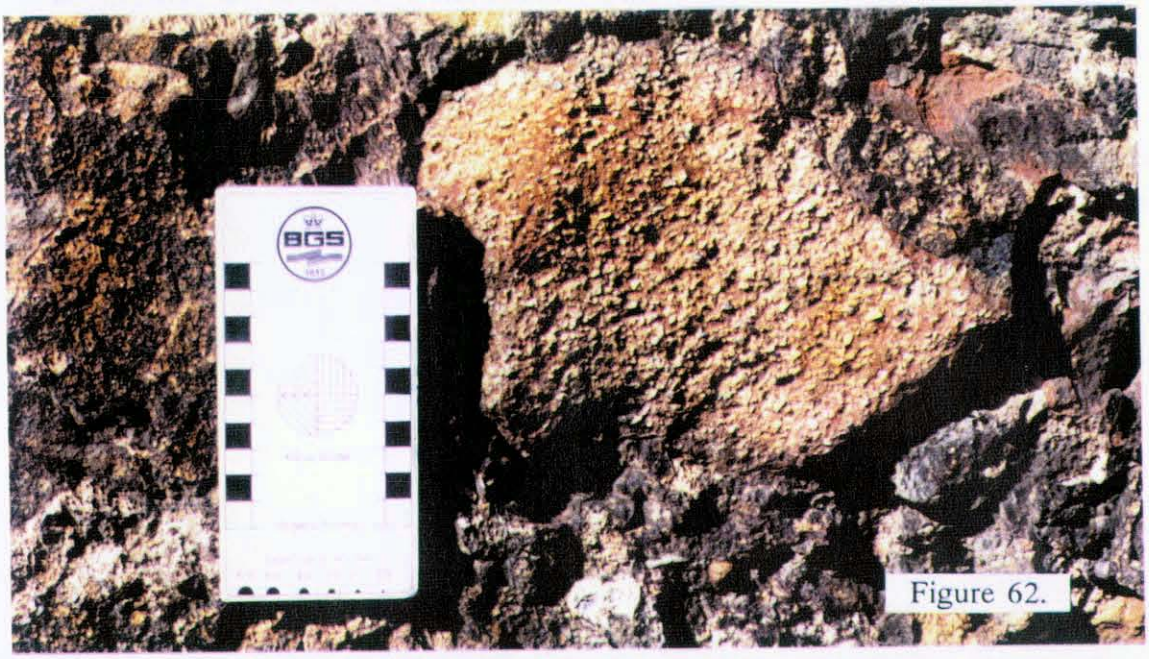


Figure 62.

Figure 63.