The stones of Stone Fort 1 and their possible source
Abstract

The purpose of this project is to identify the sources of the building stones at Vindolanda and to establish the pattern of their use in different periods and parts of the site. The work in the first two years has been carried out by a volunteer amateur geologist, advised and assisted by experts from the British Geological Survey.

The initial work has necessarily been exploratory in nature and not all the techniques tried have proved effective. Nevertheless, some useful initial conclusions have been reached and suggestions are made as to how the work should be progressed.

A thorough survey has been carried out of the area surrounding Vindolanda and widespread evidence of quarrying has been found. The evidence for or against Roman working of these quarries varies from conclusive to very uncertain, but initial suggestions are made as to which sources were exploited for Vindolanda. However, the estimated total yield of these sources only accounts for about half the total estimated volume of quarried stone in use when Vindolanda was at its most extensive. Proposals are made as to how this discrepancy might be resolved.

The stones used at Vindolanda are nearly all sandstones, with only subtle variations between them. However, factors have been identified which distinguish certain groups of stones and these have allowed a partial pattern of use to be proposed.

- The limited amount of stone needed for the 1st century bath house may have come from the small quarry near the Long Stone.
- The quarry in the Cockton Burn valley was used during the Antonine period.
- The quarries on Barcombe Hill were probably opened for the building of the Severan fort. They were used for the building of Stone Fort 2 and the vicus but the extent of Roman use of the big Barcombe quarry is still to be determined.
- The Severan period round houses employed re-used Antonine period stone.
- Most of the stone used for wall fill and for cobbled surfaces was scavenged from stream beds and valley bottoms.

The pull-out endplate of the report summarises these conclusions.

There is good reason to suppose that a considerably more detailed and accurate picture is achievable on all these issues and that techniques developed for this project could be applied to other structures in this part of the World Heritage Site.
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Frontispiece - A barracks wall of Stone Fort 1 and a probable Roman quarry above the Cockton Burn

Endplate (pull-out) - An interpretation of quarrying evidence in the Vindolanda area

All photographs and drawings are by the author unless otherwise stated.

Michael McGuire, BA(Cantab.), BSc(Hons)Geosci(Open), CITP, MBCS, is a Vindolanda volunteer who is leading the Stone Sources Project under the supervision of the Director of Excavations, Dr Andrew Birley.
1 Introduction

1.1 Background

The project had its inception in 2008 as a contribution to the research objective of the current Sites and Monuments Consent to investigate the extent to which the fort wall formed a divide between the military and civilian communities. If the two communities were using different stone sources at the same time, this would imply a distinction between military and civil administration. On the other hand, the use of a common source, probably under army control, would suggest significant military involvement in the life of the vicus.

The author of this report, a volunteer with some amateur geological experience, was asked to investigate how this work might be progressed and to take the initial steps needed to get the project under way. The author’s role has subsequently developed into that of Lead Volunteer for the project which has involved carrying out nearly all the work to date.

Contact was made with the British Geological Survey’s county geologist for Northumberland, David Lawrence, and the Building Stones team, then led by Ewan Hyslop, at the BGS Edinburgh labs. In 2009 David and Ewan visited Vindolanda and took away for analysis 28 samples, 18 from the site and 10 from possible Roman quarries. They carried out a physical examination of these and produced a preliminary report (Lawrence et al., 2010). A thin section was produced from each sample but by the start of the 2010 season BGS staff had not had time or funding available to work on these. David and his colleagues have continued to be a very valuable source of advice and expertise.

1.2 Objectives

The project has four overall objectives.

1. To identify the sources of stone used by the Roman builders of Vindolanda.

2. To determine which sources were exploited during the various phases of masonry construction of Vindolanda.

3. To identify any differences in the sources used in different parts of the site at any one time, particularly between the vicus and the fort during the Stone Fort 2 period (post AD 213).

4. To determine the feasibility of applying the techniques developed for objectives (1)-(3) to other structures throughout the Hadrian’s Wall World Heritage Site (WHS).

1.3 Methodology

The methodology for the project involves four activities.

1. Survey the stone types and quantities in the Roman masonry and correlate these with archaeological context and historical period, area of the site and type of structure.

2. Survey the surrounding area to identify potential sources of Roman stone, observe the lithologies present and estimate the potential yield.
3. Assess techniques for petrological examination and comparison of hand specimens and thin sections taken from the site and from possible quarry sources.

4. Attempt to make correlations between quarry and site lithologies and consider whether these point to any consistent patterns of use.

The work carried out on each of these activities up to September 2011 is reported in sections 2 to 5 respectively.

1.4 Scope of work for 2010

The following work was planned and undertaken during the 2010 excavation season.

1. Carry out a detailed examination of stones in selected archaeological contexts to establish the extent of variation of lithologies present on site.

2. Carry out a thorough survey of the surrounding area to identify all likely quarries.

3. Take further specimens from the site and the quarries and carry out petrological analyses, including progressing the analysis of the BGS 2009 samples.

4. Use the petrological analyses to refine the provisional correlations presented in the BGS preliminary report.

5. Consider the “volume problem” and make progress in resolving it.

6. Gain a clear understanding of local geology.

7. Clarify specific geological issues as they arise.

Some follow-up work was carried out in May and September 2011 to clarify and confirm various details.

1.5 Purpose and scope of this report

The primary purpose of the report is to make the Trust aware of the work carried out so far and the provisional conclusions drawn and to form the basis on which the future work programme is decided. It is hoped that in due course the document may provide the basis for more formal reports and/or publications.

The report provides a comprehensive description of work carried out in 2010 and 2011 together with a summary of work in 2009 (see also Lawrence et al, 2010). It covers all the investigations carried out (sections 2 to 4) and provisional analysis, conclusions drawn and suggestions for further work (sections 5 and 6). The appendix lists all the specimens collected and thin sections made and explains the specimen naming convention.

Whilst every effort has been made to ensure all inferences drawn are backed by reliable evidence and to seek professional advice where possible, it must be remembered that the observations and interpretations reported herein are the work of an amateur geologist. As with all interpretive work of this nature, in geology as in archaeology, all conclusions reached and theories suggested are open to challenge and modification.
2  The Roman masonry

This section makes some general observations about the Roman masonry at Vindolanda which are of particular relevance to the project. Results of detailed measurements and petrological examinations of some of the stones are presented in section 4. The observations and results are discussed in section 5.

2.1 The stones

Several types of stone can be identified on the site.

Sandstone is made up of individual grains of sand cemented together. The grains can generally be seen with the naked eye and give the stone a gritty feel. Flakes of shiny mica, spots of orange iron oxide and dark grey organic material may also be visible. When fresh, the local sandstones vary from very pale grey through shades of buff to bright orange or brown. Weathered stones on site are mostly grey and lichen-encrusted but in some cases the surface erodes to reveal a bright orange colour. Sandstone is classified by the average size of the grains; medium-grained sandstone has grains between 0.25 and 0.5 mm.

Dolerite (known locally as whinstone) is a very hard dark greenish-grey rock when fresh, in which individual constituent minerals are visible with a hand lens. It weathers to a dull brown, and often thin layers of the brown material break off the surface.

Mudstone is a dark grey rock made of clay particles too fine to see even with a hand lens. Mudstones hard enough to be used in buildings are generally calcareous, i.e. they contain a significant amount of calcium carbonate (lime). Most mudstones excavated at Vindolanda are pale grey on the inside with a darker rind up to 1 cm thick. Others are very dark orange-brown, usually fractured into smallish pieces and with a thin dark rind.

The local limestones are hard and fine-grained and are dark grey when fresh. Weathered limestones are generally pale buff coloured and can look similar to the sandstones but they do not have the same gritty feel and are much more likely to contain fossils.

The great majority of the stones used at Vindolanda are medium-grained sandstones. Of the facing stones, only a tiny proportion are other materials - a few whinstones in the fort walls and a few mudstones in internal buildings. Stones in the rubble fill are more varied. The fill of the curtain wall of Stone Fort 2 in particular contains a significant proportion of well-rounded cobbles, either whole or split, many of which are dolerite.

Cobbled floors and roadways also contain large numbers of naturally-rounded cobbles. The many paving slabs, both external and internal, are all good quality sandstone. Hypocaust pillars, apart from most of those in the first century bath house, are nearly all single sandstone blocks set endwise. Limestones, despite their prevalence in the surrounding area, were very rarely used as building stones.

There are some obvious differences in the way the sandstones weather after excavation, particularly during their first one or two winters after exposure. The majority of the stones
show little degradation, and precipitation during the first winter serves to clean them so that in situ observation of the lithology of the stones is easiest in the season after that in which they were excavated. In later seasons they acquire an increasing patina of oxidised minerals and lichen which helps to protect them from weathering but makes them harder to examine. However, a small but significant proportion of the sandstones weather quite markedly in their first season or two. They become very friable and may suffer considerable erosion. They also acquire a strong orange and/or almost white colouration which suggests changes have occurred in the chemistry and distribution of their iron content (figures 2.1 and 2.2). There is a strong correlation between stones showing this behaviour and masonry of Antonine date.

Figure 2.1  Weathering of a Stone Fort 1 barracks wall over the severe winter of 2010/11
Left - after excavation in September 2010 (the stone left of the hammer was removed)
Right - in May 2011; the colour change and erosion of many of the stones is very evident

Figure 2.2  Close up of some of the stones shown in the right hand side of figure 2.1
The tape measure case is 10 cm long
It can be assumed that, as one phase of building followed another, more and more of the stone will have been re-used. Even the Antonine building phase may have re-used some stone from the limited amounts of earlier building. The Severan masons may well have re-used significant amounts of Antonine stone, mainly for lower status buildings, but probably also quarried some fresh stone. Extensive re-use probably occurred in the 3rd century but this was the time of the greatest amount of stone construction and so was also the time of the most extensive quarrying. From some time in the later 3rd century the amount of stone masonry on the site declined and fresh quarrying presumably almost ceased. There may have been some limited quarrying at the time of the Theodosian rebuilding in the later 4th century (Birley, R., 2009).

2.2 The structures

Apart from the Stone Fort 2 curtain wall and parts of the bath houses, little masonry survives to more than about six courses. However, based on archaeological experience and evidence from other sites, good estimates can be made of the original heights of the masonry.

The majority of the excavated masonry is of the type known as “squared rubble” (Hill, 2006). Some of the higher status buildings have a better quality of masonry, sufficient in the case of the Stone Fort 2 Principia to be classified as “block-in-course” (figure 2.3). A few buildings had solid stone bases, above which there may have been stone or timber-framed walls. Apart from these solid stone bases, all the masonry walls have facing stones on each side which are squared on the outer face and taper, to a varying extent, into a fill of unshaped stones and mortar. The taper of the facing stones helped to key them into the mortar.

![Figure 2.3 Comparison of squared rubble and block-in-course masonry](image)

Above - Internal wall of a Stone Fort 2 barracks room (unconserved)
Below - Internal west wall of the courtyard in the Stone Fort 2 Principia

No examples of the mortar used on site have been studied. It is understood that examples have been found which are either clay or lime mortar. Both limestone and boulder clay are common in the area. The local limestones contain a proportion of clay minerals so mortar made from them will be significantly stronger than pure lime mortar.

In studying the masonry, care must be taken to ensure that only original stones in situ are observed. Conservation is typically carried out about 2 years after excavation. In this process
heavily eroded stones may be replaced with others from as close by as possible. Occasionally, significant reinstatement is carried out to make the buildings easier for visitors to understand. Parts of the first few courses of the stores building have been treated in this way, as have the *opus signinum* floors in the 1st century bath house.

There follows a brief list of the main groups of masonry currently exposed on the site. Comprehensive details of all excavated masonry are included in excavation reports. The list is not intended to be exhaustive; its purpose is to identify the groups of masonry for which it is hoped that this project might be able to identify the stone sources.

1. Pre-Hadrianic
   1.1. The first century bath house was a substantial masonry building with thick exterior walls, especially on the south (downhill) side. Most of the hypocaust pillars are stacks of tiles but include, between the *tepidarium* and *caldarium*, a row of four substantial stone pillars with well-squared stones up to 0.9 x 0.65 x 0.4 m. The main floors were of *opus signinum*.
   1.2. A small number of stone-built temples and/or mausolea have been identified.

2. Antonine - Stone Fort 1
   2.1. The fort wall was initially of turf and timber but was rebuilt in stone in the later second century. A section of the base of the northern end of the west wall was uncovered in 2007. Parts of the Stone Fort 2 west wall include masonry from the Antonine period fort. The footings of part of the original west gate are visible.
   2.2. In the past two excavation seasons substantial lengths of the foundations of barracks walls have been exposed, as well as part of a cobbled road.

3. Severan
   3.1. Masonry from the commander’s residence and a number of barracks is present within the area of the later *vicus*.
   3.2. Footings of the enigmatic round houses continue to be excavated within the area of the later fort.

4. Stone Fort 2 - AD 213 onwards
   4.1. The curtain wall is still in place for most of its length, up to 2 m high in places. There are remains of two 2-tower gates, two 1-tower gates and corner towers.
   4.2. The remains of the full central range of buildings - *Praetorium*, *Principia*, granary and stores - have been excavated and conserved.
   4.3. Two complete barracks blocks have been excavated in the north west sector plus a third range of buildings which may be a barracks or other buildings. There are various smaller buildings within the fort including several latrines.
4.4. There is high quality paving in the *via principalis* and *via praetoria* and a number of cobbled streets have been excavated.

5. **3rd century vicus**

5.1. There are numerous houses, workshops, taverns, shops, stores, etc in the main populated area.

5.2. The main street is paved and an extensive cobbled road was discovered in area B.

5.3. The bath house is smaller than that of the 1st century. It has stone hypocaust pillars but otherwise its masonry is quite similar to its predecessor.

5.4. There are temples and mausolea west of the main populated area.

5.5. A building discovered in the North Field in 2010 had a solid stone foundation with a fragment of stone masonry on it. A 3rd century date is thought likely.

6. **4th century and later**

6.1. Re-building and some new construction carried on through the rest of the Roman period and beyond. The “RIACUS” building and other shops at the west end of the *via principalis* are examples. Much of this masonry is being removed to expose the Stone Fort 2 and earlier masonry for conservation.

### 2.3 Other sites

An objective of the project is to consider how the techniques developed might be applied to other structures within the WHS. With this in mind, and to see whether anything might be learnt of value for the Vindolanda project, three other sites in the central section of the WHS were visited in summer 2010.

Along two short sections of the wall, west of Milecastle 37 and east of Winshields, stones near the top of the conserved structure were examined with a hand lens. Nothing was seen to distinguish these stones from those used at Vindolanda. All were typical medium-grained sandstones. Average grain sizes of those near MC37 were typically a little below the average for medium sand; those near Winshields were typically a little above this average. But such differences are very minor and are not uncommon in the Vindolanda stones. This brief survey suggests that identifying source quarries for stones in the central section of the Wall may be every bit as challenging as at Vindolanda. A note of caution with these observations is that there is no guarantee that all the stones used for conserving these Wall sections were used in the original construction.

Unlike Vindolanda, Chesters Fort was mostly built at a single period (i.e. as part of the Wall project) and was probably built of stone from a single quarry. Examinations were made - using naked-eye, hand-lens and photographic techniques - of stones in a number of different sections of conserved masonry. There are some differences of detail by comparison with the Vindolanda stones but all are sandstones, mostly medium-grained.
3 Possible sources of stone

3.1 General observations

During the 2009, 2010 and 2011 seasons an extensive survey has been carried out of the rock exposures in the vicinity of Vindolanda. This section describes observations made during this survey. Results of detailed examinations of rock samples are given in section 4 and discussed in section 5. The following sub-sections describe the results of the survey area by area. This sub-section makes some general observations about the distribution of relevant rock exposures in the area in the context of the overall geology, which is summarised first.

The rocks in the area around Vindolanda were laid down in the Carboniferous period, about 325 million years ago. The conditions under which this occurred and the mechanism of deposition are well described in Pickett et al (2006). The rock strata were built up in a series of cycles, typically about 60 m thick. A consistent pattern of rock types is found within each cycle - limestones at the base, mudstones and shales in the middle, sandstones towards the top and, in some cases, a thin coal at the very top.

At the end of the Carboniferous period the strata became tilted and those around Vindolanda dip mostly towards the SSE at a gradient of about 1 in 5 (12°-13°). Around 300 million years ago basalt magma was intruded into the rocks and spread sideways, utilising weakness within the strata to flow along and forming a sheet of dolerite rock up to 50 m thick, now known as the Whin Sill.

After the Carboniferous little is known of what further sediments may have been laid down because they have all been eroded from the whole of the Pennine area. Subsequent erosion of the Carboniferous rocks has been particularly rapid during the past 2.6 million years of the present ice age. Ice sheets, sometimes up to 1 km thick, have advanced and retreated numerous times. The most recent glaciation was at its height about 20,000 years ago and at this time the flow of the ice was from west to east, roughly at right angles to the dip of the strata. The ice preferentially eroded the softer strata, leaving outcrops of the harder dolerite and sandstones as linear E-W features with steep scarps to the north and shallower dip-slopes to the south. Between 20,000 and 15,000 years ago the ice gradually thinned, its erosive power weakened and some of its burden of eroded material was smeared across the landscape as glacial till (a form of boulder clay), concentrated in the hollows and absent from higher ground. From about 15,000 years ago the ice started to melt very rapidly as the climate warmed. Large volumes of melt-water created spillways through the Whin Sill and carved out the pattern of valleys and streams we see today. These volumes of water were much greater than even the most extreme flood events since and it is likely that the valleys are little altered since the ice was fully melted around 14,000 years ago.
In historic times, it has been the limestones which have been seen as particularly characterising the rock strata and the limestones at the bases of the cycles have been given individual names, mostly by miners and quarrymen. The other rock units in the cycles generally do not have specific names. Instead each cycle tends to be known by the name of the limestone at its base. For convenience in this project, the sandstones are referred to by unofficial names chosen to reflect their most important outcrops (figure 3.1).

Above the Little Limestone, conditions of deposition changed so that the cycles were smaller and few of them contain limestones. The result is a series of thick sandstones separated by thinner shales. Exposures of these sandstones occur on Barcombe Hill and extend down into the bowl of Thorngraffton Common.

The intersection of a series of sloping strata with a complex topography can result in a very confusing pattern of outcrops. Figure 3.2 shows the pattern of outcrops of the limestones immediately south of the Whin Sill. On this is marked a line of section from Hadrian’s Wall, on top of the Sill at Hotbank Crags, SSE through the top of Barcombe Hill to Thorngraffton Common. Figure 3.3 is a cross-section along this line which shows how the topography has developed to reflect, in part, the pattern of hardness of the strata.

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Figure 3.1 The vertical sequence of strata in the Vindolanda area. Names in red are used for this project only.
Figure 3.2 Geological map of the Vindolanda area showing localities studied, limestone and dolerite outcrops, the Doe Sike fault and the line of the section in figure 3.3
Background map after OS 1:25,000 sheet OL43; geology after BGS 1:50,000 sheets E13 & E19

Figure 3.3 Sketch stratigraphic cross-section along the line of section shown in figure 3.2
The undulating surface of the various rock units, as shown for example in figure 3.3, is called the outcrop. However, in most places the outcropping rocks are covered by recent unconsolidated sediments (such as boulder clay) and/or soil and/or vegetation. Where the bedrock is actually visible at the surface this is called an exposure.
There are exposures of the Cockton Sandstone along much of the south sides of the Cockton Burn and Bradley Burn valleys. It also forms the prominent scarp of Grandy’s Knowe to the north east of Vindolanda. The main exposure of the Chesterholm Sandstone is within the Chesterholm grounds, on the east side of the Chineley Burn. The Chineley Sandstone is exposed in various places further down the Chineley Burn valley. The Barcombe sandstone forms the ridge of Barcombe Hill, from the Iron Age settlement to the big quarries. The various Thorngrafton Sandstones outcrop southwards from the triangulation point on Barcombe Hill down the full extent of Thorngrafton Common.

Geologists use the word locality to designate a specific exposure or other place where they have made observations or collected specimens. Localities have been given a letter+number identifier wherever samples have been taken for analysis (figure 3.2). Table 3.1 shows how the initial letter of the locality identification scheme relates to the sandstones.

<table>
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<th>Area(s)</th>
<th>ID letter</th>
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<tbody>
<tr>
<td>Thorngrafton</td>
<td>Thorngrafton Common</td>
<td>T</td>
</tr>
<tr>
<td>Barcombe</td>
<td>Top of Barcombe Hill</td>
<td>Q</td>
</tr>
<tr>
<td>Chineley</td>
<td>Chineley Burn valley below Chesterholm</td>
<td>A</td>
</tr>
<tr>
<td>Chesterholm</td>
<td>Chesterholm grounds</td>
<td>M</td>
</tr>
<tr>
<td>Cockton</td>
<td>Bradley Burn valley (south side)</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Cockton Burn Valley (south side)</td>
<td>B</td>
</tr>
</tbody>
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Table 3.1 Stratigraphy of sandstones in the Vindolanda area (oldest at bottom)

With a very few exceptions, all of the sandstone samples taken are medium-grained and very “clean” (i.e. nearly all the grains are quartz). Whilst the lowest (Cockton) sandstone tends to be a little more coloured and the higher ones are generally paler, individual samples may vary considerably and colour is not always a good indicator of source. The lack of obvious distinguishing features between the various sandstones is one of the biggest challenges of the project.

In addition to workable sandstone exposures, several other possible sources of stone were considered during the survey.

1. Round cobbles, of the types found in the fills of the walls at Vindolanda, are a common occurrence in the bottoms of the valleys, particularly that of the Cockton Burn where they are tightly packed over an extensive area.
2. Calcareous mudstones occur at the transitions between the limestones and the shales which overlie them. A good example occurs in the east bank of the Chineley Burn just below the metal footbridge in the Chesterholm grounds. (Shale is a term for mudstone which breaks easily along horizontal planes.)
3. Very few loose stones lie on the ground surfaces in the area. Although some clearance of such stones may have taken place over the millennia of human occupation, it is not thought that they would have provided a significant building resource in Roman times (Lawrence, 2010).

Throughout the survey, a key subject for investigation has been the volume of stone which a quarry might have yielded. Estimating the “missing volume” of a quarry is difficult even where a reasonable assumption for the original surface profile can be made. But in some of the valley side quarries even this approach is fraught with difficulty. Accounting for the volume of quarried stone likely to have been on site in, say, AD 250 is another major challenge.

Where 8-figure (+/-10m) grid references are given these are GPS readings. 6-figure (+/-100m) references have been read from the 1:25,000 map.

3.2 The Cockton Burn valley

During the 2009 and 2010 seasons the Cockton Burn valley was surveyed from the bridge under the Stanegate upstream to the end of the wooded section at NY761665. Five areas of interest were identified but only the last appears to be a Roman quarry.

For at least 0.5 km upstream from the bridge the whole of the valley bottom, up to 15 m wide, is densely packed with stone of all sizes from sand to large cobbles. Many of the stones are naturally rounded. Most are sandstone but a proportion are dolerite. This is a potential source of large amounts of loose stone.

In the south side of the valley, at the east end of the North Field at NY769665, is a curved “embayment” in the valley side. The missing volume is considerable. The possibility that it might be the result of Roman quarrying was considered but rejected in favour of the more likely explanation that the embayment was eroded by high volumes of melt-water at the end of the last glaciation.

At NY769666 (localities B1-3) the near-vertical sandstone face could have been a source of Roman building stone but no evidence has been found to show that this face has been worked and there is no apparent missing volume.

Just to the north of the Cockton Burn at NY765667 is an extensively worked area with the remains of pits which are thought to be the result of ironstone extraction in the early 19th century (Johnson, 1997).

In the south face of the valley at NY765666 (locality B4) the Cockton Sandstone forms the top part of the valley side in a near-vertical exposure 60 m long and up to 3 m high (figure 3.4), the height increasing westwards. The eastern 35 m is straight but at the upstream end the exposure curves inwards, above a southward meander in the burn below. There is a narrow shelf along the base of the exposure and the valley side then falls fairly steeply to the burn, in which the Three Yard Limestone is exposed. At the western end of the
sandstone face a “promontory” stands out northwards at the level of the shelf and from it a
gentler slope runs up to the top of the valley at the northern edge of the North Field.

Figure 3.4 Possible Roman quarry in the Cockton Sandstone

No explicit evidence of quarrying, Roman or otherwise, has been identified in this sandstone
exposure. However, its position in the valley side and the degree of weathering, erosion and
vegetation are similar to the known Roman quarry at Comb Crag west of Birdoswald. Use of
stone from the Cockton Burn valley in the Stone Fort I period has been suggested (Birley, R.,
2009) and this exposure is the only obvious source.

The volume of stone which this quarry might have yielded is particularly difficult to estimate
because the extent of subsequent erosion of the soft shales forming the slope below can
only be guessed at.

3.3 The Bradley Burn valley

The southern rim of the Bradley Burn valley has been surveyed from the field north of the
Chesterholm drive entrance to the top of the woods next to the road near Grandy’s Knowe.

In the field opposite the entrance to Chesterholm, behind a clump of trees at NY77246652
(locality C1), is a small quarry in the Cockton Sandstone (figure 3.5). The face is 18.5 m long
and up to 3.5 m high. The date of working of this quarry is not clear. It may have been a
source of stone during the construction of Chesterholm. No evidence of Roman use has been
observed.
Further up the south side of the Bradley Burn valley, in the top of the wooded slope between NY77506688 and NY77656705 (localities C2 to C9), is a series of quarries in the Cockton Sandstone. Figure 3.6 shows localities C2 and C8. No evidence of Roman use has been observed, but the quarries are quite close to the Stanegate and transport of stone to Vindolanda would not have been unduly onerous.

In the 19th century a wagon way ran from the workings down to Bardon Mill. This also served Barcombe Colliery and the Colliery Company’s limestone and ironstone activities. These other activities may well have been sufficient to justify construction of the wagon way even if only a part of the sandstone quarries were worked during this period. (Note that, on some later maps, the colliery in the Chineley Burn valley at NY772657, which is mentioned in section 3.5, is referred to as Barcombe Colliery. The nomenclature used here is taken from the 1865 map which uses this name for the colliery at NY783669, down the north slope of Barcombe Hill below the Iron Age settlement.)

The workings are of several different styles which could be an indication of more than one period of working. In particular, localities C2 and C3 have been cut more deeply back into the valley side than the others. As the upper part of figure 3.6 shows, there appears to be a substantial accumulation of hill-wash soil against parts of the faces, which suggests they may be of some antiquity.
Beyond these workings, still further up the south rim of the valley, exposures of the Cockton Sandstone continue through the woods as far as the road. No clear evidence has been seen that these exposures were worked at any period.

3.4 The Chesterholm grounds

A careful survey of the Chesterholm grounds revealed no exposures of sandstone other than the outcrop of the Chesterholm Sandstone in the east face of the valley in the stretch south of the Museum Gardens.

It has been speculated that substantial Roman quarrying might have taken place in the valley bottom. Observations of the rocks in the valley floor and sides, combined with a knowledge of the geology of the area, suggest that this is unlikely to have been the case. No part of the volume of the valley within 5 metres of the present ground surface in the valley bottom has ever contained sandstone. If any sandstone above this had still been present to be quarried by the Romans, at least 5 metres of shale would have had to be eroded away in less than 2,000 years. Even in spate, the present small burn has nowhere near enough power to have done this. The present valley shape appears to be the product of natural erosion, almost entirely by a combination of ice followed by short-lived torrents of glacial melt-water.

Immediately downstream of the metal footbridge is an exposure of much of the Four Fathom Limestone cycle. The top of the limestone itself forms the stream bed and the east wall of the valley has shales in the lower part and sandstone towards the top. In the bottom of this wall, at the transition between the limestone and the shales (locality M1), is an approximately 1 m thick sequence of hard, fine-grained, dark grey mudstones which tend to
splinter when struck with a hammer. The mudstone becomes harder upwards and above it there is a rapid transition to soft shale.

In the valley bottom (locality M2) there are about a dozen large, irregular sandstone blocks, some in the burn and some on the west bank. One supports the centre of the metal footbridge. The others are all within about 20 m downstream of the bridge. Some of the faces of the blocks are quite flat and the corners and edges are only slightly rounded. The largest block lies next to the footpath (figure 3.7) and is 2.3m x 1.4 m by 1.1 m. It has several slots cut into its surface (inset to figure 3.7) which are typical of wedge holes used by the Romans for splitting stone and this method survived into the 20th century in the North Tyne Valley and probably elsewhere. None of the stones appears to have a minimum dimension less than 0.5 m. At this point, only the lower part of the Chesterholm sandstone is visible in the valley side. The bedding in this appears to be too closely spaced to yield such large boulders, so they are probably not the result of natural erosion of the lower part of the sandstone.

Figure 3.7 Large sandstone block in the Chineley Burn valley. Inset shows two of the wedge holes in the block’s upper surface

Above this part of the valley at NY772663 (locality M3) a section of the upper part of the Chesterholm Sandstone is cut back over a length of 15-20 m. The cut-away section may be 5 m or more high but this is very difficult to assess as it is extensively obscured by what appears to be hill-wash soil, as well as trees and undergrowth (figure 3.8). More hill-wash
might be expected here than, for example, at locality B4 because the whole of the slope of Barcombe Hill - 100 m high and 350 m long - is available as a potential source area. Nevertheless, the extent of the hill-wash suggests that, if the cut-away section is man-made, it is of some antiquity. It seems very likely that the large sandstone blocks in the valley below fell or were levered down from this section in which the bedding is more widely spaced than in the lower section. The apparent antiquity of the workings and the wedge holes in a fallen block mean this could be the remains of a Roman quarry but it could also represent 19th century extraction for building Chesterholm.

![Figure 3.8 Possible Roman quarry in the Chesterholm grounds showing slope of apparent hill-wash. Inset shows a close up of part of the remaining exposed face about 2 m high.](image)

### 3.5 The Chineley Burn valley

The Chineley Burn valley was surveyed from below the Chesterholm grounds to the abandoned colliery buildings.

At the south end of the Chesterholm grounds the steep east face of the valley ends opposite the Doe Sike and is replaced by a sloping-sided embayment at NY772661. The possibility has been considered that this is the result of quarrying. However, the geology suggests that no sandstone outcrop exists in this area and the embayment, like the one in the Cockton Burn valley (section 3.2), was probably eroded by melt-water at the end of the last glaciation.

At the south end of the embayment the east wall of the valley at NY77226598 (locality A2) steepens again and the Chineley Sandstone is exposed near the top. The exposed face is about 15 m long and 5 m high. It appears to be a natural exposure, not a quarried face.

Continuing down the valley, the burn runs in a narrow defile through the Chineley Sandstone. At NY772659 there is a flat area on the west side of the stream which is wooded
and strewn with boulders and has a steep sandstone cliff behind. This could have been quarried but is more likely to be natural.

In the east side of the valley at NY77216586 (Locality A1), a little to the north of the abandoned colliery in the Little Limestone Coal (called Barcombe Colliery on some maps), is a substantial exposure of the underlying Chineley Sandstone. A curved section has been cut into this about 20 m long and 5 m high (figure 3.9). This section does appear to be the result of quarrying but no evidence was seen to indicate when. Extraction of stone for the colliery buildings is unlikely as the 1865 1:2,500 OS map does not show the colliery but has a mark which appears to represent this quarry. Use of the quarry for earlier buildings at Birkshaw is a possibility.

**Figure 3.9** Exposure of the Chineley Sandstone about 100m north of the colliery

### 3.6 Barcombe Hill

A number of sandstones outcrop on Barcombe Hill and Thorngrafton Common. They are exposed in numerous places and exact correlations of these exposures to particular sandstones have not been made. For the purposes of this report it is assumed that the stratigraphically lowest of these, the Barcombe Sandstone, outcrops along the summit of Barcombe Hill and includes all the quarries visible from Vindolanda. These quarries are dealt with in this section. Quarrying on Thorngrafton Common is considered in section 3.7.

Along the northern edge of the Iron Age settlement and extending some distance to either side is a series of contiguous circular pits. These are probably ironstone workings in the form of “bell pits”. This technique of working shallow sub-surface layers for coal, iron and other minerals has been used from prehistoric times even into the early 20th century. It is therefore unclear now whether any of these workings were Roman, but they were not a source of building stone.

To the south west of the Long Stone at NY77816636 (locality Q1), just before the field wall, is an exposure of the Barcombe Sandstone which appears to be man-made (figure 3.10). The face is about 30 m long and up to 1.5 m high and is significantly weathered. In front of it is a depression with an undulating grassy surface which could well conceal spoil heaps. Some of these spoil heaps may be from the ironstone pits which continue along the ridge of the hill.
to this point. Given the state of weathering of this exposure, working during Roman times is a distinct possibility, although no direct evidence has been found. It is the nearest exposure along the hill from the top of the path leading up from the Stanegate.

**Figure 3.10 Worked area of sandstone near the Long Stone**

A short distance to the west, at NY77746634 (locality Q2) on the other side of the field wall and just below the ridge of the hill, is a smaller but deeper working into the Barcombe Sandstone. This is less weathered than locality Q1 and much of it is a flaggy sandstone typical of that used to build the field wall. The face is 20 m long and up to 1.75 m high.

From NY 77606621 to NY77586619 (locality Q3) is the one certain Roman quarry in the vicinity. The well-known graffiti left by the Roman quarrymen is clear evidence that most, if not all, of the present missing volume was removed in Roman times. The quarry is 30 m long, typically 3.5 to 4 m from front to back and generally 6 m high. About 60 m south west of this quarry is another small exposure but it is not clear whether this is natural or man-made.

**Figure 3.11 Barcombe small quarry**

Seen from Vindolanda (figure 3.12), the big Barcombe quarry from NY77566615 to NY77626621 (locality Q4) is the most prominent feature on Barcombe Hill.

**Figure 3.12 Barcombe big quarry seen from Vindolanda**
The quarry is over 90 m long and typically 13.5 m from front to back and the face averages 7.5 m in height. Observations, including a partially cut stone block, suggest that the north-eastern 50 m of the main face (on the left in figure 3.12) is probably Roman work. The remaining 40 m has been substantially cut back with the assistance of explosives. Visible marks on the re-worked part of the face are typical of 19th century stone working techniques (Hyslop, 2009) and half-sections of several drilled shot-holes are present. It is known that the quarry was extensively worked in the 1830s to provide stone for structures on the Newcastle and Carlisle Railway (opened 1838). The remains of an inclined plane run out of the quarry down towards Bardon Mill. The proportion of the missing volume created by the Roman quarrymen cannot be determined precisely but a figure around 50% seems possible.

3.7 Thorngrafton Common

The sandstone exposures on the Common have been extensively worked. A general survey has been undertaken to study the nature of the workings (including localities T1 to T10) and the characteristics of the sandstones. Most of the quarries appear to be of one of two types of working.

The first takes the form of areas of shallow extraction which have been worked into the ridges or up the dip-slopes of the outcrops. Figure 3.13 shows an example.

Figure 3.13 Locality T8. A small worked area just west of Thorngrafton Lane

Small *ad hoc* workings are very unlikely to be of Roman origin. A more likely date would be during the Enclosure process in the late 18th and early 19th centuries when many substantial dry stone walls were constructed on the Common. However, some of the larger workings of this type might be Roman, perhaps for special stones for the Wall, Housesteads or Vindolanda. Locality T7 is one possible example.

The second type of working involves larger quarries, many of which have been worked upwards into one of the dip-slopes creating a series of bays. These quarries contain large amounts of broken but otherwise unworked stone in a wide range of sizes up to metre-scale. In many cases similar stone is piled in substantial spoil heaps immediately down-slope of the quarry. The most prominent examples are at least seven contiguous bays which extend for about 150 m across the slope from NY78196654 to NY78346654 (locality T2, figure 3.14).
These vary in size but are typically 20 m from front to back and 10 m across, with a “promontory” between adjacent bays. The worked faces are up to 2.5 m high.

Figure 3.14 Sandstone quarrying at the top of Thorngrafton Common, seen from the SE. The triangulation point is visible top right. The areas designated as localities T2 and T3 are indicated. The large spoil heaps can be seen below the workings.

Historical evidence (e.g. Bruce, 1871) suggests that these quarries were worked by groups of itinerant quarrymen to provide stone for sleepers for the Newcastle and Carlisle Railway, the Haydon Bridge to Greenhead section of which was built in 1837 and 1838. The sleepers were typically 2 feet square and 1 foot deep (60x60x30 cm) (Fawcett, 2008). The piles of discarded material may well be stones which were too small or of too poor quality for this purpose.

At least one quarry (locality T9), at NY789663, fits neither of these categories. It is very extensive (though not deep) and does not contain any discarded material. No evidence has been found to clarify whether this quarry represents Roman or more recent working.

Locality T1, at NY790614, is in one of many exposures on the Common which appear at first sight to be the result of quarrying but, on closer examination, prove to be natural. Typically these take the form of north-facing vertical exposures 1 to 2 m high with extensive boulder fields down the slopes in front of them. They are thought to have been formed during the Loch Lomond Stadial cold period 12,500 to 11,500 years ago (Stone et al, 2010).
4 Petrological, dimensional and chemical observations

4.1 The nature of the sandstones

To provide a context for the observations reported below, a brief general description is given here of the nature (what geologists call the lithology) of the sandstones.

Nearly all the Vindolanda stones are sandstones which consist almost entirely of grains of quartz. They are the lithified remains of sandy sediments typical of those which might be found on a modern beach, estuary, delta or sand-bank. In addition to average grain size, such sandstones are also characterised by their range of grain sizes and by various parameters which describe the typical shapes of the grains.

In addition to quartz, other components of the sandstones are:-

- feldspars - opaque white grains which can be hard to identify because they are often wholly or partly chemically altered to clay minerals
- micas - platy minerals which tend to reflect light from their flat surfaces
- clay - tiny particles clumped between the grains and produced either by chemical alteration of feldspar grains or by precipitation from water
- oxides, particularly iron oxides - these occur either as separate grains or as thin coatings on other grains; tiny amounts of iron oxides are responsible in most cases for the wide range of colours of sandstones from almost white (no iron oxide) to bright orange, red or brown
- organic material - either as black specks or a grey background colour
- rare minerals such as tourmaline or zircon.

4.2 Observation and measurement techniques

In this early phase of the project a wide range of observation techniques has been used so that the benefits and drawbacks of each can be assessed. Sufficient observations were carried out to make such an assessment possible and to enable some initial conclusions to be drawn about the stones and their sources. However, no attempt was made at this stage to apply any of the techniques comprehensively to sizeable populations of specimens. The following list gives a brief description of the techniques used. Further details are given in subsequent sections where necessary.

1. Visual survey. Results have been given above of surveys of the excavated masonry (section 2) and possible stone sources (section 3).

2. Hand specimens. Stones in situ in the masonry and specimens taken in the field (usually with a geological hammer) have been examined with the “naked eye”, with a x10 hand lens and, in a few cases, with a digital camera on “super macro” setting.

3. Thin sections. Slivers of rock 0.03 mm thick, fixed to a glass slide, have been examined with a simple petrological microscope to identify the minerals in the rock.
4. Physical dimensions. The dimensions of some of the masonry and of some of the main quarries were measured using nothing more sophisticated than a surveyor’s tape.

5. Chemical analysis. Dilute acid was applied to samples of potentially calcareous stone. If calcium carbonate is present, carbon dioxide is released as bubbles in the acid - the stone is said to effervesce.

4.3 Observations of hand specimens

The most useful observations are of the sizes and shapes of the quartz crystals and the relative numbers of clearly identifiable feldspar crystals. Feldspars in good condition can usually be distinguished from quartz by their opacity, but the feldspars in these sandstones are in various stages of alteration into clay minerals and the dividing line between what is a feldspar and what is clay is necessarily arbitrary. Mica tends to be concentrated in layers, so observations of stone surfaces are generally not representative of the mica contents of the bulk specimen. Only qualitative descriptions can be given of other characteristics such as colour, porosity and friability.

4.3.1 Stones on site

Numerous observations were made, mainly using a hand lens, of excavated stone in situ. The primary purpose was to assess what useful information might be obtained by this approach. For this reason, the sequence of observations was not planned from the outset but rather each was selected based on earlier results.

As a starting point, stones were examined in the wall of the southernmost contubernium of the Stone Fort 2 barracks which was then being excavated (building XXIII on the excavation plan). The uppermost surfaces of all the facing stones were photographed and the initial intention was to examine most of them. However, after examining the first six stones, two things became apparent.

1. The amount of variation in the lithology of the stones was very small. All were typical medium-grained sandstones.

2. The amount of soil still adhering to the stones made detailed examination almost impossible.

This exercise was therefore abandoned and attention was switched to similar masonry excavated in the previous season.
The stones selected were the 19 uppermost outer facing stones in the west wall of one of the *contubernia* in the adjacent Stone Fort 2 barracks (building XVI, figure 4.1). For each stone an estimate was made of the average grain size and of the relative number of feldspar grains on a scale of 0 to 5. Results are given in table 4.1.

<table>
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<tr>
<th>Stone</th>
<th>Grain size (µm)</th>
<th>Feldspars</th>
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<td>3</td>
</tr>
<tr>
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<td>375</td>
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Figure 4.1 The west wall of building XVI

Figure 4.2 An area 2 cm x 2 cm on the upper surface of stone 2 in figure 4.2

Figure 4.2 shows a close-up of one of the highest-feldspar stones. The opaque white feldspars can just be made out dispersed amongst the generally larger, glassy quartz grains but are not clear enough to provide an absolute value of feldspar content.
An investigation was carried out into the feasibility of applying this technique to stones which had been exposed for several years. The stones used for this were the hypocaust pillars in the 3rd century bath house which provide a sizable population of easily examinable stones and are likely to be all of the same period. Of the 24 pillars (figure 4.3) a reasonable estimate of average grain size could be obtained for 22; numbers 19 and 20 were too encrusted with lichen. Of these 22, all but one had average grain sizes within the same range as those in table 4.1. Pillar 3 was much coarser-grained (average grain size 1 mm) and had a wider distribution of grain sizes. The extent of encrustation of the pillars prevented useful estimates of feldspar contents from being made because the opacity or otherwise of the grains could not be assessed.

Figure 4.3  24 stone pillars in the 3rd century bath house

Of the 49 stones examined to this point, none showed more than slight signs of erosion due to weathering. All were pale grey or buff coloured; none were strongly coloured. As noted in section 2, the Antonine period stones tend to be more friable and have stronger colour contrasts, especially after 1-2 years of exposure. Some investigations were therefore carried out amongst the limited number of exposed stones of this period excavated in previous seasons.
Four stones were examined in the northern respond of the original west gate of the Antonine period fort (figure 4.4). Three of these (1, 2 and 4) were indistinguishable from the Stone Fort 2 stones (table 4.1) in respect of grain size and shape. However, they had virtually no visible feldspar, were quite strongly orange coloured and had patches of erosion. The large stone (3) was much coarser grained and not strongly coloured. Some feldspar appeared to be present but the degree of encrustation made this hard to assess.

Figure 4.4 The northern respond of the original west gate of the Antonine period fort

Stones from the section of the Stone Fort 1 curtain wall, uncovered in 2007 near the NW corner of the fort area (figure 4.5), were also compared with those from Stone Fort 2 (table 4.1). Again there was virtually no observable difference in the grain sizes and shapes of the two populations. However, the earlier stones were much more orange in colour, where not obscured by 3 years’ encrustation, and close examination revealed extensive orange-brown material (presumably iron minerals) dispersed between the grains. A number of the stones are becoming severely eroded.

Figure 4.5 The north end of the west wall of Stone Fort 1
Finally, some brief examinations were conducted of excavated stones from other periods and parts of the site.

1. Inner facing stones in the west wall of the hypocaust of the 1st century bath house (figure 4.7) appeared to be very similar to those of Stone Fort 2 as regards grain size and shape.

2. The nine large stones within the hypocaust of the 1st century bath house (figure 4.6) were found to be much harder and less friable than most other stones on the site. They appeared to have a much lower porosity than the typical sandstones.

3. The 12 large foundation stones of the rectangular building excavated in Area B in 2010 had similarly greater hardness and lower porosity.

Figure 4.6 The hypocaust of the 1st century bath house with the large stone pillars in the foreground and the internal west wall behind.

4.3.2 Hand specimens from possible quarries

An extensive series of hand specimens was collected from possible stone sources in the surrounding area. For those quarries which might be of Roman origin a number of specimens were collected from various parts of the quarry face. For other quarries only one or two specimens were collected. Specimens were collected in 2010 from some, but not all, of the localities sampled in 2009. For each locality sampled in 2010, at least one of the specimens has been studied by “naked eye” and with a hand lens and brief notes made. However, because the 2009 specimens are held by BGS in Edinburgh, it has not been possible to examine these in the same way so for a few quarries, notably the small Barcombe quarry (locality Q3), no such observations have yet been made.

In each case the observations were made of a broken surface not affected by weathering. Apart from average grain size, for which a reasonably accurate numerical estimate can be made through a hand lens, all the observations are descriptive. The following is a summary of the salient points.

All the specimens are sandstones and, with just three exceptions, all are within the range categorised as medium-grained. Both the specimens from the Chesterholm Sandstone, one
from the quarry (locality M3) and one from the boulders in the valley (locality M2), fall on the boundary between fine and medium grained. The specimen from the Thorngrafton sandstone at locality T5 is coarse to very coarse grained and has a wider range of grain sizes than the other specimens. There is very little variation in the typical shapes of the quartz grains which are much as would be expected for this type of sandstone.

Mica is virtually absent from the Thorngrafton sandstones. The amounts in the other specimens vary from small to significant, though never copious, with no clearly observable patterns. Where the amounts are significant, much of the mica is concentrated in thin, darker bands.

Little or no feldspar could be seen in specimens from the Cockton, Chesterholm or Chineley sandstones. Significant amounts were observed in the Barcombe and Thorngrafton sandstones, particularly the specimen from the coarse sandstone at locality T5.

Colour varies from pale grey to bright orange/brown. These variations occur from one sandstone to another, from quarry to quarry, within an individual quarry and within a single specimen right down to the microscopic scale. So only the most generalised statements can be made about variations in colour which might distinguish one possible stone source from another. The Barcombe and Thorngrafton sandstones tend to be paler, although parts of the big Barcombe quarry yield quite strongly coloured stones. The other sandstones have a much greater proportion of coloured stone, particularly in the quarry above the Cockton Burn (locality B4) where patches of recent weathering show up bright orange.

The strength of the stone also varies considerably. The most friable can be crumbled between the fingers whilst the hardest can barely be broken with a 4 lb hammer and cold chisel. There appears to be some correlation between hardness and colour - the more strongly coloured stones tend to be more friable. The finer grained Chesterholm sandstone from localities M3 and M2 is particularly hard whereas the coarse stone from locality T5 is quite friable.

4.4 Petrology of thin sections

Thin sections were made from each of the 28 specimens collected by the BGS in 2009. However, although the BGS carried out a physical examination of the specimens and produced an initial report in 2010, they have not yet been able to examine the thin sections using their comprehensive microscopy facilities.

In Spring 2010, two further possible Roman quarries were identified (localities B4 and M3). A thin section was made from a single sample taken from each of these localities.

At the end of the 2010 excavation season, five thin sections were made from stones excavated that year together with a further five from samples taken from possible sources.

All these thin sections have been examined using a simple petrological microscope. Results of this examination are given in tables 4.2 (excavated stones) and 4.3 (possible sources). In each case the results comprise an estimate of the average grain size and a count of the
number of clearly identifiable feldspar grains in an area of 40 mm$^2$. Table 4.2 also lists the period of building and an estimate of the date of construction of the masonry from which the stone was taken.

<table>
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<th>Year AD</th>
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<td>Bath Ho. 1</td>
<td>105</td>
</tr>
<tr>
<td>V09Q-S07</td>
<td>430</td>
<td>8</td>
<td>Bath Ho. 1</td>
<td>105</td>
</tr>
<tr>
<td>V09Q-S08</td>
<td>310</td>
<td>6</td>
<td>SF2 Vicus</td>
<td>225</td>
</tr>
<tr>
<td>V09Q-S09</td>
<td>310</td>
<td>1</td>
<td>SF2 Vicus</td>
<td>225</td>
</tr>
<tr>
<td>V09Q-S10</td>
<td>330</td>
<td>16</td>
<td>Severan Barracks</td>
<td>208</td>
</tr>
<tr>
<td>V09Q-S11</td>
<td>270</td>
<td>2</td>
<td>SF2 Vicus</td>
<td>225</td>
</tr>
<tr>
<td>V09Q-S12</td>
<td>300</td>
<td>22</td>
<td>SF2 Barracks</td>
<td>213</td>
</tr>
<tr>
<td>V09Q-S13</td>
<td>310</td>
<td>1</td>
<td>Riacus Blg.</td>
<td>305</td>
</tr>
<tr>
<td>V09Q-S14</td>
<td>410</td>
<td>16</td>
<td>SF2 Vicus</td>
<td>225</td>
</tr>
<tr>
<td>V09Q-S15</td>
<td>360</td>
<td>7</td>
<td>SF1 Vicus</td>
<td>160</td>
</tr>
<tr>
<td>V09Q-S16</td>
<td>270</td>
<td>1</td>
<td>SF2 Vicus</td>
<td>260</td>
</tr>
<tr>
<td>V09Q-S17</td>
<td>330</td>
<td>8</td>
<td>SF1 Vicus</td>
<td>160</td>
</tr>
<tr>
<td>V09Q-S18</td>
<td>350</td>
<td>1</td>
<td>SF1 W Wall</td>
<td>180</td>
</tr>
<tr>
<td>V10Q-S03</td>
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<td>0</td>
<td>SF2 Vicus</td>
<td>260</td>
</tr>
<tr>
<td>V10Q-S06</td>
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<td>0</td>
<td>SF1 Barracks</td>
<td>180</td>
</tr>
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<td>0</td>
<td>SF1 Barracks</td>
<td>180</td>
</tr>
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<td>12</td>
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<td>180</td>
</tr>
<tr>
<td>V10Q-S10</td>
<td>270</td>
<td>1</td>
<td>SF2? N Field</td>
<td>225</td>
</tr>
</tbody>
</table>

*Table 4.2 Results of analysis of thin sections taken from excavated stones*
Table 4.3 Results of analysis of thin sections taken from possible source locations
Sources (identified by the letter and digit after the hyphen) are described in section 3

The second figure, in red, for the feldspar count in specimen V10Q-Q4/2 was counted on an additional thin section which had been chemically stained to highlight feldspars.

As well as these numerical values, brief descriptions of the main features have been written for the thin sections in batches 2 and 3. These will be published later, together with similar descriptions for the first batch of thin sections and sample photographs.

4.5 Dimensions of masonry and quarries

4.5.1 Excavated masonry

A series of measurements was made, in May 2011, of excavated masonry on the Vindolanda site. The objective was to obtain sufficient information to demonstrate that useful estimates can be made of the total volume of the facing stones and fill used in building the structures.
present on the site at various points in its history. The dimensions measured are listed in table 4.4 which also gives typical values for a Stone Fort 2 barracks block.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Typical value for SF2 barracks</th>
</tr>
</thead>
<tbody>
<tr>
<td>height of each course (m)</td>
<td>0.16</td>
</tr>
<tr>
<td>mortar gap between courses (m)</td>
<td>0.01</td>
</tr>
<tr>
<td>average width of each stone (m)</td>
<td>0.28</td>
</tr>
<tr>
<td>mortar gap between stones (m)</td>
<td>0.01</td>
</tr>
<tr>
<td>average depth into wall of each stone (m)</td>
<td>0.20</td>
</tr>
<tr>
<td>average gap between stones at inner end (m)</td>
<td>0.06</td>
</tr>
<tr>
<td>volume of facing stone per m$^2$ of wall (m$^3$)</td>
<td>0.305</td>
</tr>
<tr>
<td>average thickness of fill (m)</td>
<td>0.25</td>
</tr>
<tr>
<td>total length of external and internal walls (m)</td>
<td>145</td>
</tr>
<tr>
<td>assumed height of masonry (m)</td>
<td>2.5</td>
</tr>
<tr>
<td>assumed ratio of stone to mortar in the fill</td>
<td>70:30</td>
</tr>
<tr>
<td>volume of facing stone (m$^3$)</td>
<td>110</td>
</tr>
<tr>
<td>volume of fill stone (m$^3$)</td>
<td>63</td>
</tr>
</tbody>
</table>

Table 4.4 Stone dimensions in a typical Stone Fort 2 barracks block

Figures in red are calculated from the measured values

The fort may have contained 12 buildings of roughly this size, either barracks blocks or other utility buildings, requiring a total of about 1,300 m$^3$ of facing stones and 750 m$^3$ of fill stones.

Further measurements, in somewhat less detail, have been made of other buildings in the fort, including the curtain wall, gates and towers. These suggest that the total volume of facing stones required for the fort was in the region of 3,500 m$^3$. The volume of stone in the fill was about 4,000 m$^3$, of which nearly half was for the curtain wall which averages 1.4 m in thickness. These figures include no allowance for wastage and do not include the mortar. They also do not include any internal or external flooring, either quarried paving slabs or stone for cobbled roads. No attempt has yet been made to estimate the stone needed for any of the extramural buildings or roadways.

4.5.2 Quarries

In order to estimate the volume of useable stone which has been extracted from a quarry, the five values needed (figure 4.7) are:-

- length - which can easily be measured with a surveyor’s tape
- average height of the face - which is also reasonably easy to measure using a weighted line or, preferably, a theodolite
Figure 4.7 Barcombe small quarry from the SW, showing dimensions measured

An attempt has been made to determine these values for seven quarries which were, or may have been, worked by the Romans. For the Barcombe Hill quarries (localities Q1-4) and for the quarry just north of Chesterholm (locality C1) the values are reasonably easy to estimate. However, for the quarry in the Cockton Burn valley (locality B4) and the quarry in the Chesterholm grounds (locality M3), hill-wash into the quarry and erosion of the underlying ground make estimates of the height, depth and profile very speculative. Nevertheless, with some assumptions, estimates can be made. Table 4.5 shows the estimated values for all seven quarries, together with the resulting yields. The profiles are expressed as a percentage of the rectangular area formed by multiplying the average height by the average depth.
<table>
<thead>
<tr>
<th>Quarry</th>
<th>Length (m)</th>
<th>Av Height (m)</th>
<th>Av Depth (m)</th>
<th>Profile (%)</th>
<th>Usable %</th>
<th>Yield (m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B4</td>
<td>60</td>
<td>2.5</td>
<td>3</td>
<td>50</td>
<td>70</td>
<td>160</td>
</tr>
<tr>
<td>C1</td>
<td>18.5</td>
<td>3</td>
<td>5</td>
<td>70</td>
<td>70</td>
<td>140</td>
</tr>
<tr>
<td>M3</td>
<td>16.5</td>
<td>5</td>
<td>5</td>
<td>50</td>
<td>70</td>
<td>140</td>
</tr>
<tr>
<td>Q1</td>
<td>30</td>
<td>1.5</td>
<td>10</td>
<td>50</td>
<td>75</td>
<td>170</td>
</tr>
<tr>
<td>Q2</td>
<td>20</td>
<td>1.5</td>
<td>4</td>
<td>60</td>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td>Q3</td>
<td>31</td>
<td>6</td>
<td>4</td>
<td>70</td>
<td>75</td>
<td>390</td>
</tr>
<tr>
<td>Q4</td>
<td>92.5</td>
<td>7.5</td>
<td>13.5</td>
<td>70</td>
<td>75</td>
<td>4920</td>
</tr>
</tbody>
</table>

Table 4.5 Estimates of dimensions and yields for seven potential source quarries

4.6 Mudstones

A small proportion of the facing stones in the excavated masonry appear to be mudstones. A characteristic feature of these stones is that they have a “rind” of clearly different material which breaks away easily and is often partly missing even before the stone is uncovered. The rind is brittle and dark whereas the bulk of the stone is a paler, grey colour and has a powdery surface. Figure 4.8 shows such a stone with a remnant of the rind adhering to its surface.

Small samples of the rind and bulk of such a mudstone were treated with dilute hydrochloric acid. The bulk material effervesced copiously whereas the rind showed no reaction at all (figure 4.9). This test shows that there is a significant proportion of lime (calcium carbonate) in the bulk material but not in the rind. Samples of the hard mudstones described in section 3.4.1 (locality M1) were also tested with dilute acid and also effervesced, indicating that they are also calcareous.

Figure 4.8 Mudstone at the inner SW corner of building XXIII (30 cm ruler)
Figure 4.9 Calcareous mudstone effervescing in acid while the rind does not react.
Photo Malise McGuire

The implication of this result is that during much of the time the mudstones have been buried in the soil they have been soaked in acid rainwater which has leached the calcium carbonate out of the surface layer, leaving a rind of hardened mud.
5 Discussion

5.1 Characterising and correlating the sandstones

The success of the project depends on being able to distinguish stones from different sources and from different groups of buildings on the basis of differences in one or more clearly identifiable characteristics. Differences in colour, friability and weathering behaviour can provide useful general indications. But a much more detailed characterisation of the stones is needed to enable reliable correlations to be determined between stones in situ and specimens from their sources.

Characterising excavated Roman sandstones in situ is particularly difficult. In the first months after excavation, the surface of the stone is obscured by soil particles which are not thoroughly removed until the stone has been exposed over a winter. From about two years onwards, an increasing patina of lichen and oxidised minerals hides the detailed structure. At about the same time, masonry which has not been removed is normally conserved which makes the stones harder to access and may involve some replacement of stones. Even at their best after just one winter’s exposure, when the detailed structure and composition can be reasonably clearly seen with a hand lens, the sandstones of the Vindolanda area are all very similar and such subtle differences as do exist cannot reliably be identified by this technique. Initial results suggest that close-up photography may be of some value in recording the basic structure of medium to coarse grained sandstones in situ.

Better results can be obtained if it is possible to break a stone to reveal a fresh surface. Examining such hand specimens, whether of excavated stones or of rocks in a quarry, is the most basic of geological skills. Provided the surface is representative of the specimen and is not affected by weathering, a good assessment can be made of the range of sizes and shapes of the sand grains, the material which cements the grains together, the presence of minerals other than quartz, the presence of any structures in the stone and its hardness, porosity and colour. Even so, discerning significant differences between such similar sandstones with any degree of certainty is not always possible by this means.

Much more reliable information can be obtained by examining a thin section using a petrological microscope. By this means an accurate picture can be obtained of the sizes, shapes and relationships of the quartz grains which make up the bulk of the sandstones. Other mineral grains such as mica and feldspar can be identified. The presence can also be detected of other materials - such as clay, iron oxide and organic matter - even though the particles are usually too fine to be identified individually. There can be some difficulties in identifying feldspars as they are often in the process of chemical alteration to clay, but a chemical staining process can be used to identify the feldspars clearly. The main disadvantage of this technique is the cost - preparing a good quality thin section costs in excess of £40 and chemical staining of feldspars raises the total cost to nearly £60.
Provided reasonably dependable identifications can be made of variations in characteristics of the stones, the process of correlating masonry with its sources can begin. But now two further difficulties arise. One problem is in the source rocks, in which variations can occur within a quarry which are as great as those between one quarry and the next. Individual beds within a sandstone may have been laid down with a significant time gap between them so the conditions of deposition may be quite different. There may also be differences laterally along a bed, just as there are from one part of a modern beach to another. The other problem is that of re-use of stones, which means that stones within a single block of masonry may have different sources because some of the stones may have been quarried at an earlier period. Allowance must be made for both these uncertainties when attempting correlations.

The clearest correlation observed so far concerns the feldspar contents.

![Feldspar contents of site samples (upper) and quarry samples (lower)](image)

**Figure 5.1** Feldspar contents of site samples (upper) and quarry samples (lower)
The graphs in figure 5.1 suggest a significant correlation may exist between the use of stone from the two main Barcombe Quarries (localities Q3 and Q4) and the third century masonry. However, accurate determination of feldspar contents has proved difficult. In hand specimens, distinguishing feldspars from the mass of quartz grains simply on the basis of opacity gives very variable results. This is especially true for stones *in situ* as is shown by the wide variation in the relative feldspar counts for a group of very similar third century stones (table 4.1). Even in thin sections, the normal method of distinguishing feldspars under a polarising microscope is not very effective where widespread chemical alteration is present. In table 4.3, it can be seen that the feldspar count for a stained specimen was over five times that obtained by the normal method. This demonstrates that a conclusive correlation between the Barcombe quarries and third century masonry will require the production of a number of further stained thin sections. Unfortunately, it is not possible to stain existing thin sections retrospectively because the cover slips cannot be removed.

Further study of the existing thin sections is needed to find out whether any other correlations exist. Characteristic factors might be the size, shape and relationships of the quartz grains, the porosity and the amount and distribution of mica.

Further study of the hand specimens which have already been collected will help in identifying useful characteristics and will also help to clarify the amount of variation within each of the main quarries.

It has been clear to the archaeologists for some time that many of the stones in the Antonine period masonry and the Severan round houses are strongly coloured and friable and are prone to severe erosion due to weathering. This has been well demonstrated over the 2010/11 winter (figures 2.1 and 2.2). Similar strongly coloured and friable patches have been noted in the quarry above the Cockton Burn (locality B4). This tends to support the archaeologists’ view that this area was the source of the Antonine stone. Further work on the existing hand specimens and thin sections, and possibly a few further thin sections, should help to firm up this correlation.

Interestingly, the thin section taken from a Severan Barracks building (specimen V09Q-S10, table 4.2) is relatively high in feldspar, suggesting that the Barcombe quarries may first have been opened to build the Severan fort in around AD 208. On the other hand, the round houses built outside this fort seem, from their colour and weathering characteristics, to have been built from re-used Antonine stones. Figure 2.2 shows that not all of the Antonine stones themselves exhibit these weathering characteristics so some may be from a different part of the quarry or may have been re-used from an earlier period.

There is clearly potential for establishing useful correlations between the compositions of the Roman stones and possible source quarries. But there are considerable difficulties to be overcome, not least in studying a sufficient number of those stones which are, and must remain, *in situ*. An effective way forward might well be to establish a reference collection of examples of common stone types, both from Roman masonry and from quarries. Each
example would have weathered and freshly broken surfaces and a feldspar-stained thin section. These examples could be compared with stones in situ, possibly using close-up photographs, for rapid classification of stones on site and in the field.

Another useful approach would be to prepare a number of stones of various types which would be left exposed to the elements over a number of years to study the effects of weathering in a controlled way.

5.2 Sources of stone

This section summarises the evidence to date for Roman use of the main possible sources of stone.

As figure 5.2 shows, there is a marked similarity between the distributions of types, sizes and shapes of the stones in many of the wall fills and of those in the local stream beds. It seems likely that most of the fill used in masonry of all periods came from such sources. A possible exception is the substantial wall in the 2011 area B in which the fill appears to be largely the waste from dressing and quarrying the facing stones.

Figure 5.2 Left – the 10 m wide bed of the Cockton Burn to the east of the North Field; Right – the 1m wide curtain wall in the North West corner of Stone Fort 1

Characteristics of some of the stone in the quarry in the south side of the Cockton Burn valley (locality B4) – low feldspar, strong colouration and rapid erosion due to weathering – are typical of stones in the Antonine period masonry. The quarry is similar in nature to Comb Crag quarry which is known to be Roman.
There is no dating evidence for the small quarry just north of the Chesterholm drive (locality C1). It is close to Vindolanda but even closer to Chesterholm.

The quarries in the south bank of the Bradley Burn valley (localities C2-9) are quite extensive. They were probably worked in the 19th century but the extent of what appears to be hill-wash against some of the faces suggests parts may have been worked at a considerably older date.

The quarry in the east side of the Chineley Burn valley within the Chesterholm grounds (locality M3) is the source of the large boulders in the stream below. The wedge holes in one of these boulders are typically Roman but equally could be later. There is no direct evidence as to when in the Roman period it might have been worked, but a late date would explain why the boulders were not subsequently made use of.

The quarry further down the east side of the Chineley Burn valley (locality A1) could be of Roman date but its location is much closer to more recent buildings at Birkshaw than to Vindolanda.

The small quarry just west of the Long Stone (locality Q1) is perhaps the most enigmatic. There is no direct evidence as to its age, but the extent of weathering and encrustation suggests it is of some antiquity. The feldspar counts for the two thin sections from this quarry (11 and 6 grains per 40mm²) bracket those for the two from the 1st century bath house (7 and 8 grains per 40mm²). As table 4.3 shows, this is the only one of the likely sources which has so far yielded this intermediate feldspar content. It is a source with only limited potential which would not have been suitable for later building programmes but would have been ideal for the early bath house and the few stone buildings contemporary with it.

The other small quarry in this area (locality Q2) has a less weathered face and contains a good deal of thinly bedded stone typical of that in the adjacent field wall.

The well known graffiti makes it certain that the small Barcombe quarry (locality Q3) was created in its present form during the Roman period. The high feldspar content of the thin sections from this quarry only appears in the Vindolanda masonry from the early 3rd century Severan fort onwards.

The big Barcombe quarry (locality Q4) reached its present size during the railway age (in or around 1837). However, it seems that the railway masons re-opened a Roman original which could have been quite sizeable. High feldspar contents show that this Roman precursor is likely to be of 3rd century date.

No direct evidence has been found that any of the quarries on Thorngrafton Common (localities T2-10) are of Roman origin. Quarrying during the Enclosure period, during the Railway age and for 19th and 20th century building could account for most or all of the visible workings. All of the Thorngrafton Common quarries were worked down into the top of a ridge or upwards into a dip-slope. By contrast, all the quarries listed above as certainly or
possibly Roman (as well as many known Roman quarries such as Queen’s Crags, Comb Crag and those in the Gelt Valley) were worked horizontally into the face of an escarpment or the side of a valley.

Writings about the Thorngrafton Find (an arm purse discovered in 1837) persistently claim that it was made in a Roman quarry. The dates of the coins in the purse place its deposition in the early Hadrianic period. However, an assessment of the historical evidence surrounding the find (Bruce, 1871, and a number of earlier papers), together with the results of the survey reported in sections 3.6 and 3.7, have revealed no justification for such claims. Most probably the purse was deposited in a natural rock fissure. Hence the Find provides no useful evidence about Roman quarrying on Barcombe Hill or Thorngrafton Common.

The small proportion of mudstones in the Vindolanda masonry may have been quarried from beds immediately above one of the limestones but are more likely to have been taken from stream beds.

5.3 The volume problem

In section 4.5.1 the volume of stone needed to build the 3rd century fort was estimated at 3,500 m$^3$ of facing stone and 4,000 m$^3$ of fill. To obtain an estimate of the volume of stone used on the whole site at the height of the 3rd century, estimates must be added for:-

- the facing stones of the masonry in the vicus (although many of the walls would be masonry to a lower level than those in the fort, the excavated buildings are numerous and many more are unexcavated)
- the paving slabs for the main roadways and some internal floors, both inside and outside the fort
- the footings of earlier structures buried below those of the 3rd century
- the fill stones of the extramural buildings (although the volume of these would be proportionately less than in the fort because the extramural walls are generally thinner)
- cobbled stones for roads and some larger areas which probably came from the same source as the fill stones.

A very rough estimate would be that the total amount of quarried stone - facing stones and paving slabs - would be at least twice that of the fort structures alone, say 7,500 m$^3$. The total of fill and cobbles would be a little smaller but perhaps at least 6,000 m$^3$.

The volume of possible quarry sources is dominated by the big Barcombe quarry and the key uncertainty with this is how much of the present “missing volume” was removed in Roman times and how much by the railway builders. Using the figures in table 4.5 and making the assumption that the Roman period accounted for 50% of the big quarry and 100% of the rest gives a total of 3,510 m$^3$ of stone, which is just under half of the estimate above for quarried stone used at Vindolanda.
To give some idea of the volume of stream-bed stone needed for the fill stone and cobbles, 6,000 m$^3$ would require the excavation of 1 km of stream bed 10 m wide to a depth of 1 m, assuming a 60% packing density. The streams around Vindolanda do provide a sufficient area for this extraction. Whether a sufficient depth of stones was available 2,000 years ago is a matter of conjecture, but since these are the only suitable nearby sources it must be assumed that this was the case.

A comprehensive picture of the stone sources used at Vindolanda at different periods can only be obtained once sufficient probable sources have been identified. The discrepancy between the estimates of quarried stone in use and the yield of the quarries identified so far suggests that further sources wait to be confirmed. So resolving this “volume problem” is a very important aspect of the project.

In seeking to resolve the problem, a variety of activities will be needed. These include:-

- further detailed surveys of excavated masonry and paving
- additional estimates of original heights of masonry
- comprehensive allowances for unexcavated areas
- detailed surveys of all known quarries including careful examination for any evidence of Roman working styles or graffiti
- historical research aimed at finding any maps or other documents which record quarries which predate the industrial era
- identification of sources for special types of stone such as paving slabs and the hard, low-porosity sandstones such as those in figure 4.6
- continuing petrological analysis.

5.4 Review of progress against objectives

Progress with the objectives set out in section 1.2 can be summarised as follows.

1. The area around Vindolanda has been extensively surveyed and many possible Roman stone sources identified. There is still much work to do to clarify which quarries were exploited by the Romans and how much stone they would have provided.

2. Good progress has been made in identifying the sources used at particular periods.

3. The Severan fort and the contemporary round houses appear to have employed different sources of stone but there is no indication to date that different sources were used for the 3$^{rd}$ century fort and vicus.

4. Initial observations at Chesters and at two points on the Wall suggest that the issues involved in identifying stone sources for these structures will be very similar to those for Vindolanda.
6 Conclusions and recommendations

6.1 Summary of conclusions

There are extensive sandstone outcrops in the Vindolanda area which have been extensively quarried for building stone from Roman to recent times. Working out which quarries were used in the Roman period is one of the main challenges of the project. A number of conclusions have been reached so far.

The small Barcombe quarry is entirely Roman work but the proportion of Roman work in the big Barcombe quarry is a matter of conjecture. The small quarry near the Long Stone may also be Roman. The quarry in the south side of the Cockton Burn valley is almost certainly Roman and that on the east side of the valley in the Chesterholm grounds may also be.

There is extensive quarrying in the south side of the Bradley Burn valley but how much of it is Roman is still an open question. Most of the quarrying in the Chineley Burn valley and on Thorngrafton Common is likely to be 18\textsuperscript{th} to 20\textsuperscript{th} century. Much of the stone used for wall fill and cobbled surfaces appears to have been scavenged from stream beds and valley bottoms.

The lithology of the sandstones varies relatively little. As a result, determining the source of quarried sandstone is a considerable challenge. However, two factors - feldspar content and weathering characteristics - have so far been identified which can help in identifying sources.

The evidence to date suggests the following possible pattern of use.

1. The limited amount of stone needed for the 1\textsuperscript{st} century bath house came from the small quarry near the Long Stone.
2. The quarry in the Cockton Burn valley was used during the Antonine period.
3. The quarries on Barcombe Hill were opened for the building of the Severan fort and continued in use for the building of Stone Fort 2 and the vicus.
4. The Severan period round houses employed re-used Antonine period stone.
5. Re-use of stone occurred to an increasing extent. After the later 3\textsuperscript{rd} century any new stone used may have been from the small quarry in the Chesterholm grounds.

The estimated total yield of the Roman quarries identified so far is only about half the estimated volume of quarried stone used on the site.

The valley in which Chesterholm sits was not a major source of Roman stone.

Early indications are that identifying the quarries used for other structures in the central section of the WHS will present similar challenges to those being faced at Vindolanda.

There is no strong evidence to support the accepted wisdom that the Thorngrafton Find was made in a Roman quarry.

There is good reason to suppose that a considerably more detailed and accurate picture is achievable on all these issues. Section 6.2 recommends how progress towards this goal should be made.
6.2 Recommended next steps

As a result of experience to date, the following actions are recommended. All are aimed at achieving a steady improvement in the ability to identify with confidence the sources of the Vindolanda stones.

1. Develop the ability to characterise and identify stones by:-
   1.1. completing comprehensive descriptions, with photographs, of the existing thin sections
   1.2. carrying out a comprehensive study and recording of all existing hand specimens
   1.3. developing the ability to identify feldspar contents accurately by getting further stained thin sections
   1.4. considering the contribution which other factors, such as mica content, might make to characterising the sandstones
   1.5. improving the ability to relate weathering and colour to lithology, including the possibility of long-term weathering experiments
   1.6. developing a library of stones with weathered and broken surfaces and feldspar-stained thin sections
   1.7. carrying out further close-up photography.

2. Carry out further detailed study of potential source locations, particularly the quarries in the Bradley Burn valley, the quarry near the colliery in the Chineley Burn valley, the quarry near the Long Stone and stream-beds.

3. Attempt to identify sources of “specialised” stones such as paving slabs.

4. Search historical archives to improve understanding of which quarries pre-date the industrial era.

5. Carry out further detailed work on stone volumes on site and in likely quarries.

6. Continue to obtain professional geological advice and assistance.

7. Consider in more detail how the techniques developed for this project might be applied to other structures in the WHS, including those in the eastern and western sections where similar techniques should be effective even though the different geology will mean that different characteristics of the stones are likely to be diagnostic.
7 References


Bruce, J. Collingwood (1871) *The story, partly sad and partly gay, of the Thorngrafton Find*, Newcastle-upon-Tyne


Hyslop, E. (2009) Personal communication


Lawrence, D. (2010) Personal communication

Lawrence, D., Weintritt, J. and Hyslop, E. (2010) 'A trial study into the geological characterisation and identification of sources of building materials found at Vindolanda Roman site, Northumberland – Preliminary findings', *British Geological Survey Internal Report IR/10/010*


Acknowledgements

I am most grateful to Andrew Birley for his unstinting support for the project and for much helpful advice. Robin Birley has kindly read a draft of the report and provided many perceptive comments. David Lawrence has also commented helpfully on an early draft and he and his colleagues at the BGS continue to provide invaluable advice and assistance. All three have both encouraged my efforts and curbed my excesses, but any remaining errors are all my responsibility.
Appendix – Identification of Specimens

A similar system has been adopted for identifying stone specimens as is used for identifying archaeological contexts at Vindolanda.

1. For specimens of Roman stones taken from the site, the identifier for each specimen has the form VyyQ-Snn, where yy is the year (e.g. 10 for 2010) and nn is a sequential number. No attempt is made to correlate the numbering with parts of the site. Detailed records and photographs are taken of the original locations.

2. For specimens from potential quarries or elsewhere in the surrounding area, the identifier for each specimen has the form VyyQ-xm/n, where yy is the year, x is a letter denoting a geographical area as follows:
   - A - Chineley Burn valley below the Chesterholm grounds
   - B - Cockton Burn valley
   - C - Bradley Burn valley
   - M - Chesterholm grounds
   - Q - Barcombe Hill
   - T - Thorngrafton Common,
   m is a one or two digit number identifying a locality within the relevant area and n is a one or two digit number identifying a specimen from that locality. All the localities are comprehensively described in section 3.

In 2009, 18 specimens (V09Q-S01 to V09Q-S18) were taken from the site by the BGS. The specific locations on the site from which they were taken are listed in the BGS preliminary report (Lawrence et al., 2010).

The 11 specimens taken from the site in 2010 and 2011 are listed in table A.1

<table>
<thead>
<tr>
<th>Specimen ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V10Q-S01</td>
<td>Rubble from packing below SF2 <em>Via Praetoria</em></td>
</tr>
<tr>
<td>V10Q-S02</td>
<td>Rubble from packing below SF2 <em>Via Praetoria</em></td>
</tr>
<tr>
<td>V10Q-S03</td>
<td>Part of one of the large stones from a building in the 2010 area B</td>
</tr>
<tr>
<td>V10Q-S04</td>
<td>Facing stone from wall in NW corner of the 2010 area B</td>
</tr>
<tr>
<td>V10Q-S05</td>
<td>Stone from semi-circular structure in SE corner of the 2010 area B</td>
</tr>
<tr>
<td>V10Q-S06</td>
<td>Facing stone from E wall of SF1 barracks adjacent to SF1 <em>Via Decumana</em></td>
</tr>
<tr>
<td>V10Q-S07</td>
<td>Facing stone from E wall of SF1 barracks adjacent to SF1 <em>Via Decumana</em></td>
</tr>
<tr>
<td>V10Q-S08</td>
<td>Facing stone from W wall of same barracks building</td>
</tr>
<tr>
<td>V10Q-S09</td>
<td>Stone from wall in “ditches” trench in N field</td>
</tr>
<tr>
<td>V10Q-S10</td>
<td>Upper half of facing stone from building in N field</td>
</tr>
<tr>
<td>V11Q-S01</td>
<td>Part of outer facing stone from large wall discovered in the 2011 area B</td>
</tr>
</tbody>
</table>

Table A.1 Site specimens taken in 2010/11
In 2009 the BGS took 10 specimens from potential quarries in the Vindolanda area. They gave these their own internal numbers which are listed in their report. Table A.2 relates these numbers to the corresponding Vindolanda numbers.

<table>
<thead>
<tr>
<th>BGS number</th>
<th>Vindolanda number</th>
</tr>
</thead>
<tbody>
<tr>
<td>ED10577</td>
<td>V09Q-Q1/1</td>
</tr>
<tr>
<td>ED10578</td>
<td>V09Q-Q3/1</td>
</tr>
<tr>
<td>ED10579</td>
<td>V09Q-Q3/2</td>
</tr>
<tr>
<td>ED10580</td>
<td>V09Q-Q4/1</td>
</tr>
<tr>
<td>ED10581</td>
<td>V09Q-B1/1</td>
</tr>
<tr>
<td>ED10582</td>
<td>V09Q-B2/1</td>
</tr>
<tr>
<td>ED10583</td>
<td>V09Q-B3/1</td>
</tr>
<tr>
<td>ED10584</td>
<td>V09Q-C1/1</td>
</tr>
<tr>
<td>ED10585</td>
<td>V09Q-C2/1</td>
</tr>
<tr>
<td>ED10593</td>
<td>V09Q-T1/1</td>
</tr>
</tbody>
</table>

Table A.2  BGS 2009 Specimens

In 2010 a wide range of specimens was taken from potential stone sources around Vindolanda. These are listed in table A.3.

<table>
<thead>
<tr>
<th>Localities</th>
<th>Samples</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>1</td>
<td>Loose stone</td>
</tr>
<tr>
<td>B4</td>
<td>9</td>
<td>From locations spaced along and up the face</td>
</tr>
<tr>
<td>C2</td>
<td>1</td>
<td>From a different part of the face from the 2009 BGS sample</td>
</tr>
<tr>
<td>C3 to C9</td>
<td>7</td>
<td>One from each locality</td>
</tr>
<tr>
<td>M1</td>
<td>6</td>
<td>Equally spaced up the 1 m high calcareous mudstone</td>
</tr>
<tr>
<td>M2</td>
<td>1</td>
<td>From the boulder between the footpath and the burn</td>
</tr>
<tr>
<td>M3</td>
<td>7</td>
<td>From 5 locations along the face and 2 lower down</td>
</tr>
<tr>
<td>Q1</td>
<td>6</td>
<td>Equally spaced along the face</td>
</tr>
<tr>
<td>Q2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Q4</td>
<td>6</td>
<td>Equally spaced along the face</td>
</tr>
<tr>
<td>T2</td>
<td>3</td>
<td>From the 2nd, 4th and 8th “bays”</td>
</tr>
<tr>
<td>T3 to T8</td>
<td>6</td>
<td>One from each locality</td>
</tr>
<tr>
<td>T10</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Table A.3  Hand specimens collected during the 2010 survey of the environs of Vindolanda
Three batches of thin sections have been made. 

Batch 1 was made by BGS in 2009. This batch of 28 sections was made from the 18 site specimens described above (V09Q-S01 to V09Q-S18) and the 10 specimens listed in table A.2.

Batch 2 was made by Edinburgh University in July 2010 and comprised two specimens - V10Q-B4/2 and V10Q-M3/1.

Batch 3 was made by BGS Keyworth in March 2011 and included 5 site specimens - V10Q-S03, V10Q-S06, V10Q-S07, V10Q-S08 and V10Q-S10 - and 5 other specimens - V10Q-A1/1, V10Q-M2/1, V10Q-Q1/7, V10Q-Q4/2 and V10Q-T2/3. A second section made from specimen V10Q-Q4/2 was stained to highlight feldspars.
Cockton Burn valley - Roman (Antonine)

Long Stone quarry - Roman? (pre-Hadrianic??)

Cockton Burn - A major source of rubble

Chesterholm grounds - Roman boulders?

Chesterholm grounds - source of boulders

Barcombe small quarry - Roman (3rd C)

Barcombe big quarry - Roman (3rd C) extended in 1837

Other workings:
- Ironstone pits (19th century and earlier)
- Collieries (19th - 20th century)
- Limestone quarries (19th century, and earlier?)
- Sandstone quarries (18th - 20th century, and Roman?)
- Sandstone quarries (19th century, and Roman?)

Map source: OS 1:25,000 sheet OL43

An interpretation of quarrying evidence in the Vindolanda area