University of Reading

Making flour the German way: Imported lava querns and millstones in Roman Britain

PhD Archaeology

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Abstract

The importance of food processing in the past is evident from the frequent occurrence of milling tools on archaeological sites. During the Roman period in Britain, imported lava milling tools complement those of indigenous stone types, but distribution and use of lava in the province has never been systematically examined. This research presents the first study of this material in Roman Britain, cataloguing and analysing 2,707 lava milling tools from 564 sites. A further 601 sites where lava was absent but other lithologies occurred have also been recorded. Analysis was completed using an object biography approach to investigate the key stages of manufacture, distribution, primary use, reuse/modification, and deposition at various case study sites to reflect lava milling tool use in rural, urban, and military contexts.

Quarrying and manufacture of lava milling tools at Mayen, Germany, was examined in detail, and distribution analysis was undertaken to explore spatial, chronological, and social distribution. This has demonstrated that lava consumption was limited geographically and socially, with regions in the south-east and east of England, alongside military and urban sites being most likely to use lava milling tools. Lava millstones were most common in southern urban and northern military contexts, showing that access and use of centralised food processing technology was unequal. Chronological analysis of lava distribution has shown that the earliest lava imports occurred in the first century, with a peak in deposition during the second to third centuries.

Evidence for the modification of lava querns has provided insight into innovation and specific modes of lava quern use, while varying use wear prior to deposition points to privileged access to imported lava at urban and military sites compared to rural ones. Analysis of deposition suggests that lava querns were ritually deposited in pits in urban contexts, and that reuse in construction and road surfaces was common at military sites.

Overall, this study has generated a large corpus of new data, the analysis of which has delivered previously unknown detail of the role of lava milling tools in Roman Britain. The dataset also creates the potential for future analysis to help build a more complete view the complex biographies of these significant objects and their relationship with past peoples.

Acknowledgements

Many people have been involved in this project and I am very grateful for the help and assistance throughout. The complexity of conducting research during a global pandemic created a range of difficulties in accessing materials and information, and without the support of the people named here, this thesis may not have been possible. First and foremost, I must thank the Arts and Humanities Research Council South-West and Wales Doctoral Training Partnership. Without funding, this project would probably never have happened, and the added career and personal development opportunities provided by the scheme have made me a better researcher and archaeologist. I would like to thank my supervisors; Hella Eckardt and Ruth Shaffrey, who were responsible for the initial research idea for this project that I then helped to develop, and then helped me the whole way through the PhD. They have both been incredibly supportive, full of good advice, guidance, and information. I cannot emphasise enough how much I have enjoyed working with them and how much I have learnt from being their student. I would also like to thank Martin Pitts who supervised and contributed to the development of the project whilst providing invaluable feedback that made me consider aspects of my research using new perspectives, and John Creighton who helped me navigate some of the more complex aspects of the Roman economy and offered guidance as a mentor throughout the PhD. Extra thanks to John Cruse and the Yorkshire Quern Survey who helped to sponsor this project and have provided support, information, and assistance throughout. I would like to extend my thanks to the University of Reading and all staff and students who have helped me over the years: offered work, lent books, or been a sounding board for quern-related theories and thoughts. This includes the administration teams in SAGES and the Graduate School, especially Heather Browning, Elizabeth Wyeth, Susie Fullarton, Marie Taylor and Jen Baker. Thanks also to Sara Machin and Kev Williams who provided lab training. Although this part of the analysis was not completed due to Covid restrictions, their time has been much appreciated.

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I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

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Chapter 1. Introduction

Aims and Objectives

Processing grain is an activity fundamental to agrarian societies, and often imbued not just with economic but also social and ritual significance. The need to feed a growing population in Britain from the Iron Age onwards resulted in an increase in the production and consumption of cereals as a foodstuff, and the vital role of the quern for grain processing grew significantly as a result. Querns saw widespread use and are frequently present on most archaeological sites dating from the Iron Age onwards. Although not entirely ubiquitous after the introduction of mill technology, for a long period of time querns were essential tools in food production. They fulfilled the role of grain processing tools within domestic contexts for small-scale immediate food consumption but may also have been used on a larger scale to feed entire communities or to provide surplus flour for wider regions. Querns were probably used to feed a mobile army during the invasion of Britain and also to feed stationary troops in garrisons and forts. The significance of grain to the military diet is well-attested and quern use would have played an important role in the everyday life of the Roman soldier, who literary evidence suggests, was responsible for preparing his own daily food ration (Davies, 1971).

Imported lava was one of the most popular choices for querns and millstones in Roman Britain, but distribution and use of this material in Britain has never been systematically studied. My thesis will consider this neglected body of material culture to enhance our understanding of Romano-British food production, of the rural economy and of the social, cultural, and religious identities of the people who used them. The key research question of this project is: What can lava querns tell us about Romano-British food production, trade, and social identities and potentially ritual practices?

The aim of this research is to investigate what lava querns and millstones can tell us about life in Roman Britain; their use in food production, involvement in trade and exchange networks, ritual activities, and the role they may have played in the formation and maintenance of socio-cultural identities. Objectives include: to produce the first ever corpus of this material for Roman Britain; to reassess the current typology in use for lava querns and to adjust or suggest amendments where necessary; to explore the chronological change in lava milling tool use with regards to volume of consumption and spatial distribution; to examine context and patterns of deposition; to apply new methods for investigating the lives of lava milling tools, including measuring the thickness of upper and lower stones prior to deposition, identifying traces of wear relating to primary use and reuse, and examining objects for evidence of modification.

This aim will be completed using a theoretically informed approach, applying the concept of object biography to analyse the various stages of the lava quern or millstone lifecycle (Kopytoff, 1986). The stages are manufacture, distribution, primary use, reuse/modification, and disposal/deposition. For each stage, an examination will take place of the interactions between human and object, the possible social and economic implications of these interactions and how these may have changed over time. The study will take place on both a localised micro-scale by examining specific case studies, whilst also considering the wider Romano-British macro-scale data and interpretations. Case studies have been selected to specifically address variation across different site types: military, urban and rural. Overall, 2,707 lava milling tools from 564 sites in Roman Britain were captured in the dataset, alongside 601 sites where milling tools were present, but none of lava: making 1,165 sites in total.

Context of Study

While major advances to our understanding of Roman rural life have recently been made, artefactual evidence has often been ignored (Smith et al., 2016). Stone artefacts such as querns in particular have been neglected, with earlier studies focusing mainly on petrology (e.g. Peacock, 1980). More recently, there has been an increased emphasis on understanding the social and economic implications of these objects, for example by distinguishing between querns and millstones and by linking petrology explicitly to trade and consumption (e.g., Williams & Peacock, 2011; Shaffrey, 2006). There has also been an increased recognition of deposition practices, which can have ritual aspects (e.g., Buckley & Major 2016, p. 135).

Romano-British lava querns are generally assumed to have come from the Eifel region (Germany), but this has never been investigated scientifically and alternative sources have also been suggested, notably Volvic in France (Mangartz, 2012; Röder, 1953; Welfare, 1995, p. 214) (see also Chapter 2). Querns and millstones made from lava provided a technological advantage as the cavities in the volcanic rock are effectively self-sharpening. While easily recognised by non-specialists as volcanic, the substantial body of material from Roman Britain has never been studied as a group, and we therefore remain ignorant of even the most fundamental information on typology, chronology, and distribution, let alone the detailed provenance information now available for continental material (Gluhak & Hofmeister, 2009). The new data on lava querns will be compared to published data on other types of Romano-British querns (Shaffrey, 2006; Shaffrey & Roe, 2011) to create a holistic picture of food production practices, economic connections, and social identities in Roman Britain.

Routine practices, especially those connected with food production, can offer profound insights into ancient societies but imported lava querns have never been studied in depth. Building on a discussion of their typology, chronology and distribution the project will provide new insights into trade relationships (cf. Morris, 2010) and consumption preferences. Nuanced studies of even small fragments can, for example, distinguish between centralised and de-centralised grain processing (Shaffrey, 2015). There has also been an increased recognition of (ritual) deposition practices, which can include placement in pits, wells and postholes and 'transitional' locations, such as within enclosure ditches and under thresholds (Brück, 2006, pp. 300-304). This research will, therefore, contribute to our understanding of Romano-British identities and culture change under colonial rule.

Querns as Artefacts

Archaeologically, the introduction of the quern as a means of food processing is strongly associated with the introduction of agriculture during the Neolithic period (Peacock, 2013, pp. 17-21: 26), though the tool itself has precursors dating back to the Palaeolithic (de Beaune, 2004). As European populations became increasingly reliant on grain as a foodstuff, a dependence on the tools used to transform grain into edible food products also developed. Querns may also have been used to crush other materials, such as metal ores and pottery tempers (Watts, 2014, pp. 22-23), though interpretations relating to these methods of use are highly contextual and most querns are ordinarily associated with food processing activities. The earliest quern forms in Britain are of the 'saddle' type, consisting of a large slightly dished lower stone that can hold the grain, and a smaller hand-held stone that was moved back and forth, crushing the grain between the two stones (Peacock, 2013, pp. 18-19) (figure 1). This form continued to be used in Britain well into the Iron Age and examples have been recovered in small numbers from Roman contexts, showing a long period of use (for example, see Williams & Zeepvat (1994) and Stead (1976)).

The introduction of the rotary quern brought huge change to an everyday activity, reducing the amount of work needed to process the same volume of grain (Peacock, 2013, pp. 120-130). Despite the name, there is a high possibility that rotary querns were oscillated to imitate the movement of a saddle quern, and not rotated (Heslop, 2008, p. 55; Watts, 2014, p. 21). The precise chronology relating to the introduction of the rotary quern in Britain is not known and is likely to have been regionally different (Shaffrey, pers. comm.), but is thought to have occurred sometime between the middle to Late Iron Age (Watts, 2002, pp. 27-29; Peacock, 2013, pp. 54-58). For Northamptonshire Chapman concluded that their appearance dated no earlier than 250-200 BC (Chapman, 2019, p. 68) and this is likely to have been the time of their introduction across much of eastern England (Willis, pers. comm). Rotary querns were already used in use in many areas of continental Europe prior to their introduction in Britain, and it is possible that the concept and design was imported through trade and exchange with the continent (Shaffrey, 2019), or that it was the product of separate innovation (Peacock, 2013, p. 58).

Figure 1- Early Neolithic saddle quern from Etton Cambs (Wikimedia commons license).

Rotary querns take the form of a pair of stone of relatively equal sizes (figure 2). Different quern forms or types exist, and these can be regionally or chronologically distinct (Peacock, 2013, pp. 63-76; Watts, 2002, pp. 31-38), but all tend to have circular grinding surfaces; one on the upper (*catillus*) and one on the lower stone (*meta*). The lower stone remains stationary, while the upper stone is either rotated or oscillated via a spindle fitted into the lower stone that is pivoted on a 'rynd', usually of iron, fixed into the upper stone (figure 3). Grain is fed into the quern via an opening in the upper stone, sometimes widened at the top to form a hopper. Various handle fittings exist across different rotary quern types, used to move the upper stone. Querns are typically made from sandstone, conglomerate, limestone, or lava, though any suitable geology can be utilised. In regions with access to suitable stone types, these were locally sourced, while good stone for querns was often moved many miles to supply regions without (Moore, 2007, pp. 84-85; Parkhouse, 1997; Morris, 2010, p. 78; 107). The stone needed to be hard enough to withstand the friction of movement associated with grinding without excessive breakdown of the material, while remaining suitably rough to maintain the friction needed to cut or crush the grain (Peacock, 2013, p. 2; Watts, 2002, p. 29).

Figure 2- Rotary quern in use in Tibet (photo Beger, (1938), creative commons license).

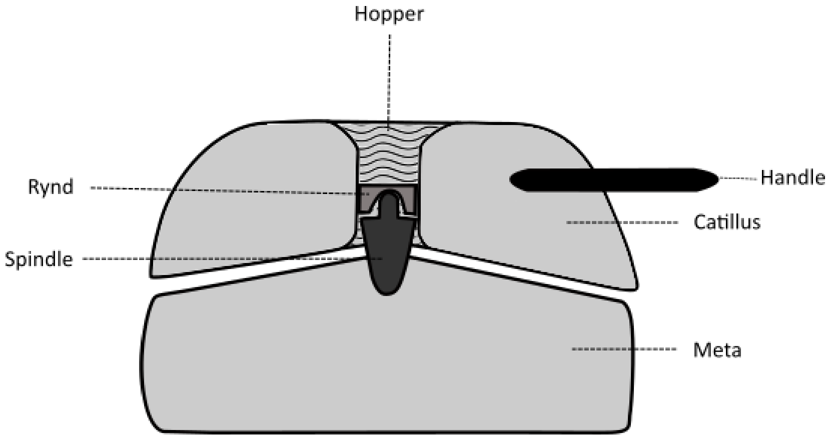


Figure 3- Diagram of general components of a quern of indigenous British form.

Most modern interpretations of ancient quern use tend to focus on utilitarian aspects of function, form, and mode of operation as well as the relationship between querns and the economy of the stone trade and food production. However, the social significance of these objects has come increasingly to the forefront of investigations. The important and diverse role that querns held in past cultures is well recognised in prehistory (Brück, 2006; Hill, 1995, p. 108; Watts, 2014, pp. 5-12; Hamilton, 2002, p. 40; Moore, 2007, pp. 90-91), and these ideas are supported by anthropological studies involving quern use in modern-day traditional societies (Watts, 2014, pp. 31; 33-35). Less focus has been given to such relationships between people and querns in the Roman period, which might relate to the fact that there is such a large volume and variety of material culture available for study. This makes it much harder to establish patterns in deposition or use. However, the socio-cultural significance of these objects appears to span time and space and it is highly likely that querns in the Roman Britain also held more value than that of their function alone.

Mills and Millstones

Roman period mills in Britain existed in two main forms: disc or 'Pompeian' types (figure 4) (see Chapter 2). Both could be powered by humans or animals, while disc types could also be turned using water. Structural evidence for mills within the province is a rare occurrence (figure 5), though it is highly likely that a greater number of mills were in use than have currently been recorded. Shaffrey (2015) has named known Roman period mills at Fullerton, Ickham, Stanwick and Silchester, with possible mill structures at Darenth, Kenchester and Dickets Mead. The Rural settlement of Roman Britain Project has identified a further 13 possible mill structures (Allen, et al., 2018), while two probable watermills are known at military sites at Chesters and Haltwhistle Burn on the northern frontier (Simpson, 1976, pp. 26-49). Current distribution of identified mill structures suggests that there was a greater number in the south of the province, which might relate to population, but may also be indicative of more modern-day development in these areas.

Figure 4- Disc-type Roman millstone (left) (Dreesen, et al., 2014, p. 18) and Pompeian style mill (right) (photo by author of millstone from Princess Street in Museum of London).

Utilisation of mills can also be identified by the presence of millstones, which have a much better survival rate than other evidence types, meaning they have a higher probability of recovery than timber mill structures. Despite there being some debate about whether millstone presence constitute the existence of a mill (Dawson, 2019, pp. 239-240), the occurrence of millstones, especially those with clear signs of wear, can and should be connected to a probable mill in the area; even if this is not necessarily within the immediate vicinity (Shaffrey, pers. comm). Sometimes, these provide the only means for identifying the existence and extent of centralised grain processing within specific regions and chronologies; they act as an important indicator of population, status, organisation of labour, centralised food production, and access to technology and innovation. All these interpretations of millstone use can provide a vital glimpse into the economy and society of past peoples.

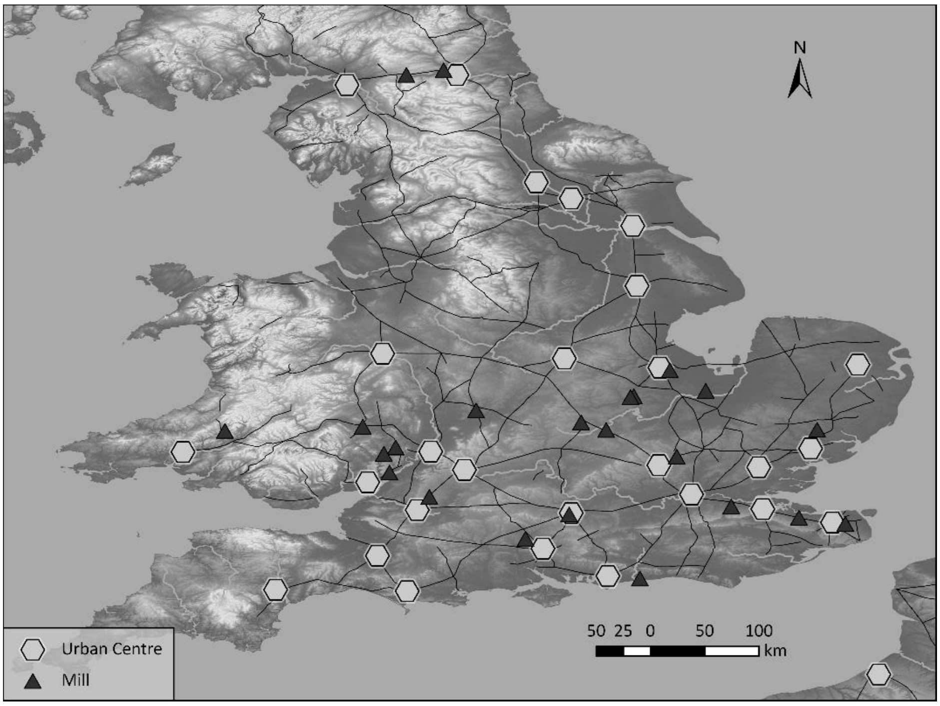


Figure 5- Location of identified and possible mill structures from structural evidence in Roman Britain, also showing the main urban centres.

Differentiating Between Mills and Querns

The ability to turn or oscillate a quern comfortably and use it efficiently as a hand-operated tool is highly dependant on ergonomics. The mechanics of grinding influence tool design heavily, whilst human requirements such as physical range of movement and the impact or stress on muscular and skeletal systems are also an important factor (Sefryn, 2013, p. 692). Similarly, the concept of 'affordance', as taken from design theory, has been applied to archaeological material to help interpret how form might be related to function using evidence of actual use (Swift, 2014, pp. 203-204). Although this approach also considers the design of an object as being conducive to its intended use, it actively examines differential use and adaptation of purpose through alterations in the material and signs of use-wear. This is something that should be applied to quern and millstone identification too.

It is expected that there should be a maximum and minimum size for a quern when considering average human physical capability and quern form, as these factors will dictate how the object can be used. For example, it is not possible for an average person to comfortably reach two metres in front of them from a seated or standing position, and so a quern diameter would probably not be this large. As millstones are not constrained by size, there can be a much wider variation in stone diameter than for querns, and it is generally assumed that millstones would be larger and more productive than querns to justify the extra investment in the mechanics of the device and any associated expense of running them. As querns or millstones may have been used differently to that of the intended design, there could be some 'blurring' between these definitions. Therefore, although a relatively clear separation in stone diameter between querns and mills might be expected, there will also be some overlap. Shaffrey (2015) has determined that anything larger than 570mm should be defined as a millstone, while Peacock (2013) suggests a slightly larger size of 600mm. However, these definitions encompass milling tools of all stone types and more specific divisions may exist for particular types or classes of millstone/quern. Where this separation exists for lava milling tools will be discussed further in Chapter 2.

Thesis Structure

This thesis will commence by first outlining in Chapter 2 the specific terminology applied to lava querns and millstones, which will provide a reference for subsequent chapters. This will be followed by an examination of the mechanisms and mechanics of lava quern operation and the typological characteristics that have been identified for these objects in previous studies. Lava millstones of disc and Pompeian types will then be discussed, followed by an examination of the geology of lavas used to manufacture milling tools. The chapter will continue with a full examination of the extensive research completed by the Römisch-Germanische ZentralMuseum on Mayen lava quern and millstone manufacture. As most research outputs from the RGZM have previously been published in German, this is the first occasion where a full summary of the literature has been provided in English. Subjects will include quarrying and organisation of labour at the quarry sites, the processes involved in quarrying, tools used in the extraction of lava at Mayen, and the process of quern finishing. The chapter will conclude with an overview of the Roman economy and the stone trade on the continent and in Roman Britain.

Chapter 3 will outline the methodology that was applied during the data analysis stages of the research, including both the theoretical and the practical approaches that were selected and utilised. These will be described in detail to illustrate how a theoretically informed approach has aided interpretations of the economic and social significance of lava milling tools in Roman Britain.

Data analysis results are presented from Chapter 4 until Chapter 7 and these sections have been organised thematically according to site type. Each of these chapters will have a specific emphasis, but inter-relations between the site types will be considered throughout. Chapter 4, which will present analysis of the full lava milling tool dataset, will highlight the general trends and patterns that can be observed in the data and highlight regions and chronologies where data is absent or problematic.

Chapter 5 will investigate quern and millstone data taken from the Rural Settlement of Roman Britain Project. Although thematic approaches to Roman Britain tend to begin by exploring military sites (for example, Mattingly (2006), Wacher (1978)), the importance of milling tools in rural life has led me to prioritise rural before other site types in this thesis. This has been done intentionally to highlight the role of querns in agricultural production. Despite the common assumption that lava querns were the remit of the military community, and they do have strong associations with military sites, this research will highlight that they also played an important role in rural life, which is largely underplayed due to issues relating to publication, preservation, excavation bias and misidentification. Furthermore, it is important to reemphasise that most of the population of Roman Britain lived in rural parts of the province (Smith, et al., 2016, p. 416). The introduction of lava milling tools, thus, potentially impacted a greater number of lives in these areas than in other communities. The order of investigation here will, therefore, reposition lava milling tools back within the category of agricultural tools whilst emphasising the important relationships that may have existed between people and lava milling tools in rural settings.

This will be followed by two major urban site case studies in Chapter 6: Silchester, Verulamium, with a third minor urban site, Dorchester-on-Thames included in Appendix 2. Finally, Chapter 7 will look at four military case study sites: Housesteads, Chesters, Corbridge and Vindolanda. A detailed examination of the relationship between rural and urban sites in terms of quern and millstone use will then be undertaken in Appendix 3, which uses Chichester, Fishbourne Palace and the rural hinterland of these key sites as a case study. Overall conclusions of the analyses will be presented in Chapter 8.

Chapter 2. From Quarry to Quern: Previous research on lava milling tools, their sources and distribution

Lava Milling Tools

As outlined in the previous chapter, milling tools can be defined as querns or millstones depending on their mode of operation, which will be further defined and described in the following sections.

Lava Querns

Terminology

Only rotary lava querns are known to have been imported into Britain as their import did not commence until the Roman era, when only rotary forms were being produced in the Mayen region (Fitzpatrick, 2017; Watts, 2002, p. 33). As previously described in the introductory chapter, rotary querns consist of two paired stones, the *catillus* (figure 6), and the *meta*. These tend to be the only surviving remains of a lava quern, are often fragmentary, and are rarely uncovered as pairs (figure 7). For lava querns, both the upper and lower stones were disc shaped and, prior to usage, were around 100-120mm thick (Mangartz, 2008, p. 94). The grinding surface of the upper stone was manufactured to be concave in profile, while the lower stone was convex to the same degree. Both stones were fully perforated through the centre, with the central hole in the upper stone often being termed 'the eye'. For the upper stone, this was usually circular in plan with a cylindrical profile, while the central hole for the lower stone widened from the opening in the grinding surface to where it exited the lower surface of the stone creating a partial conical profile.

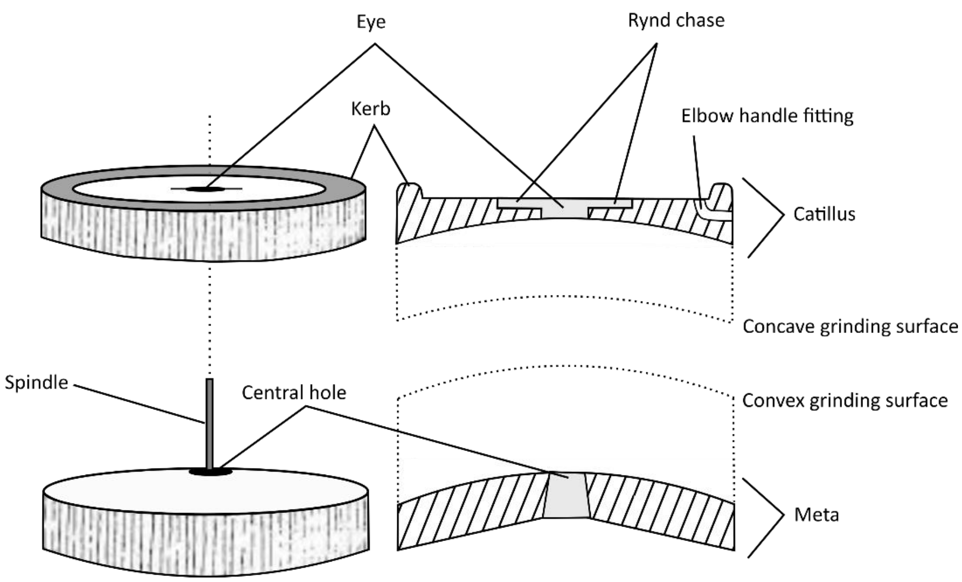


Figure 6- Diagram of typical lava quern stones showing the terminology used for different parts of the tool.

The eye was bridged with a strip of iron, called the rynd, which was bedded into the top surface of the upper stone within a cavity on either side of the eye, known as the rynd chase, and fixed into position at either end using lead. This strip provided the pivot point for the upper stone, which rotated on a spindle. The spindle was fed through the upper and lower stone, fixed into position in the lower stone, probably using a bung (see example from de Meern 1, this chapter). The upper stone was moved via a handle fitting, the most common type being an 'elbow' socket. This was an angled perforation of the upper stone that began on the upper surface and ended at the side, creating an elbow shaped profile. The handle fitting was threaded through this hole, allowing it to be fixed to the side of the upper stone. This handle fitting was reinforced with a raised annular kerb, or rim, that was created around the outer circumference of the upper stone.

Figure 7- Stone remains of a complete Roman period lava quern with completely perforated meta (right) (Lepareux-Couturier, 2014, p. 151, fig. 6). The mechanical parts of a quern are generally not found in association with the stones, and this example shows the remains from which the complete workings of a quern have been postulated.

The grinding surfaces of Roman period lava querns tend to be dressed, which describes a way of etching, scoring, or pocking the surface of a milling stone to alter the texture of the surface. Dressing appears in several forms, with harped, radial, and pecking being the most common (figure 8). Harped dressing, sometimes referred to as segmented radial, is a linear style that produces a repeated grouped pattern of lines, one group of which resembles a harp. This is the most recognised form associated with lava querns, which were probably originally dressed to this specification, and the form was often reproduced on worn stones that were redressed with varying degrees of success. Radial dressing patterns are also linear, but they consist of straight lines that radiate out from the central point of the stone, and these also commonly occur on lava querns. Linear tooling on the grinding surfaces is often described as radial by default, even when the dressing is harped or unidentifiable on fragmented stones. The final form, pecking, is a method whereby the surface of the stone was periodically indented using a chisel or hammer. Though this type of dressing would seem redundant on vesicular lava, which is already pocked with small holes, it is common on indigenous quern types and is also known to occur on lava stones.

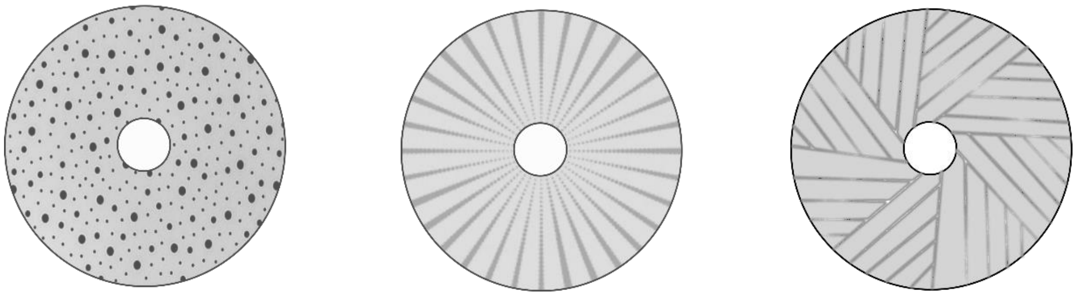


Figure 8- Different styles of dressing for lava quern stones. Left- pecked, centre- radial, right- harped or segmented radial.

Mayen lava querns typically also carry 'decorative' linear dressing on the upper surface of the upper stone. This continues across the kerb and appears as vertical striae on the sides of the upper stone. These are also found on the sides of the lower stones. Although often interpreted as decoration (Jodry, 2011, p. 88), there is some suggestion that this represents a way of 'branding' the querns as products of the Bellerberg quarries and may have been a way of visually uniting querns from different quern manufacture sites as products of a single region and standard (Wenzel, 2020, pp. 2-4; Mangartz, 2012, p. 12). They may also have been added to provide interval measurements for redressing worn grinding surfaces in the distinctive, yet complex harp style.

Quern mechanisms and components.

With regards to the specific functional design of querns, there is some debate as to how the component parts may have fitted together and what these consisted of. The mechanical elements of querns are not usually found in association with stone remains and are often misidentified or unrecognised, meaning that there is some difficulty in determining precisely how a full quern assemblage may have operated (Shaffrey, 2019, pers. comm.). The sparse evidence we have of non-stone components associated with all types of quern show that metal, predominantly iron and lead, was often used. Few examples of quern handles are known to exist and it is likely that these were formed of organic materials, such as wood (Reniere, 2018, p. 20), evidenced by a fragment of a wooden handle of ash recovered at Newstead Fort (Curle, 1911, p. 145). Heslop (2008, pg. 52) has also discussed the possibility of iron handles using evidence of wear in Iron Age quern handle holes/slots.

However, it should not be assumed that all querns operated the same way or had the same constituent parts and more complete examples cannot be taken as representative of all quern mechanisms. A larger number of quern production sites would create a wider range of variability in how these objects were assembled. In the case of lava querns, the high level of standardisation present and the fact that they were centrally produced at Mayen translates into greater uniformity in the mechanical workings for lava querns across Romano-British assemblages. Very few Mayen lava quern unworked stone blanks were exported, and so this greatly reduces the variability present in lava quern assemblages (Wenzel, 2020, p. 3). If blanks were imported into Britain, deviation from the standardised form might be expected, but this is unlikely to have occurred at any scale. Therefore, the few examples that we have of partially assembled lava querns or those which show mechanical elements provide a good guide for the kinds of lava quern set-up in existence during the Roman period. One such example presents an almost complete 'working' Roman period quern of Mayen lava that was recovered from a shipwreck in De Meern, Netherlands (Mangartz, 2007) (figure 9). Most of the component parts were well preserved and the quern was fully assembled. The iron rynd was still in place within the rynd chase, but no elbow handle fitting is perceptible.

Figure 9- Top and bottom stones of a rotary quern retrieved from the Roman shipwreck De Meern 1. This view shows the upper side of the catillus and two possible handle holes are visible. Also seen here is the rynd of iron which is embedded/recessed into the upper surface of the catillus and fixed in place using lead at both ends (Mangartz, 2007, p. 248)

An example of a complete elbow handle fitting on a lava quern was recovered from Newstead Fort (Curle, 1911, pp. 145-146), and is described by Mackie (2007) (figure 10). The wooden handle, which had not survived, would have sat upright, fitted within an iron loop formed from a band. This loop was attached to the side of the stone via a hole, through which the ends of the iron band were fed. The ends emerge at the top surface of the stone, just clear of the kerb, terminating as spikes that were hammered down to lie flat against the surface. The iron was fixed into position by pouring molten lead into the opening, thus plugging the spaces between the band and the stone. Although it is not common to find complete examples such as this, it is generally assumed that most elbow type handle holes would have been assembled in a similar way.

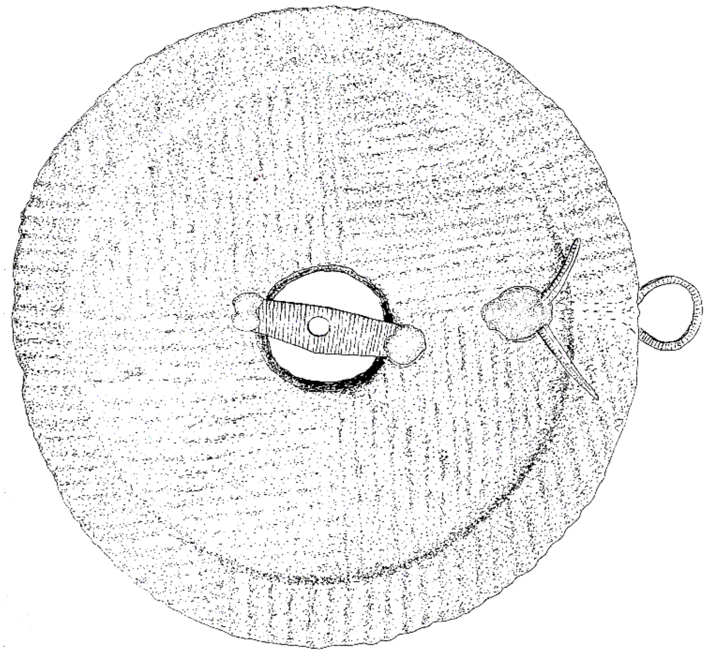


Figure 10- Catillus from Newstead Fort with complete metal components showing how an elbow handle was assembled (MacKie, 2007, p. 494). The upright wooden handle would have fit into the iron loop, seen here emerging from the right side of the quern.

The missing elbow handle socket on the De Meern 1 example, which was being used as ship equipment, implies that perhaps a greater degree of variability is present for lava querns than first thought. A long wooden pole found with the quern may have served as a 'swivel pole' handle that fit into one of the two holes in the upper surface of the quern when in use (Mangartz, 2007, p. 246). These handles are well-known with regards to historical quern operation and can be found in medieval images of quern use, alongside more modern depictions (figure 11). There is currently no clear evidence to suggest that the mechanism was used as early as the Roman period, but the concept behind 'swivel pole' querns is not complex and could have been implemented during this era also.

The set-up was designed to be used on a table or at a similar working height. A swivel pole consisted of a long handle/pole, probably of wood that would be fitted into the top stone via a hole on the surface, or from a loop at the side. This would be used to rotate the mill. The longer handle length reduces the angle of rotation for larger stones, allows for multiple people to turn the handle at the same time, and provides a more comfortable working position. The far end of the pole could be poked through a hole or in something fixed to the ceiling or other elevated fixed object (figure 12). The quern recovered from De Meern 1 had a diameter of 40cm, a relatively standard size for a hand operated quern (Mangartz, 2007, p. 245). However, as the tool is likely to have been used in a permanent fixed position, especially considering the listing of a moving ship, there would be good reason to arrange the quern as such. This format may have been replicated elsewhere, as the long pole handle had the ability to compensate for the larger sized querns/small millstones, allowing for them to be turned more easily. It should be expected that handle holes would not fully perforate the *catillus* if the handle was fixed into the top surface in this way, though a long handle placed in an iron loop from an elbow handle slot would be similarly effective and indistinguishable from shorter handle forms.

Figure 11- Two women grinding corn on a quern mill on Pine Mountain, Kentucky (Gallery V Exhibits, 1998). The photograph shows relatively modern use of the swivel pole method for grinding and how two people could work the quern simultaneously. Though the top of the pole handle is not visible, it was probably threaded through a loop or hole in the ceiling to keep it fixed in place as seen in figure 12.

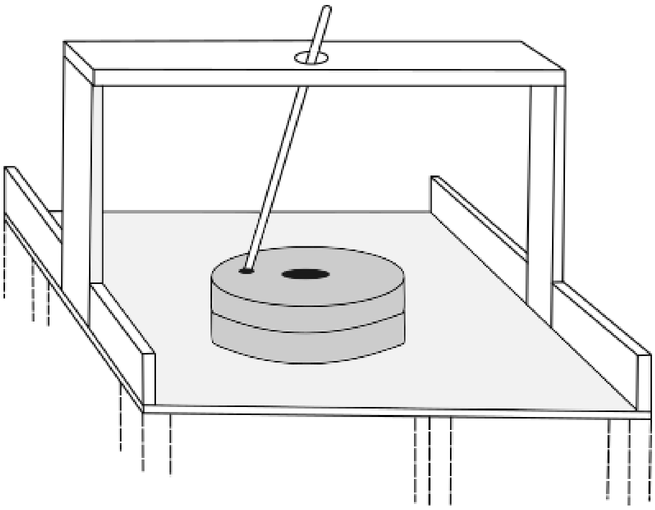


Figure 12- Illustration to show an example of how a swivel pole quern mechanism would have operated. The set-up would have worked best with equipment placed on a table or other raised surface and the length of pole handle is variable.

Other aspects of the quern mechanism revealed from the De Meern 1 quern include the way that the spindle and rynd were assembled to provide the rotary motion. The rynd, as seen in figure 9 measures 150mm by 30mm and has been fixed into place at both ends. It spans the central hole and is perforated in the middle, with the perforation measuring approximately 10mm. The spindle would either feed through this hole or use it as a fulcrum, centring the top stone over the lower stone and providing the pivot on which the *catillus* could rotate. As the quern was fully assembled at the time of its discovery it has been possible to observe how the spindle was arranged, its dimensions and how it assisted in the operation of the device. This level of detail is rarely available for querns, and it is with some difficulty that accurate reconstructions of this part of the mechanism are produced. With the De Meern 1 example, the spindle comprises an iron rod with a square-shaped cross-section measuring 160mm in length which had been wedged into the lower stone's central hole using a 70mm long wooden plug (figure 14). The pivot end of the spindle is more rounded, whilst the other terminus ends in a slightly bent spike which may have helped stabilise the weight of the top stone.

Observations have shown that the spindle is not long enough to lower or raise the catillus using a tentering device (tentering will be discussed in more detail below). It might be assumed that the upper stone balanced on the end of the rounded spindle, although this arrangement must have been fairly unstable considering the weight (15.5kg) of the *catillus* and the depth of the rynd (7mm). Whether or not the spindle fed completely through the rynd hole can only be speculated; current assumptions are that a separation needed to exist between the upper and lower grinding surfaces (also known as the 'light'), which would mean that the rynd took the full weight of the stone. However, experimental work using lava querns suggests that the upper stone can fully rotate without this separation, and that the stones can sit directly on top of one another with no restriction in movement (Chapman, Unpublished). This would imply that the spindle could be safely threaded through the rynd, creating a more stable stone pairing.

In Britain there have been at least four querns, of both lava and non-lava, recovered with spindles *in-situ*, though these have since been dismantled with no record of how they were originally fitted together. The four known examples were recovered from Newstead Fort during excavations in the early 20th century. Curle (1911) describes one spindle as being 7.5 inches in length (approx. 190mm), with one pointed end that was probably inserted into a wooden peg fixed into the lower stone. The other end of the spindle was rounded, which had been passed through the perforation in the rynd bridge. Unlike the De Meern 1 spindle, two from Newstead (figure 15) show an increasing diameter from the rounded top where it provided the pivot, to where the spiked end begins. Therefore, if the spindle did feed through the rynd perforation, the rynd would sit on the spindle where the spindle diameter became wider than the perforation; this may have prevented it from falling to the level of the *meta* grinding surface, creating a separation between the stones.

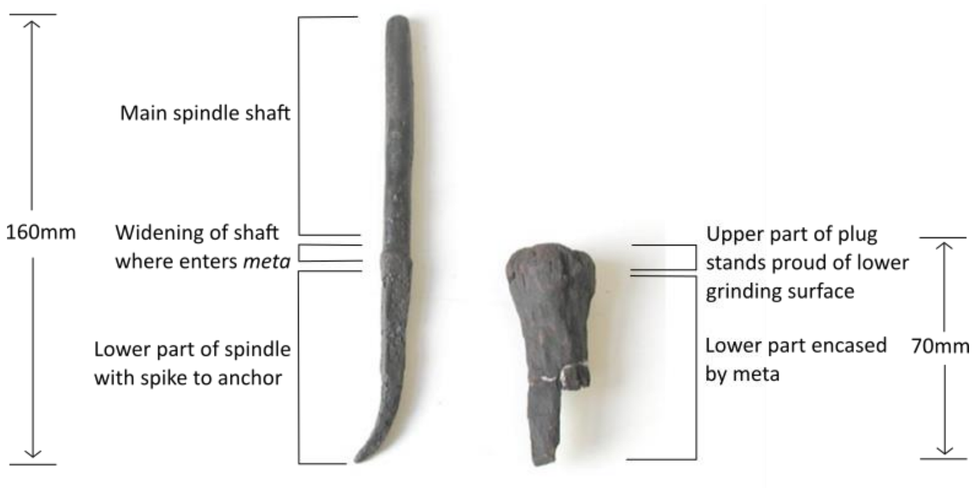


Figure 13- Spindle (left) and wooden spindle plug (right) from quern recovered from De Meern 1 (edited by author using images from Mangartz (2007, p. 246)).

Figure 14- Meta from quern recovered from De Meern 1 showing how the spindle components fit together (Mangartz, 2007, p. 246).

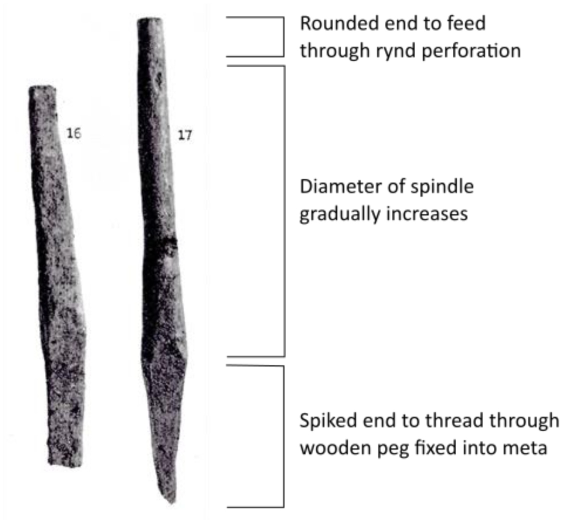


Figure 15- Two of four spindles recovered intact from lava querns at Newstead Fort (edited from Curle, 1911, plate LXVI). The shape of the objects indicate how they may have contributed to the mechanics of rotary quern movement.

The main difference between an Iron Age and a Roman period rotary quern is that the *meta* is almost always fully perforated. This is frequently interpreted as a functional feature to enable adjustment of the 'light', known as 'tentering'. How this was achieved through use of the central hole in the lower stone is rarely explained in any detail, and it has become a statement often replicated with little supporting evidence. Medieval examples of querns could be tentered, but this was achieved through adjustment of the rynd. Moritz (1958) produced a diagrammatic version of a tentering mechanism using an example from a contemporary Scottish quern (figure 16) (see also Reniere (2018, pg. 24, Fig. 4) and Amouric (1997)). Here, the spindle is attached to a moveable board that is lowered or raised by adjusting the length of the string at the side. The arrangement requires that the rynd and rynd chase are fixed within the grinding surface of the upper stone in what is referred to as an 'underdrift' configuration. In Britain, lava querns tend to have an 'overdrift' rynd fitting, being placed in the upper surface of the upper stone (Watts, 2002, p. 153), as can be observed on the illustrated examples from De Meern and Newstead (figures 9 and 10). This is not to say that lava querns were not tentered, as this would provide an efficient means of dehusking grain (Watts, 2002, p. 63; Reniere, 2018, p. 22), but other explanations need to be sought for how this may have been achieved alongside identification of typological features on the lava querns that might relate to this form of operation.

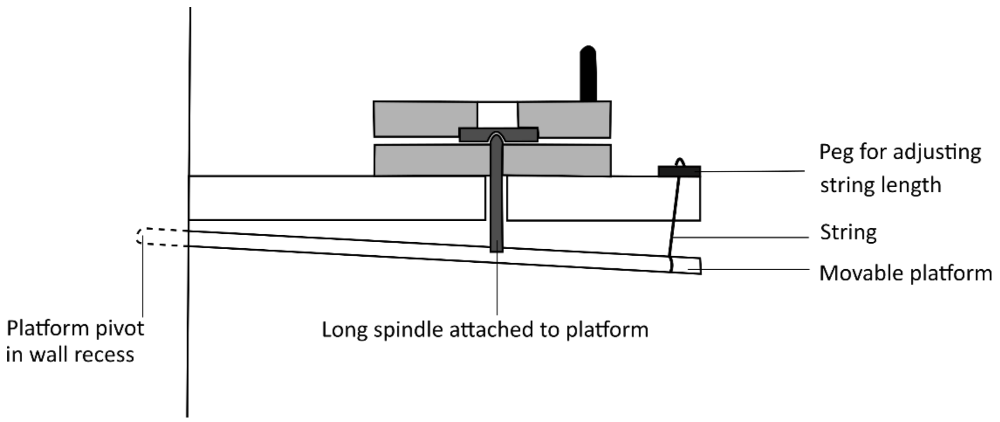


Figure 16- Diagram to show the configuration of a Scottish rotary quern that is assumed to be the same or similar to the Roman lava quern tentering mechanism (after Moritz, 1958, p. 119, Fig. 11).

Lava Quern Typology

Currently, there is only one working typology that has been created specifically for Mayen lava querns. The distinguishing features that mark the difference between quern types were first identified and recorded by Röder (1955) and developed into a typology using querns recovered from well-dated contexts at unspecified German settlement sites and waste dumps of roughouts at Mayen quarries (figure 17). The Mayen quarries saw a long period of exploitation to produce querns, stretching from the early Neolithic into the Medieval period (Röder, 1955, p. 69). Therefore, the typology covers a long chronology, leaving little room for nuance or detailed differentiation. According to this typology, the Roman period had two quern types, 5 and 6, differentiated by handle and rynd fittings. The early Roman quern (type 5) has a handle socket fitted vertically into the upper quern surface, while for the late Roman period, the handle is fitted laterally with a bowtie shaped rynd chase (type 6). Neither of these types have been identified in this study.

Most of the lava querns in Roman Britain are of type 4 (Chapter 4), classified by Röder as produced from La Tène period onwards, which seems somewhat ambiguous. It must relate to the late La Tène, while the end date for production has not been specified. The fact that type 5 and 6 are classified as Roman confuses the picture somewhat as this suggests that type 4 was not in production during the Roman era. It is possible that types 5 and 6 were, at times, produced alongside that of type 4 in Germany, or that these were later Roman period innovations that did not arrive in Britain. It is a shame that a more precise chronology for these changes has not been determined, as the absence of type 5 and 6 in Britain could be used to identify when Roman Britain ceased to import lava

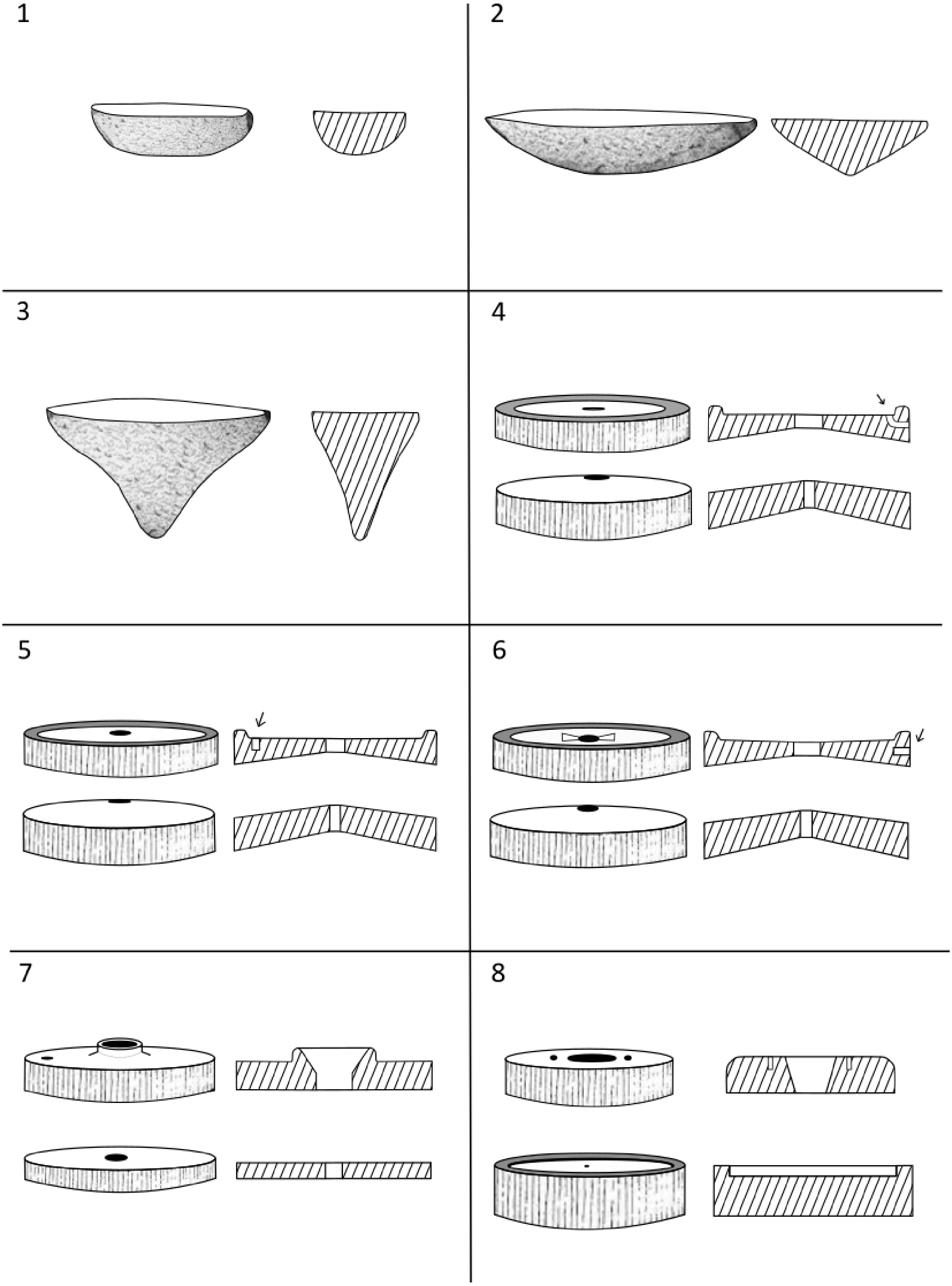


Figure 17- 1. Neolithic to Middle Hallstatt, 2. Late Hallstatt (600-400 BC), 3. Napoleon hat (Early and Middle La Tène), 4. Oscillating rotary quern (from La Tène onwards), 5 and 6. Completely rotating quern (Roman period), 7. Early Medieval, 8. About A.D. 1000 (after Röder, 1955, fig 1).

querns. However, as the Röder sequence was derived from querns recovered from German settlements, some variation between the British and the German data should be expected, especially if only specific types were exported/imported. It is beyond the scope of this project to update the typology and to examine lava quern data from German settlement sites produced since the 1950s, and so the typology has been used in its current form.

Geochemical analysis of lavas from querns in north-west Europe by Gluhak & Hofmeister (2011, p. 1618) proved that different Mayen quarries were exploited to supply different areas, some of which had a wide reach. Whether the different quarries produced different types or styles of quern has not yet been discussed. The continental material would benefit from an in-depth study of typological variation alongside that of geochemical characterisation to clarify this further. It does also provide justification for developing a typology and chronological sequence for the Romano- British material, instead of simply applying Röder's scheme unquestioningly. The absence of a British lava quern typology is, however, understandable; the extent to which these objects are standardised has not incentivised such endeavours. Other material culture types, such as brooches or coins, show clear chronological and regional variation that can be used to generate interpretations relating to Roman period society, culture, and economy. This is less obvious when examining lava milling tools. There is a general agreement in excavation reports that catalogue and discuss lava querns that there is a 'regular' type that describes most examples, eliminating any perceived need for detailed description or further examination.

Furthermore, the fragmentary nature of many lava querns when recovered means that diagnostic features are often absent, and comparisons cannot be made. For example, of lava recovered from 23 different contexts during excavation work on the Ewell Bypass, Surrey, none had diagnostic features (Shaffrey, pers. comm.). To be able to develop a typology, single site analysis is unlikely to supply enough diagnostic pieces to yield much insight into the potential for variety. Therefore, if there are any typological differences, these would be better explored from an inter-site perspective, including a wide range of different material from different regions and different site types. The approach being applied as part of this research provides the best opportunity for exploring such similarities and differences, and for the generation of a more nuanced Romano-British lava quern typology.

There are some aspects of quern stones that are less suitable for the development of a typology, and these are the parts that are more likely to have been subject to repair. For example, the distinctive method of dressing the grinding surface of a lava quern that is very typical of the Roman era, known as 'harping'. As a quern would be redressed several times during its use-life, this is not a feature that can be consistently used to inform a typology. Furthermore, lava does not require dressing to function adequately in grinding activities, and so querns may not have necessarily been redressed once the original finish had worn away. Mending also creates some issues when identifying typological features and care must be taken to recognise evidence of alteration from the original type. This is especially challenging if the quern is incomplete, as original features may not always be presented in the remaining fragments, but mended features might. Original features may also become obscured by later reworking of the material, and this appears to be commonplace with regards to the rynd chase and eye which were subject to heavy wear. Nonetheless, so long as a suitable number of querns can be examined in detail, there should be sufficient data available for categorisation to be possible.

Upper stones of lava querns are the most diagnostic in terms of distinguishing features. Upper stones have more of the operational features necessary for a quern to function, and it is these aspects that are found to have changed over time when referring to the Röder typology. These comprise the handle and the rynd fitting, though the size and shape of the stone is also of significance. Stone diameter seems to be relatively variable, and further data collection will allow for this to be related to other characteristic features. Currently, features of the prevalent Röder type 4, illustrated in the typology and observed on British examples, can be described as follows (figure 18):

1. Rynd fitted to the top of the upper stone, bridging the eye of the quern.
    a. Rectangular chase to accommodate the rynd that is set into the top of the upper stone and bridges the eye.
    b. Rounded eye that is circular or sub-circular.
    c. Iron rynd fixed into the rynd chase by lead at the furthest ends.
    d. Perforated rynd to accommodate spindle.
2. The upper stone has a flat top, a concave grinding surface and a raised annular kerb that runs the circumference of the upper surface.
    a. The handle slot perforates the top of the upper stone, runs below the kerb, and emerges at the side of the quern.
    b. An iron loop used to accommodate the handle is fixed in place by two split pins that emerge from the bottom of the loop at either side and are fed through the handle slot.
    c. The split pins are fixed in position with lead on the top surface of the quern.
    d. The rounded iron loop probably held a handle made of wood or other organic material.
3. The top surface of the upper stone was ‘decorated’ with a linear design in quarter sections. Incised lines are at regular intervals and continue onto the kerb.

4. The incised lines also exist on the sides of the quern at regular intervals. Many of these appear to be a continuation of the top surface incisions.

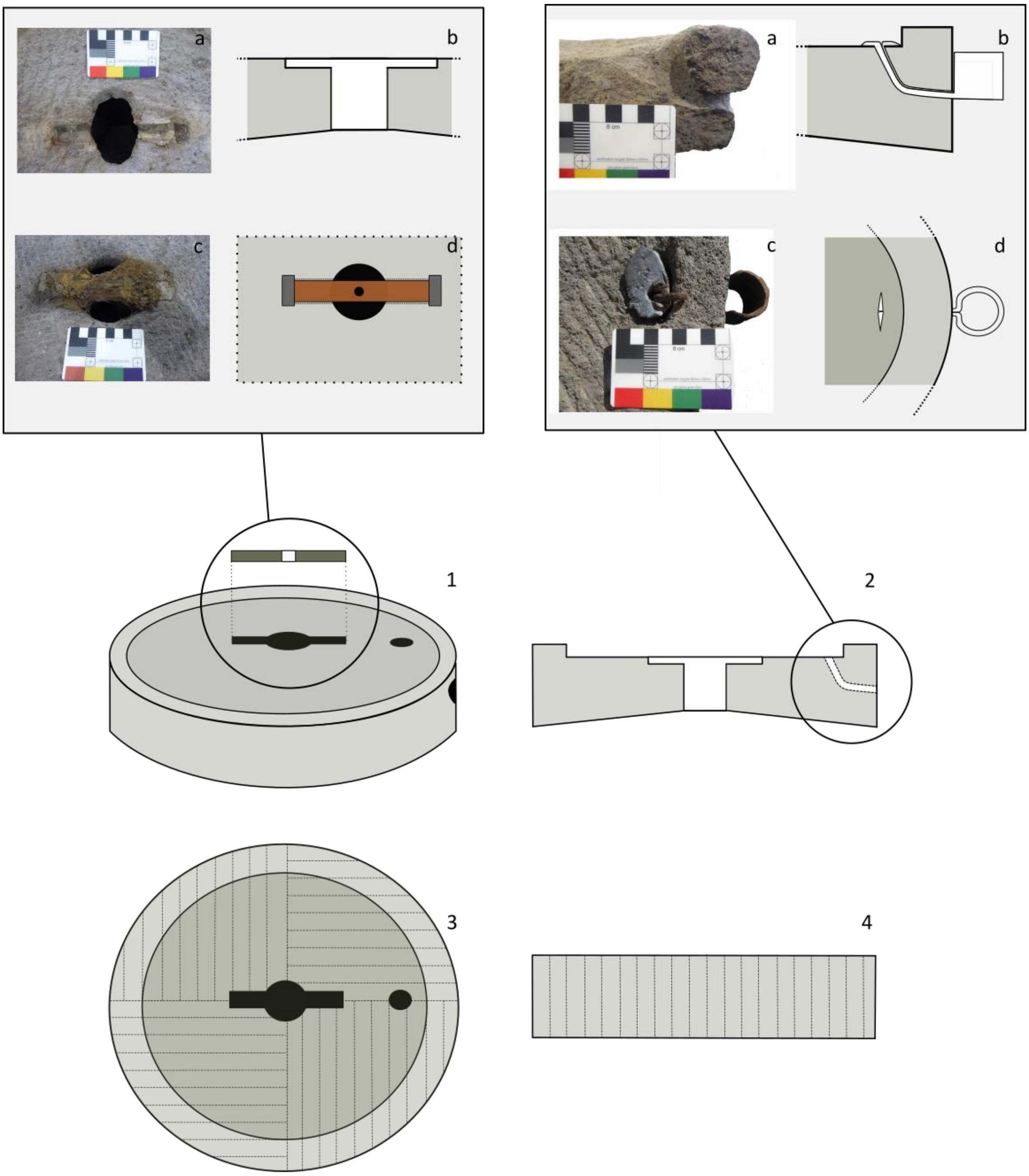


Figure 18- The main features that describe what is currently defined as a Röder type 4, and the most prevalent type in Romano-British contexts.

There are few diagnostic features for lower stones, and even in the Röder typology there is nothing to differentiate between types 4, 5 and 6. As a relatively featureless component, it would be difficult to group these typologically. A convex grinding surface is consistently present, as are incised vertical lines on the external edge. The lower surface tends to be roughly tooled and slightly concave. It may be possible to determine the presence of variation between examples using dimensions, such as diameter and central hole width, but this will need to be determined during the data analysis as any differences are not immediately apparent.

Lava Millstones: Disc Types

Millstones can be defined by their size as they tend to be larger than querns, though the precise size difference between querns and millstones is a matter of debate and should also involve evaluation of functional features. Lava millstones of disc types from Romano-British contexts are relatively rare, which is probably the result of poor recording and identification, alongside the issues of preservation and fragmentation that often occur with this material type. However, disc types occur more frequently in Britain than 'Pompeian' types, which suggests that, in comparison, they were more commonly used (Chapter 4). There are also problems in identifying how disc millstones may have been rotated as they could have been turned using human, animal or waterpower, and the method of operation is not always apparent on the stones themselves. It seems probable that larger sized millstones were turned using water, but there is no way of determining if this was the case, or where any separation in size between water and animal/human powered millstones might lie.

The main feature that could be used to determine the mechanism type is the rynd, as this can be positioned on the underside (underdrift) or the upper side (overdrift) of the upper stone. Alternatively, there can be slots cut through the upper stone (probably also overdrift) (figure 19) (Wilson, 2010; Shaffrey, 2015, pp. 67-69). There is some debate as to whether this characteristic is distinctive of the mode of operation, as it is possible that water, animal, or human power could have been used regardless of whether the rynd were cut into the upper or lower surface. However, current opinion tends to suggest that overdrift stones were turned by people or animals, while underdrift mills were turned using waterpower (see Shaffrey, 2015 for details of this debate). In general, millstones in Roman Britain appear to have been predominately overdrift types, probably turned by people or animals, such as donkeys. Underdrift types, probably turned by water, are only known from contexts of the early second century or later, implying a later date of introduction (*ibid*).

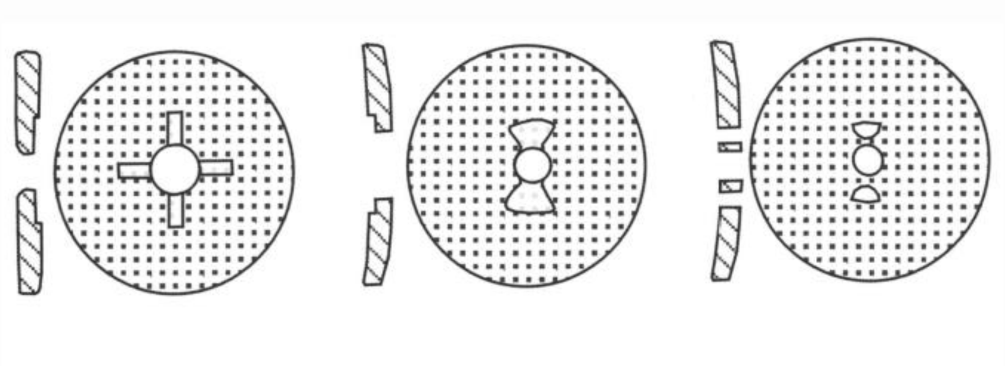


Figure 19- The three types of rynd fitting for millstones. Right- rynd cut through the stone (probably overdrift. Middle- Rynd cut into the grinding surface (underdrift). Left-Rynd cut into the upper surface (overdrift) (Shaffrey, 2015, p. 68).

Disc type lava millstone blanks have been recovered from the quarries at Mayen, showing that they were sourced from Bellerberg quarries (Mangartz, 2012, p. 86), but blanks are not given functional features at this stage of the manufacture process. Meanwhile, finished or partially finished millstones at Andernach, where the final stage of manufacture was completed, were not retained or fully recorded at the time of excavation (Röder, 1961; Schäfer, 2000). Consequently, there is no current detailed typology or chronology for Mayen lava disc millstones. The rynd fitting described above provides one possible way of differentiating between different lava millstone types, but as the precise mechanics of a powered disc mill is not fully understood, nor the manufacture standard/varieties known, original features might be difficult to distinguish from modification or reuse. Complete millstones of other stone types may be used as a guide for the forms that would have been in use during the Roman era as powered mills were probably similarly operated regardless of the type of stone used. Reconstructions of complete mill assemblages have also been theorised using recovered millstones and mill components, literary descriptions and knowledge of historical mill mechanisms.

A complete mill assemblage presented by Wenzel (2019), provides a standard underdrift mill arrangement that appears in a similar form across different published sources (figure 20). The form is based on a mill design described by Vitruvius (*de Architectura X*), though the translation and content of this description has presented some difficulties, especially with regards to the interpretation of terminology and mill components (Moritz, 1956). The literary account is partially supported by the discovery of a complete but disassembled lava mill recovered from a well in Saalsburg in 1912 (Baatz, 1995; Jacobi, 1914), which together provide an idea of how a Roman period geared mill operated. The set-up could have been powered by water or by animals/humans (figure 21).

An overview of the basic mill is provided here using modern-day English terminology. As these are different to those applied in the Roman era, and because Latin terms for mill components were not widely used in Roman literature, it is likely that some of the associated functional meaning for these terms has been lost in translation. It should be noted that constituent parts of a mill assemblage would ordinarily need to be recovered in association with millstones or structural mill remains for them to be used to identify the presence or use of mill technology. If found alone, the parts are rarely identified as associated with mills, if identified at all. These include the damsel, or dosing cone, which is a cone-shaped rod usually formed of iron that is positioned above the spindle and projects upwards to a funnel-like container for the grain, called the shoe (not illustrated). The damsel vibrates or moves as the millstone is rotated, striking the shoe to release a steady flow of grain into the eye of the upper millstone for grinding. Roman period damsels have been recovered

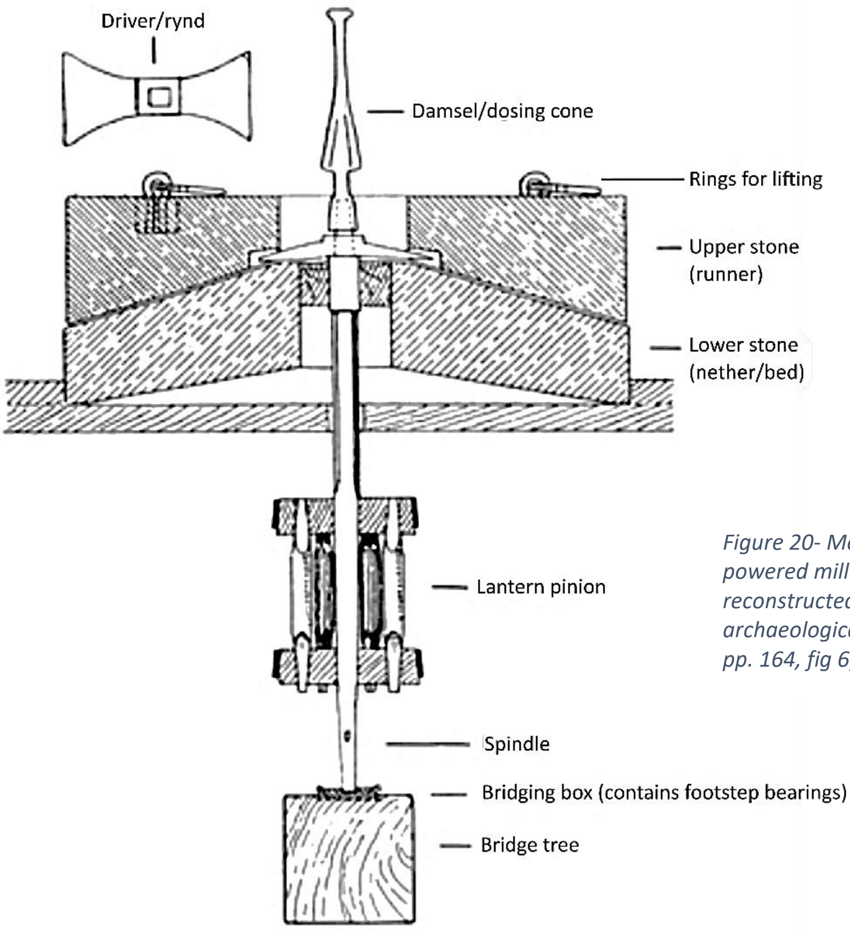


Figure 20- Mechanical parts of a powered mill from the Roman period reconstructed using literary and archaeological evidence (Wenzel, 2019, pp. 164, fig 6).

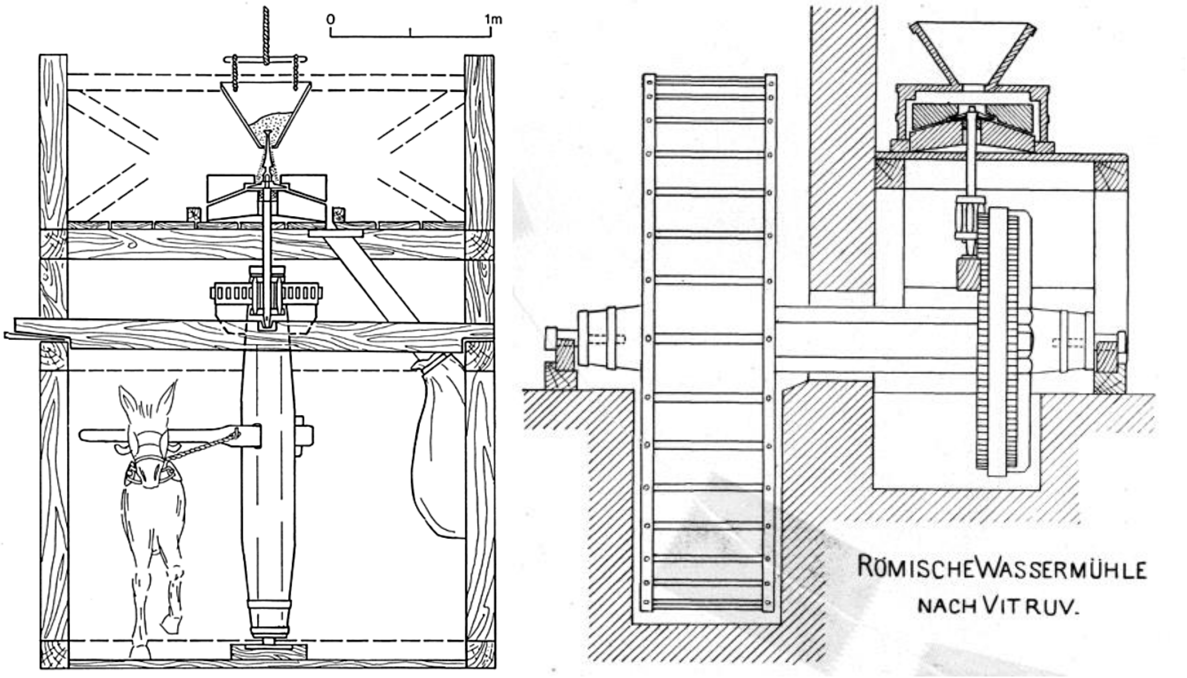


Figure 21- Mill set-up with mechanical workings as shown in figure 20 but powered through different means. Left, an animal powered mill that could also be turned by people (Wenzel, 2019, pp. 165, fig 8), right, a water powered mill (Jacobi, 1914, pp. 91, fig 45).

from archaeological sites in Belgium, but misidentification is common (Reniere, 2018, pp. 32-33). Attached to the spindle below the millstone is the lantern pinion, which is a geared cylinder that provides the rotation for the runner stone via the waterwheel/animal wheel/crank. Below this, the weight of the upper millstone is supported at the bottom of the spindle by a footstep bearing housed within the bridge box. A piece of basalt recovered from the remains of a probable mill at Haltwhistle Burn has been identified as a bearing of this type (Simpson, 1976, pp. 38-39) (figure 22). The bridge box itself is secured to the bridge tree, which is a horizontal beam fitted into the wall of the millhouse structure. This could be moved up or down to raise or lower the runner stone, thus providing a means for tentering the millstone configuration.

Figure 22- Possible footstep bearing used to hold the weight of the upper millstone via the spindle, whilst still providing the means for the spindle to pivot. This example is made of basalt and recovered with the remains of a probable mill at Haltwhistle Burn, Hadrian's Wall. Scale is approximate (Simpson, 1976, pp. 38, fig 3a).

The most important typological features that can be identified on archaeological millstone remains include: the rynd chase, the stone diameter (which can be applied to both upper and lower stones), and the presence and placement of iron ring fittings to lift the upper stone (see example in figure 134, Chapter 6). The rynd chase is an element of an upper millstone that is shared with upper quern stones, though for the example illustrated in figure 20 the shape of the rynd is 'dovetailed'; different to the rectangular shaped rynds of lava querns in Britain. The dovetail shape mirrors the rynd chase on the lava millstone from the well in Saalsburg, along with others from the same site (Moritz, 1956), and this shape has also been noted for rynd chases on upper millstones of indigenous stone types recovered from Romano-British contexts. The extent to which it is present on lava millstones in Britain is yet to be determined, as are alternate forms. This feature might present the clearest and most identifiable typological feature for a lava millstone but can only be applied to upper stones that have this feature remaining.

In terms of chronology, Shaffrey (2015) suggests that lava disc type millstones are likely to have been imported into Britain around the same time as the Pompeian style donkey mills. They have been found in first century contexts at Bath and Mucking and second century contexts at Verulamium and Northfleet (Shaffrey, 2015, p. 60). Considering the extent of the movement of lava querns from Mayen, this seems highly probable. However, as lava millstones are likely to have been specially ordered, they did not necessarily travel in bulk to Britain in the same way that lava querns did. i.e., as possible saleable ballast on the return journey of grain shipments to the Rhineland (see section on trade/economy below). Furthermore, production areas for lava millstones were separate to that of the querns at Mayen, occurring near to the port at Andernach (Mangartz, 2008, pp. 77-78), and may have been part of very different production, distribution, and trade mechanisms. This has implications for the duration of their use in the province, as special orders for lava millstones may have extended beyond the period when lava quern stones were imported or ended much sooner.

Pompeian Style Mills

Roman period millstones of the easily identifiable hourglass shape, known generally as Pompeian millstones from their iconic presence at the site of Pompeii (Williams-Thorpe, 1988b, p. 275; Buffone, et al., 2003, p. 207), are some of the most extensively researched grinding tools in Europe. These were predominantly manufactured using lavas from a variety of sources depending on exchange networks and local supply. The unusual shape of these mills has helped archaeologists separate them easily from other lava grinding implements, and their impressive appearance has promoted the interest of many researchers.

The 'typical' Pompeian-style mill (figure 23) comprises two stones: the *catillus* (upper stone) and the *meta* (lower stone). The *catillus* is hourglass/ hollow biconical-shaped and thus reversible, providing a new grinding surface once the first had been worn down. On either side of the narrowest part of the *catillus* sit two square projections with sockets/mortises for square timbers from which a 'yoke-like' frame could be fitted (Thurmond, 2006, p. 45). The *catillus* fit onto the *meta* which had a rounded conical/bell shape at the top, widening to a cylindrical shape at the bottom. This was sometimes hollow, which would have greatly reduced the overall weight and cost of the apparatus, whilst also making it more transportable (Jaccottey & Longepierre, 2011, p. 98). The top of the meta had a hole, into which a spindle could be fitted, providing a pivot to facilitate rotary motion. This presumably also carried the weight of the *catillus*, maintaining a gap between the two stones for ease of movement. It is likely that the separation between the stones was adjustable to compensate for wear, whilst also enabling a range of different grain types to be processed and different grades of flour to be produced.

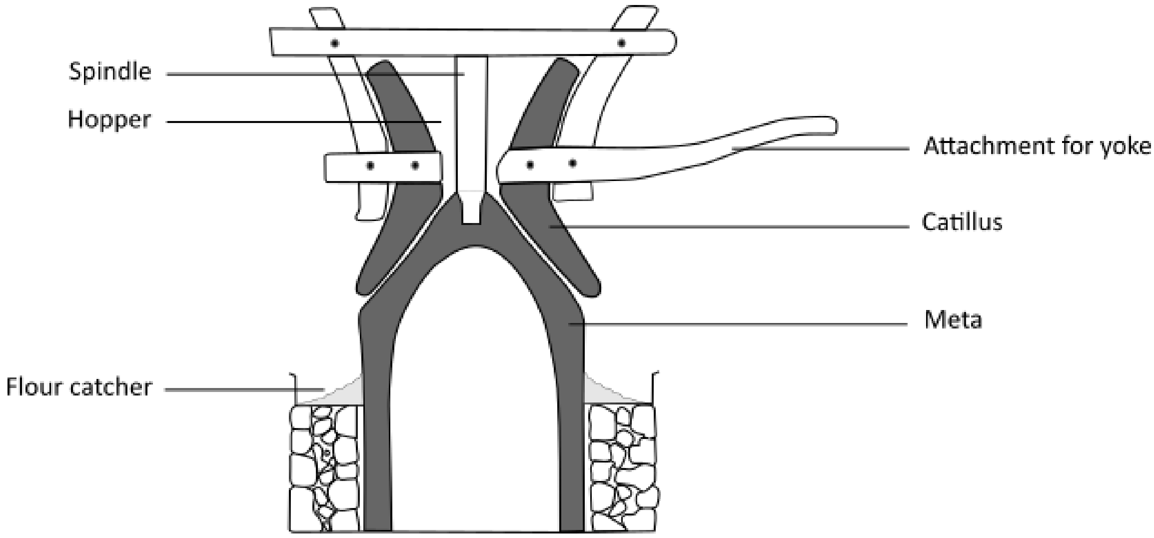


Figure 23- Cross-section of a typical Pompeian style mill (after Williams & Peacock, 2011, p. 117).

Figure 24- Bakery with in-situ Pompeian-style mills, at Pompeii (Watts & Watts, 2016). These show how the stones fitted together and how they were fixed in position. Trough-like flour catchers (gremia) would have been placed on top of the structure that held the meta in place.

Although not all mills would have operated the same, *in-situ* examples at Pompeii (figure 24) have presented an idea of function at one specific site. There, mills were rotated using donkeys or mules, as shown by the remains of two donkeys still in harness at mills at a Herculaneum bakery (Deiss, 1966, p. 204). Depictions of donkeys, mules or horses being used in this way have been found on shop signs (figure 25) (Wilson & Schorle, 2009, p. 104) and friezes (Hackworth Petersen, 2003)(figure 26). Classical sources that mention the *mola asinaria* are largely believed to be in reference to the Pompeian style mill due to these numerous visual representations. Alternatively, Bennet & Elton (1898, p. 181) argue that the mills at Pompeii were positioned too close to each other to allow for donkeys or other animals to be used, implying that slaves may have been employed in some cases.

An example of graffito from Rome depicts the use of a donkey, but the accompanying text suggests that slaves were used in their place, possibly as a form of punishment (figure 27).

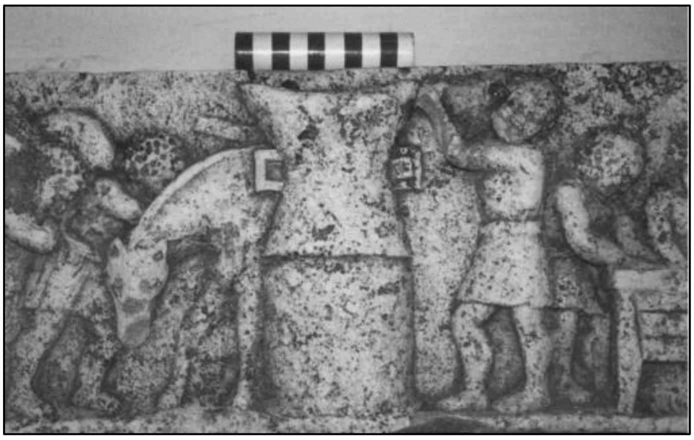


Figure 25- Part of a Roman period relief depicting bread-making, found over the oven in the bar of the restaurant 'Romolo' in Rome. The detail shown here shows the Pompeian style mill in use, with a donkey or mule being used to rotate the device (Wilson & Schorle, 2009, p. 104).

Figure 26- Drawing of part of the frieze from the tomb of Eurysaces the baker, at the Porta Maggiore. This section of the frieze shows the grinding of grain to flour using Pompeian-style mills powered by donkeys or mules (Wilson & Schorle, 2009, p. 110).

Figure 27- Graffito found at Rome depicting a donkey harnessed to a Pompeian style mill. The text reads, 'LABORA ASELLE QUOMODO EGO LABORAVI ET PRODERIT TIBI, which translates as 'Toil on little donkey as I have done and much good may it do you'. The text indicates that slave labour may have been used to turn mills as a form of punishment (Blümner, 2022, p. 45).

Unfortunately, there is less detailed evidence on the operation of such mills in Britain. A reconstruction of a mill using part of a *catillus* recovered from Princess Street, London, currently on display at the Museum of London (figure 28), is significantly smaller than those seen at Pompeii. It seems very probable that the set-up would have been different for this mill due to its size, leading us to believe that the examples at Pompeii cannot be used in direct comparison with the British material when considering method of operation and use.

Figure 28- Pompeian style millstone reconstruction created from catillus lava fragment recovered from a site on Princess Street, London (photograph by author).

Pompeian mills have been subject to a great deal of research in continental Europe and the Mediterranean region (Anderson, et al., 2011; Antonelli, et al., 2001; Buffone, et al., 2003; Gallala, et al., 2018; Jaccottey & Longepierre, 2011; Peacock, 1989; White, 1963; Williams-Thorpe, 1988a; Williams-Thorpe & Thorpe, 1989; Williams-Thorpe & Thorpe, 1993; White, 1963), due also in part to their relative abundance, while research associated with the study of the comparable British material is also high considering how few examples have been found. For the British Pompeian lava mills, the fragmentary nature of the evidence relating to this mill type has presented some difficulties in determining a typology. To date, only provenance analysis has been used as a means of differentiating between them. In total, there have been: two examples of Pompeian style lava millstones from Dorset, one of lava from the Massif Central area of France and the other, probably non-Roman, of lava from Sardinia (Williams-Thorpe, 1988b); one almost complete *catillus* from Princess Street, London, also of French lava from the Massif Central (*ibid)*; several fragments Pompeian millstones from 1 Poultry, London, suggested by Williams and Peacock (2011) as belonging to three separate mills and provenanced to Mayen; and fragments of at least one example from Silchester, also provenanced to Mayen (Allen, 2012) (see 'Lava Sources' section, this chapter). There is also one other example mentioned by Frere and Stow (1983, p. 251) from Canterbury, thought this is purported to be of Kentish ragstone, and a 'lava donkey mill' mentioned in the database of finds for Corbridge, though neither example has been published or recorded elsewhere and both artefacts have since been lost. Overall, these papers have predominately focused on the provenance of the millstones to identify potential trade links, without considering their wider socio-economic significance relating to centralised food production, the import of bulk food processing tools and the use of distinctive iconic millstones strongly associated with a Mediterranean culture within a provincial setting. However, research by Shaffrey (2021) looking specifically at centralised food processing at Silchester has presented a more nuanced discussion relating to the presence of Pompeian mills in the town and the implications of their use.

With regards to chronology, the small number of British Pompeian millstones available for study has limited the possibility for understanding the time range for use in the province. We do know from the continental material that the Pompeian type mill has early origins that pre-date the Claudian invasion of Britain (White, 1963), and these mills could potentially appear in the earliest Romano-British contexts (Shaffrey, 2021, p. 21). Nonetheless, a date for when manufacture of this millstone type commenced at Mayen is an important consideration, as this is likely to have been the main source of lava for Britain. The evidence we have for the manufacture of Pompeian style mills of Mayen lava at Andernach is sadly undated, meaning that there is a need to identify provenanced millstones from dateable deposition or use contexts. Thus far, there is only one such example; a Pompeian millstone recovered from Haltern, Germany, of Mayen lava provenanced to the Kottenheimer Winfeld quarry and securely dated from 11 BC to AD 9-16 (Gluhak, 2010, p. 281). As this also pre-dates the Roman period in Britain, Pompeian mills of Mayen lava could be present in the very earliest Romano-British contexts. There were no 'new' Pompeian millstone fragments recorded as part of this study and none were examined or identified during data collection. However, one current published example has been discussed in relation to urban case study of Silchester.

Lava sources

This section discusses the geology, geochemistry, and exploitation of lava at Mayen for quern and millstone manufacture.

Mayen Lava as a Material

Throughout this thesis, reference is continuously made to Mayen lava as the dominant source of material used to produce the many lava querns and millstones that were in use in Britain during the Roman period. This conclusion has been reached mainly due to the knowledge that we have about the extensive quarrying and quern production area at Mayen in the Eifel region, plus our understanding of North Sea trade and the connections that Britain had to the Rhineland; proven by looking at the distributions of a variety of products that were imported via this route. However, we do know that other sources of lava were used in the province, such as French lava from the Volvic area of France (Massif Central) that was used to make 'Pompeian' millstones present in Romano-British contexts (see previous section). Though the potential for different lava sources has never been systematically studied for Roman Britain, it has been explored more extensively in continental Europe and several small-scale studies have been completed for the British material. This section aims to examine what the geological background and identification of Mayen lava is and how lava has been studied with regards to geological provenance. There will then be a short discussion on what should be done in the future to identify and understand the different lava sources that may have been in use in Roman Britain.

Geological Background

The East Eifel region, where Mayen and the Bellerberg volcano are located, can be found in western Germany and is part of the Cenozoic Central European Volcanic Province (CEVP), which includes several regions in mainland Europe (figure 29). The Eifel is at the centre of this region, which consists of a wide arc of volcanic areas north of the Alps, comprising tertiary and quaternary volcanic fields. It stretches from the Auvergne to the Carpathian Mountains and is related to the tectonics of Central Europe, specifically the folding of the Alps, the opening of the North Atlantic and the formation of extensive fault systems such as the Upper Rhine Rift Valley and the Lower Rhine Bay (Mangartz, 2008, pp. 3-4). As a relatively young volcanic region, volcanic activity began in the East Eifel around 0.65-0.45 million years ago, when the first lava flows and tephra deposits were formed (Smithsonian Institution, 2021). The Bellerberg volcano from which the Mayen lava querns and millstones were formed, consists of multiple lava flows within one volcanic group. The 'cinder cone' is known to have been formed as recently as around 200,000 years ago (figure 30), created during an eruption of low-gas basaltic magma from a great depth below the Earth's surface. This was cooled by the air as it emerged, forming loose cinder walls around the location of the eruption. A cinder cone eruption generally loses momentum over time and magma then emerges with a lower gas content and thrust, creating a lava flow. This process can occur multiple times during the active life of a volcano group, as it did in this case. The different lava flows of the Bellerberg, thus, have different names, which correspond to the quarries from which lava was sourced; Ettringer Lay, Mayener Grubenfeld and Kottenheimer Winfeld (Gluhak & Hofmeister, 2009).

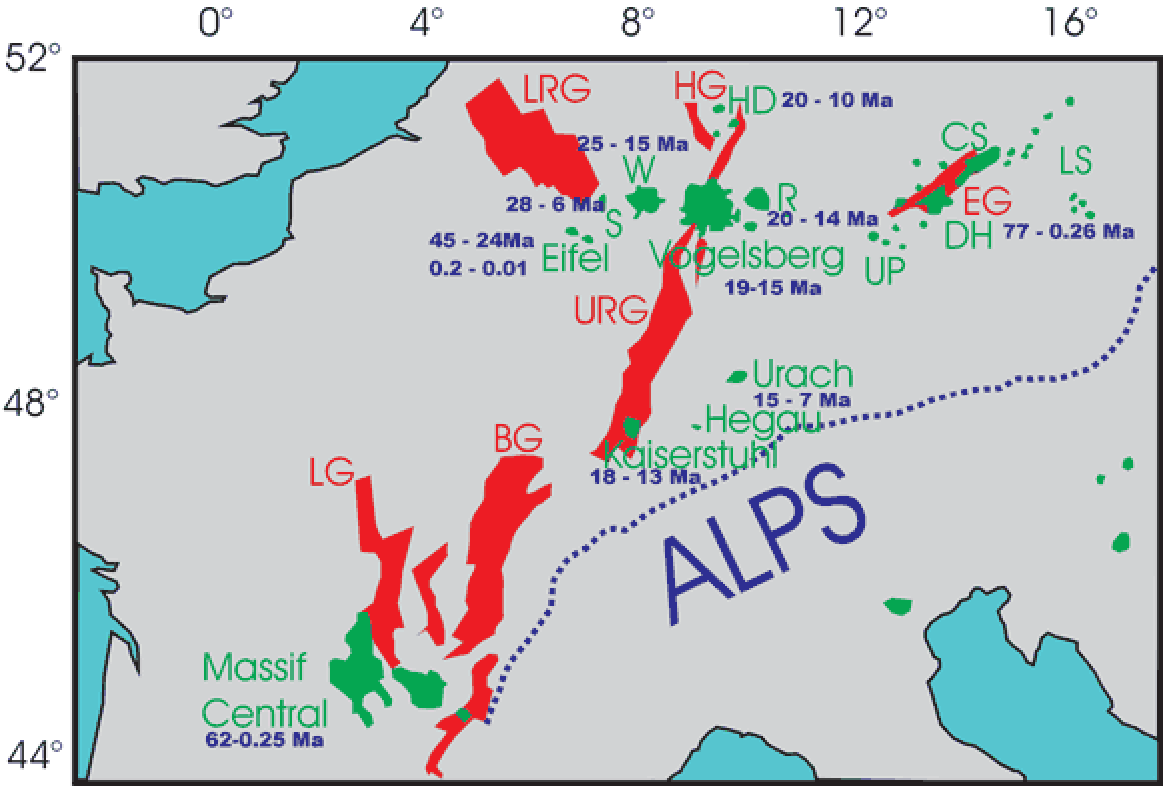


Figure 29- Map showing the Cenozoic volcanic rocks of central Europe in green, with rift-related sedimentary basins in red: URG. Upper Rhine Graben; LG. Limagne Graben; BG. Bresse Graben; LRG. Lower Rhine Graben; HG. Hessian Grabens; EG. Eger Graben. Volcanic sub-areas are represented using initials- S. Siebengebirge; W. Westerwald; HD. Hessian Depression; R. Rhöon/Heldburg; UP. Upper Palatinate; DH. Doupovské Hory; CS. Českè Středohoři; LS. Lower Silesia (Meyer & Foulger, 2007).

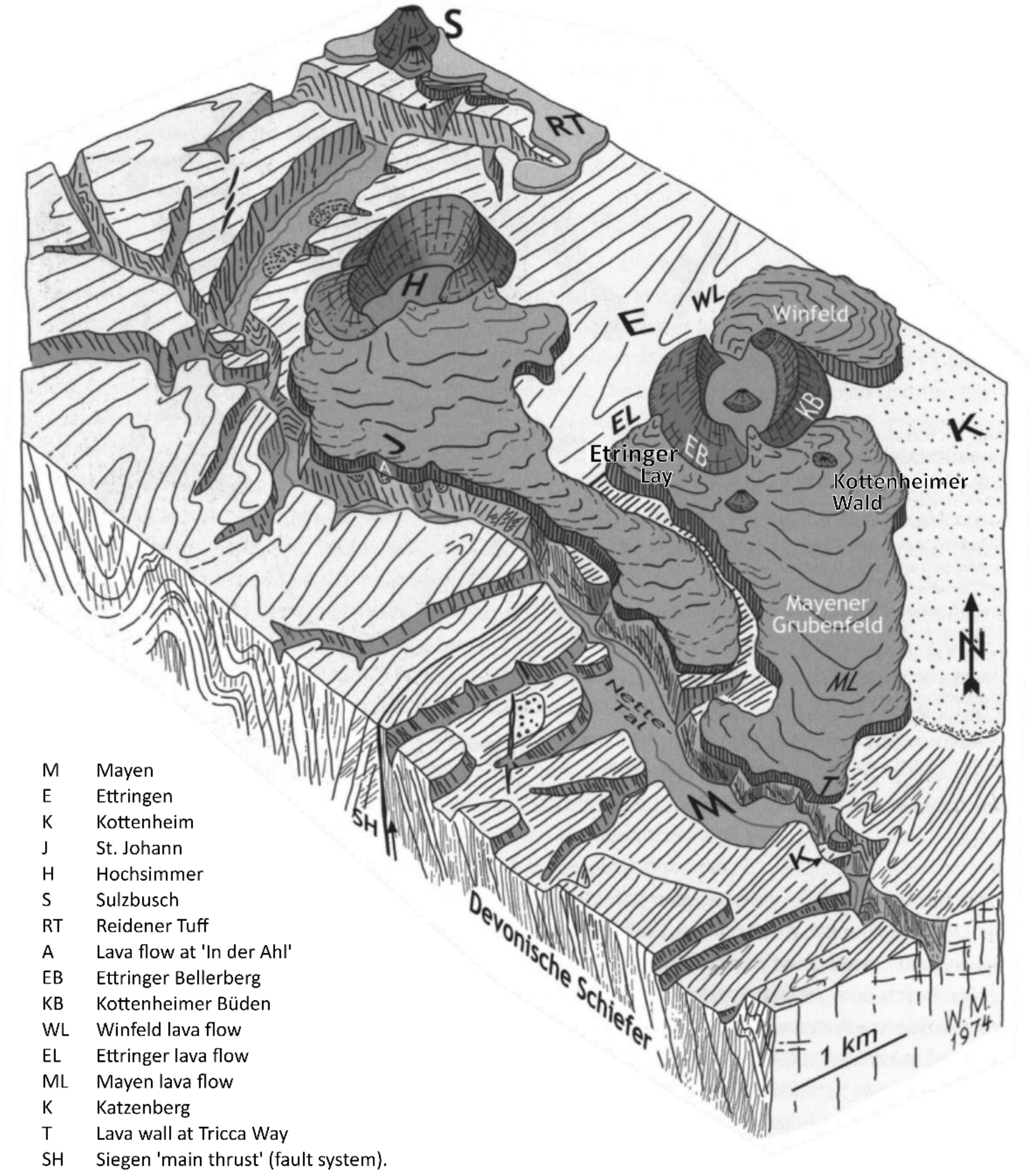


Figure 30- Diagram showing volcanoes and lava flows north of Mayen, including the lava flows and components of the Bellerberg volcano group (Mangartz, 2008, p. 8).

Geological Description and Properties.

Mayen lava from the lava flows of the Bellerberg volcano in the Eifel region of Germany is of a rare type and can be defined as a nepheline tephrite (Peacock, 1980, p. 49); a crystalline, basic igneous rock, though not a 'true' basalt. During formation of the lava stone, gasses within the magma cause the liquid rock to solidify around bubbles when cooling to create vesicles (holes) of a few mm in size within its structure (figure 31). The presence of these vesicles is one reason why the material is suitable for milling, as these allow the grain to be 'cut' instead of crushed, creating a more efficient means of flour production and a better grade of flour. They also helped to reduce the density of the stone as these ‘bubbles’ have the potential to make up around 25% of the volume of the material, making it up to 25% lighter than comparably dense rocks (Mangartz, 2008, p. 9). The very fine crystalline structure of the rock is another feature that assisted grinding, and lava milling tools did not need to be dressed to function well as they were ‘self-sharpening’ (Fitzpatrick, 2017, p. 196). The structure described was formed during rapid solidification of the lava flow, meaning that the mineral matrix of the rock hardly had time to form crystals. This process results in fewer abrasives within the fabric, such as quartz or quartzite, which are often found in the sandstones used for other quern or mill types. These abrasives can be damaging to teeth if they get into the flour (which they must have often done), providing lava with some clear benefits for use in milling (Mangartz, 2008, p. 9). Some of the physical properties of Mayen lava can be found in table 1.

Figure 31- High resolution image of Mayen lava to show the vesicles (holes) that are an identifying feature of the material. It is also possible to see some of the sanidine phenocrysts, visible as white crystalline material (Photograph attributed to ‘Roll-stone’, 2009, creative commons license).

Table 1- Physical properties of Mayen lava (Mangartz, 2008, p. 24).

Physical property type	Physical property
Bulk density	2.3 g/cm^3
Porosity	15-25 vol.%
Compressive strength	165 N/mm^2
Flexural strength	6.1 N/mm^2
Abrasion resistance	12cm^3/50cm^2
Water absorption	8vol.-%
Thermal expansion	0.9mm/mK
Elastic modulus	5800-10300 N/mm^2

The physical appearance of Mayen lava can be described as a fine-grained pale to medium grey vesicular rock with frequent felsic xenolith inclusions, these being foreign rocks within the lava matrix. These inclusions comprise small clinopyroxene phenocrysts, seen as dark coloured crystals, and occasional larger sanidine phenocrysts, seen as white crystals, of up to 10mm. In thin section, it can be described as having a fine-grained matrix composed predominantly of nepheline, sanidine, clinopyroxene crystals, plagioclase and opaque ores with minor grains of leucite and apatite (Reniere, et al., 2016, pp. 408-409) (figure 32).

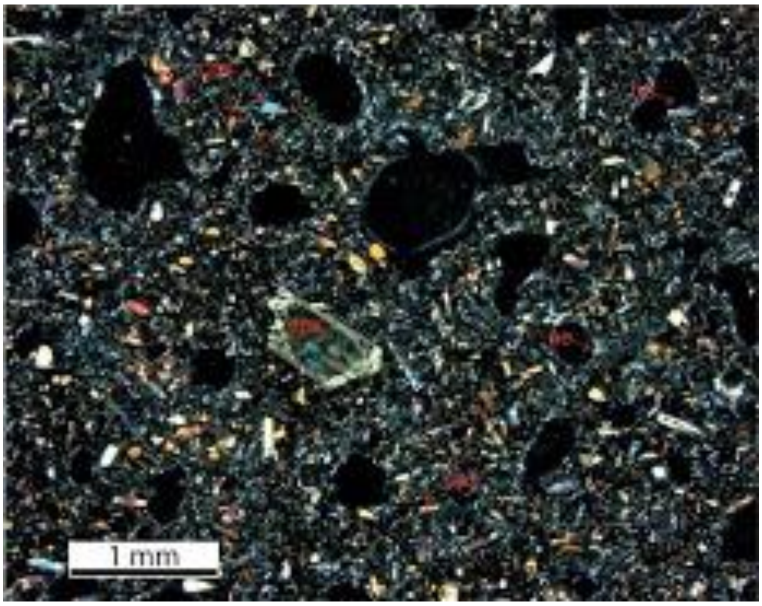


Figure 32- Photomicrograph of Mayen lava in thin section with cross polarised light (Hartoch, et al., 2015, fig 32).

Previous Research on the Geology of Mayen Lava- Petrographic and Geochemical Analysis.

As scientific methods of geological analysis have developed over the years, the ability of archaeologists to determine the provenance of stone building materials and artefacts has improved considerably. New methodologies have created new ways of answering questions relating to the use and distribution of different ancient stone objects, such as millstones and querns, and these have been well utilised within the discipline for certain artefact categories and stone types. Lava as a fabric has been well-researched, especially with regards to trade and exchange of Roman period millstones in the Mediterranean region of Europe and North Africa (Anderson, et al., 2011; Antonelli, et al., 2005; Antonelli & Lazzarini, 2010; Buffone, et al., 2003; Gallala, et al., 2018; Renzulli, et al., 2002; Williams-Thorpe & Thorpe, 1993; Williams-Thorpe, et al., 1991). Many of these studies have made use of XRF geochemical analysis, thin section analysis, or a combination of both approaches to compare the types of lava used to make millstones with reference samples taken from potential millstone quarry sites.

More recently, a similar methodology has also been applied to lava quarried in regions of mainland Europe north of the Alps. Reference samples of lava have been taken from known lava quarry locations in use during the Roman period and throughout the geographical reaches of the empire. These have been geochemically analysed using XRF to produce data for comparison with lava querns or millstones of unknown origin. At Mayen, several quarry locations were in use during the Roman period (see Chapter 2) and reference examples exist of individual lava flows of the Bellerberg volcano, which each have unique geochemical signatures (Gluhak & Hofmeister, 2009). This data has been used to further investigate the provenance of lava querns and millstones recovered from Roman period sites north of the Alps and to study their distributions relative to provenance (Gluhak & Hofmeister, 2011; Dreesen, et al., 2014; Reniere, 2018). It was found that most of the querns and mills analysed could be provenanced to Mayener Grubenfield, with some from Kottenheimer Winfeld and significantly fewer from Ettringer Lay. Distribution analysis also demonstrated that there was another competing lava quern manufacturing area, probably located in the Massif Central region of France, and that the Mayen and French lava querns had separate 'catchment' areas of consumption (Gluhak & Hofmeister, 2011, pp. 1617-1618) (see 'Distribution of lava querns and millstones in mainland Europe', this chapter for map of results). On a macropscopic scale, the French lava looks very similar to the Mayen lava. Thin section analysis can be used to differentiate between the two (figure 33), but as lava is inconsistent in the way that it forms, the specific characteristics that separate French from German lava can often be absent in any given sample. Geochemical analysis has provided a more uniform approach for identifying the material, as the two are chemically distinct.

There have been smaller scale geochemical and thin section analyses carried out on lava from British contexts and these have been very revealing. Most of these have been carried out on the iconic 'Pompeian style' millstones (Allen, 2012; Williams & Peacock, 2011; Williams-Thorpe, 1988b) (see previous section, this chapter). The results from these separate studies have shown that both French and Mayen lava was present in Roman Britain in the form of animal-powered mills. Though an important revelation, the relative rarity of these objects in Britain means that these results present us with exceptional examples of unusual objects that are unlikely to tell us much about normal trade and exchange in the province. It is possible that the French sourced example is a rare case of a specially commissioned tool. Thus far, there is no data to suggest that French lava is present in Britain in the form of hand operated querns, but systematic geochemical analysis of these objects has never been carried out for Romano-British material, and even small-scale provenance analysis is currently rare. Shaffrey and Gluhak (2020) have demonstrated how this can be done using material taken from a single site. Results of this study have shown that querns manufactured from the Kottenheimer Winfeld lava quarries were exported to Kent in the early post-conquest period. Though significant, this needs to be put into wider context with the inclusion of more data.

Figure 33- Thin section of basalt lava sample from Banne d'ordanche, Monts d'Ore in the Massif Central region of France (Derochette, 2010).

Future Research

As has already been indicated, a great deal more work remains to be done with regards to examining the provenance of lava querns and millstones in use during the Roman period in Britain. The importance of understanding the provenance of lava quern stones is becoming increasingly recognised as a gap in our current knowledge of the Roman economy and society. The geochemical data of the reference lava samples taken from the Bellerberg quarries is now widely available, as is the methodology used as part of German and Belgian research. It appears very possible that there may have been more than one source of lava being used to produce these objects, which were then exported to Britain from the continent. Geochemical and thin section analysis of 'Pompeian style' millstones has already demonstrated that French lava is present in the province. The different distributions of Mayen and French lava handmills in continental Europe suggest that distributions of lava querns in Britain may also be more nuanced when provenance is considered. A systematic scheme of sampling and analysis of the British material is needed to include lava from both millstones and quern stones of different chronologies, social and geographical distributions. In doing this, it will be possible to further clarify the different trade routes that were in place between Britain and mainland Europe, how these changed over time and how they impacted different communities. Further to this, it will help us to gain a better understanding of distribution networks that existed within the province. For example, connectivity between different groups and settlements and the identification of well-travelled or lesser travelled exchange routes. All this information will provide a much richer vision of the Roman past.

Quarrying and Organisation of Labour

Quarry sites are a relatively neglected area of research for a variety of reasons. There is limited information available from ancient sources and quarries are rarely described or explained in any detail. Further to this, the excavation of ancient quarries is an expensive and dangerous undertaking and much of the evidence has often been removed by later activity on the site (Peacock, 2013, pp. 131-132; Russell, 2013, p. 37). By 2011, there were only 16 millstones quarries that had been subject to excavation within Europe (Belmont, 2011, p. 2). This neglect is unfortunate as there are many aspects of quern studies that would benefit from more extensive exploration of production sites. The types of investigation completed thus far using evidence from quarry sites have included: provenance related research (Gluhak & Hofmeister, 2011), methods of stone extraction and identification of tools used (Belmont, 2011; Anderson, et al., 2011) and chronological variation in the intensity of quarrying and features of labour organisation (Crawford & Röder, 1955). These studies have addressed predominantly economic facets of quarrying activity, but there are now alternate avenues of interest that relate more specifically to social organisation, quarry worker identity and human-landscape interaction (for example, Bloxam, 2011). These are factors that would similarly influence both social and economic aspects of how lava milling tools were manufactured, distributed and used.

As the quern quarries of the Eifel region in Germany are well-known and have been extensively researched (Crawford & Röder, 1955; Gluhak & Hofmeister, 2011; Gluhak & Hofmeister, 2009; Hörter, 1994; Major, 1982; Giljohann, et al., 2017), there is an unusually abundant amount of information available to explore such questions. The Eifel region describes a wide geographical area and saw a long chronology of lava exploitation dating from the Neolithic to the present (Crawford & Röder, 1955, p. 71; Gluhak & Hofmeister, 2009, p. 1774; Belmont & Mangartz, 2006, pp. 25-34). It is, therefore, necessary to ensure that the appropriate terminology is applied to address the specific period of quarrying and production areas investigated in this research. Lava used to produce querns sourced from the Eifel region has been given a variety of different names: Andernach, Niedermendig and Mayen. Andernach is the name of a nearby town and harbour, the location of which does not relate to any lava source, whilst Niedermendig quarries only supplied grinding stones in later periods (Crawford & Röder, 1955, p. 68). Mayen itself was a small settlement prior to the Roman period, which later grew as quarrying activity increased. For the purposes of this thesis, Mayen will be used as the most appropriate name for lava quarried from this region during the Roman period.

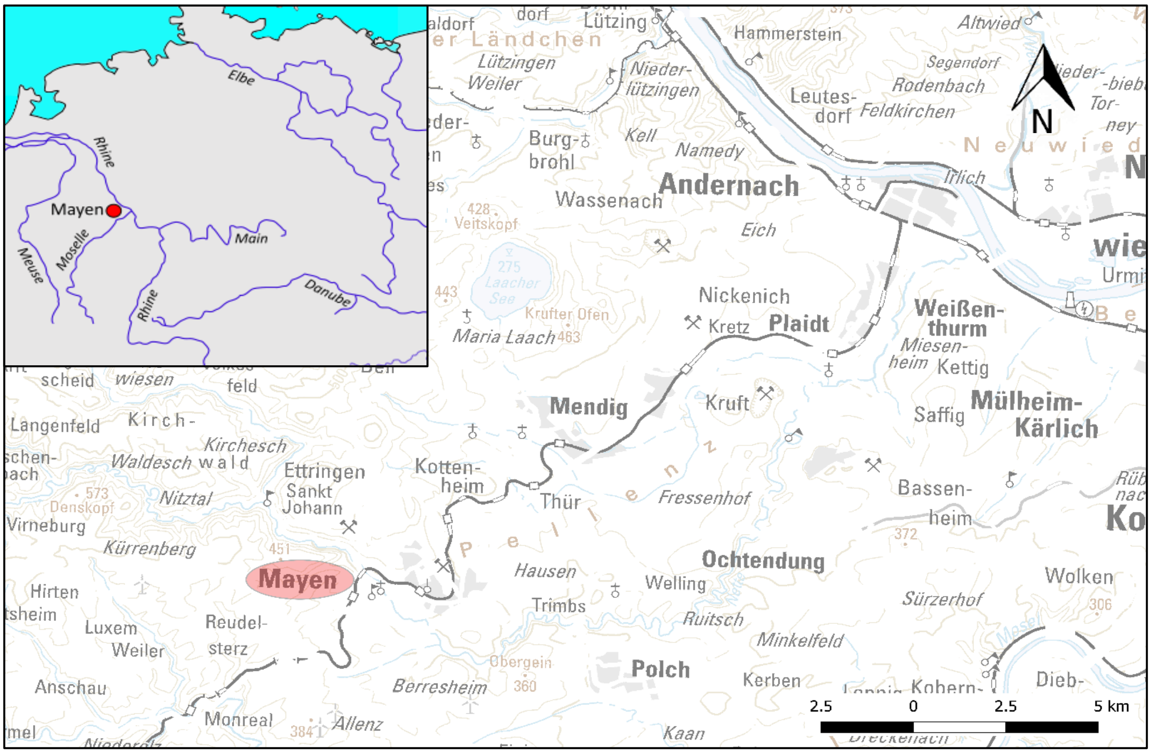


Figure 34- Location of Mayen within Germany (backdrop map copyright OpenStreetMap).

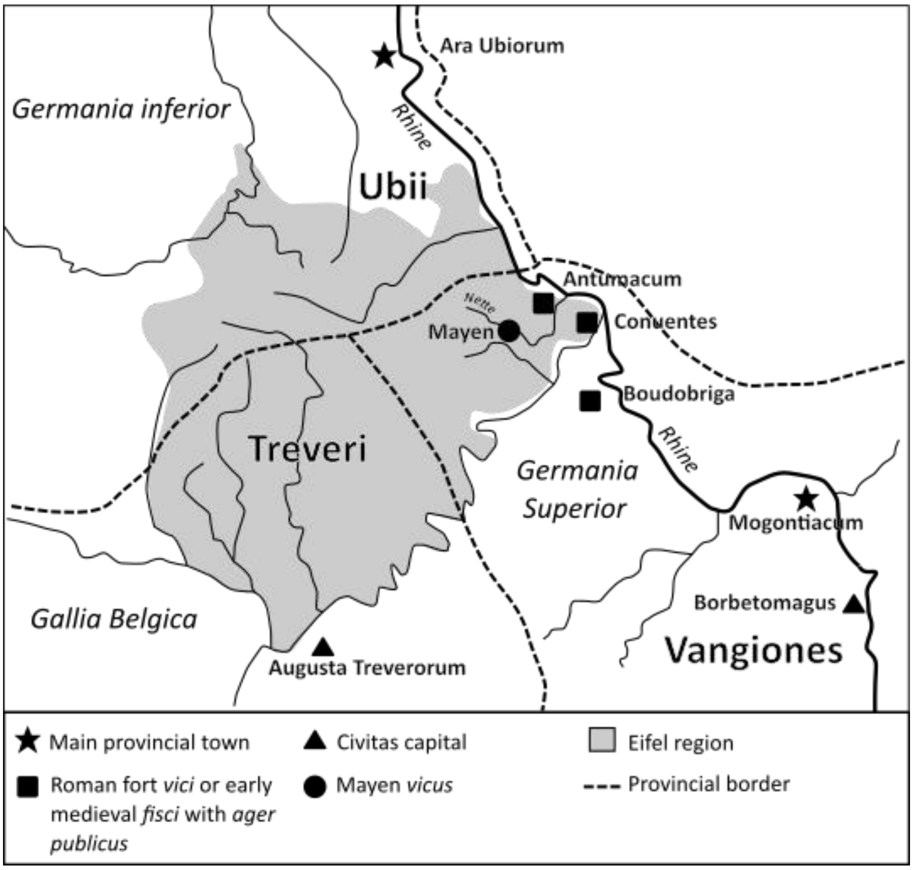


Figure 35- Location of Mayen with respect to Roman administrative province boundaries around AD 90. Mayen is within Germania Superior, having been removed from Gallia Belgica and split from its previous civitas capital Augusta Treverorum (Trier) between 27 BC and AD 17 (after Köstner, 2012, pp. 74, fig 1).

Mayen lava was sourced from the Bellerberg volcano and is named after the town that is situated close by. The town of Mayen is in modern day Germany (figure 34), on the western side of the Rhine and northern bank of the Moselle and belonged to the 'tribal' area of the Treveri during the Iron Age. The territory, which included the modern Eifel region, came under Roman rule after the Gallic war of 58-51 BC and was wholly incorporated into the newly created imperial province of Gallia Belgica in 27 BC during Augustan administrative restructuring (Köstner, 2012, p. 74). At some stage between 27 BC and AD 17, the original Treveri territories were subdivided for military administrative purposes, and the Eifel region split between Germania Inferior, Germania Superior and Gallia Belgica (figure 35). The Mayen quarries became part of Germania Superior (Giljohann, et al., 2017, p. 130), though this does not appear to have been recognised as a distinct imperial province until 82-90 AD (Köstner, 2012, p. 74), indicating that effects of subdivision may not have had immediate demonstrable consequences for those living there. Nonetheless, the Mayen region would have been substantially affected by the establishment of Roman rule, with further impact possibly caused by the following administrative reorganisation phases (see section on the Roman economy and the role of stone within it).

The Mayen quarries are located within wider lava fields in the modern East Eifel region and were the source for large volumes of locally consumed and exported lava milling tools during the Roman period. Work completed by Gluhak & Hofmeister (2011) to provenance continental Roman lava querns and millstones demonstrated that of forty-four Eifel lava artefacts in the study, all had been manufactured using basaltic lava from the Bellerberg volcano and were, thus, of East Eifel and Mayen origin (see previous section). The lack of any querns or millstones from the West Eifel region has been used to support Mangartz's (2008) discussion that lava from there was used only for localised consumption of querns. Bellerberg lava was intensively exploited during the Roman period, sourced from three main quarry sites with geochemically different lava flows: Ettringer Lay, Mayener Grubenfeld and Kottenheimer Winfeld (figure 36). Most of the Eifel lava from the querns and millstones tested was found to be from the Mayener Grubenfeld quarry, with fewer sourced from the other two locations. Further to this, none were produced using basanite lava from other volcanic areas in the East Eifel, which appear to have been predominately used for the manufacture of building blocks. There is, therefore, the indication that individual quarries provisioned specific manufacturing industries, and that some quarries were used to supply different regions.

Exploitation of the different lava flows also shows some variation in terms of when each of these were more extensively used for quern production. Although the querns from Ettringer Lay were a

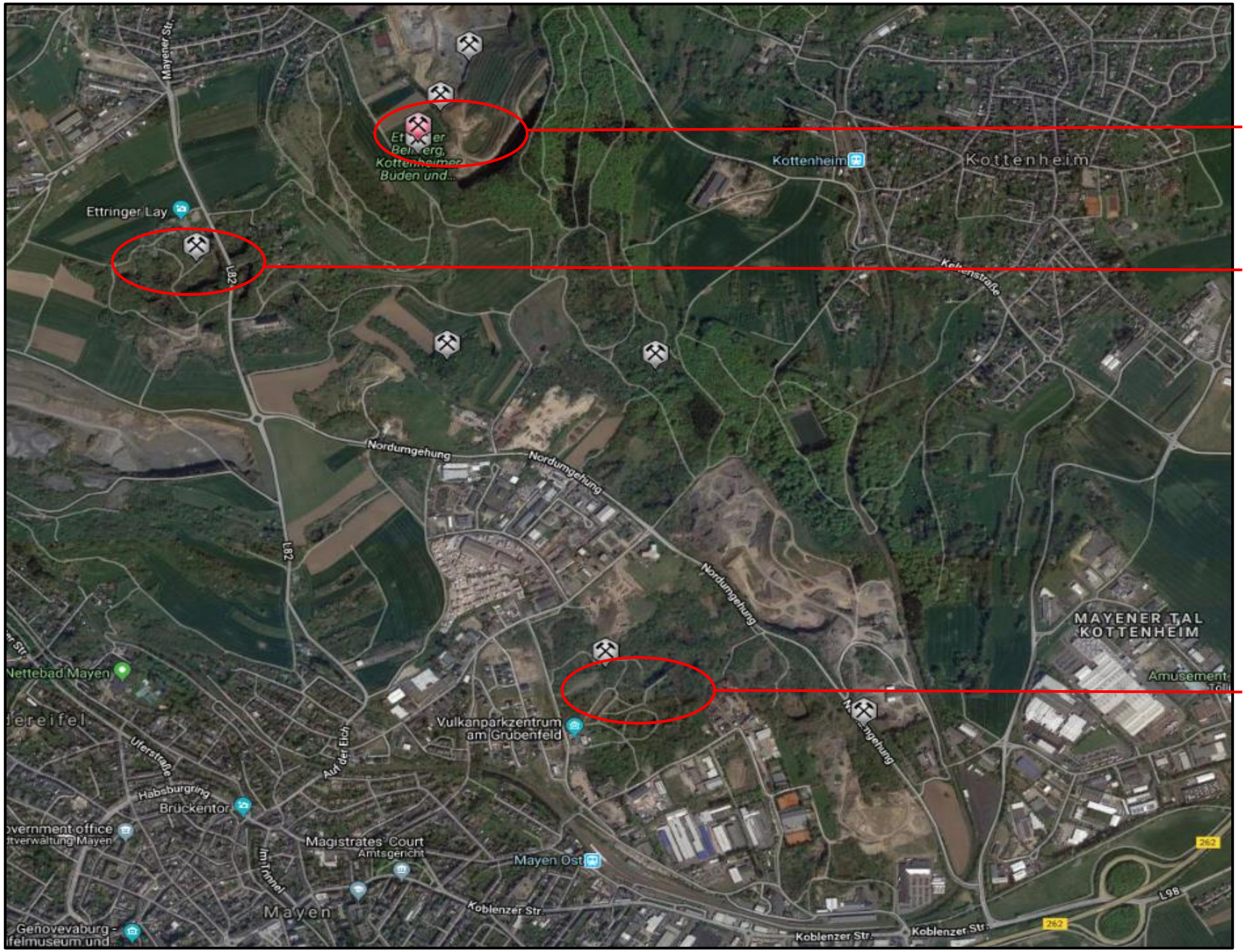


Figure 36- Satellite image showing the relative locations of the three Roman period Bellerberg volcano lava quarries in Mayen.

minority, totalling only 4, these provide some of the earliest examples, dated to 7-5 BC/9-6 AD and 11 BC/ 8-7 AD. Of these four, three were recovered from military contexts, suggesting that the quarry at Ettringer Lay was a significant supplier to the military along the *limes* in the earliest phases of Roman lava exploitation. A study by Reniere (2018) on Eifel querns recovered from northern Gaul has added some detail to this. Although the ratios of querns from Mayener Grubenfeld and Kottenheim were very close to that determined by Gluhak & Hofmeister (2011), with the majority coming from Mayener Grubenfeld, the Ettringer Lay querns were dated to the second and third century. This could indicate that there was a change in the way that lava from Ettringer Lay was exchanged and that it may not have had such an important role to the military in later phases, but the low numbers of querns from Ettringer Lay do not allow for absolute conclusions to be drawn. Further provenance analysis of a range of lava querns from military sites of different periods, both along the *limes* and further afield, could help to further refine the chronology of military consumption of lava querns from specific lava sources.

The landscape of the Mayen quarry area lends itself well to the millstone trade, not only with respect to its natural geology, but also its proximity to the Rhine and Moselle. Both rivers provided transport routes to the north, south and west of Mayen, widening the potential distribution area. The success of Mayen as a quern and millstone production area is closely correlated to these transport links; stone would have been very difficult to transport by road, and querns were probably moved in bulk via waterways and the coast wherever possible (for example, see Tucker (1972)). The nearby port of Andernach on the Rhine saw an increase in growth and development during the Late Iron Age and Roman era, indicating that it was probably a key location through which Mayen goods were exported (Deutsche Forschungsgemeinschaft, 2019). Possible lava millstone workshops and unfinished lava millstones found at sites in Andernach also indicate that it may have played an important role in the finishing of lava millstones for export (Mangartz, 2008, pp. 76-78).

The *vicus* of Mayen was established in the Late Iron Age and was the economic centre of the region (Glauben, 2012; Köstner, 2012; Oesterwind, 2012), growing in size and population during the Roman period, with development of the surrounding landscape visible in the archaeological record (Giljohann, et al., 2017, pp. 126-127). Mineralogical analysis of lava querns recovered from military sites on the River Lippe indicate that Mayen lava querns were incorporated into Roman military equipment as early as the Augustan Germanic campaigns (Gluhak, 2010). It is likely that the new role of Mayen as a military supplier initiated widespread social and economic change within the region due to the volume of material required to fulfil military contracts. Developments in Mayen are clearly visible from the first century AD, when paved streets, a water pipe system, and public baths were added to the infrastructure, transforming the indigenous settlement into a *vicus* (Giljohann, et al., 2017, p. 130). These changes would have been further assisted by other industrial activity in the vicinity (Giljohann, et al., 2017, p. 127) (figure 37). Some interpretations have determined that the wealth of the area and its people is attested archaeologically by the large number of 'high status' residences; constructed of stone, slate and decorated with plaster and mosaic (Baur, 2012) with 'rich' burials at the 'Auf der alten Eich' Roman period cemetery (Grünewald, 2012, pp. 80-81). The unusually high density of high status *villae* in the region could indicate that agricultural production was not responsible for the widely visible signs of prosperity, and that the quarries and other industries of the region had a more important role to play (Baur, 2012, pp. 242-243). However, it is not possible to ascertain whether this was always the case, as wealthy or elite sites do not have to be directly connected to the immediate landscape in terms of their economic or social roles.

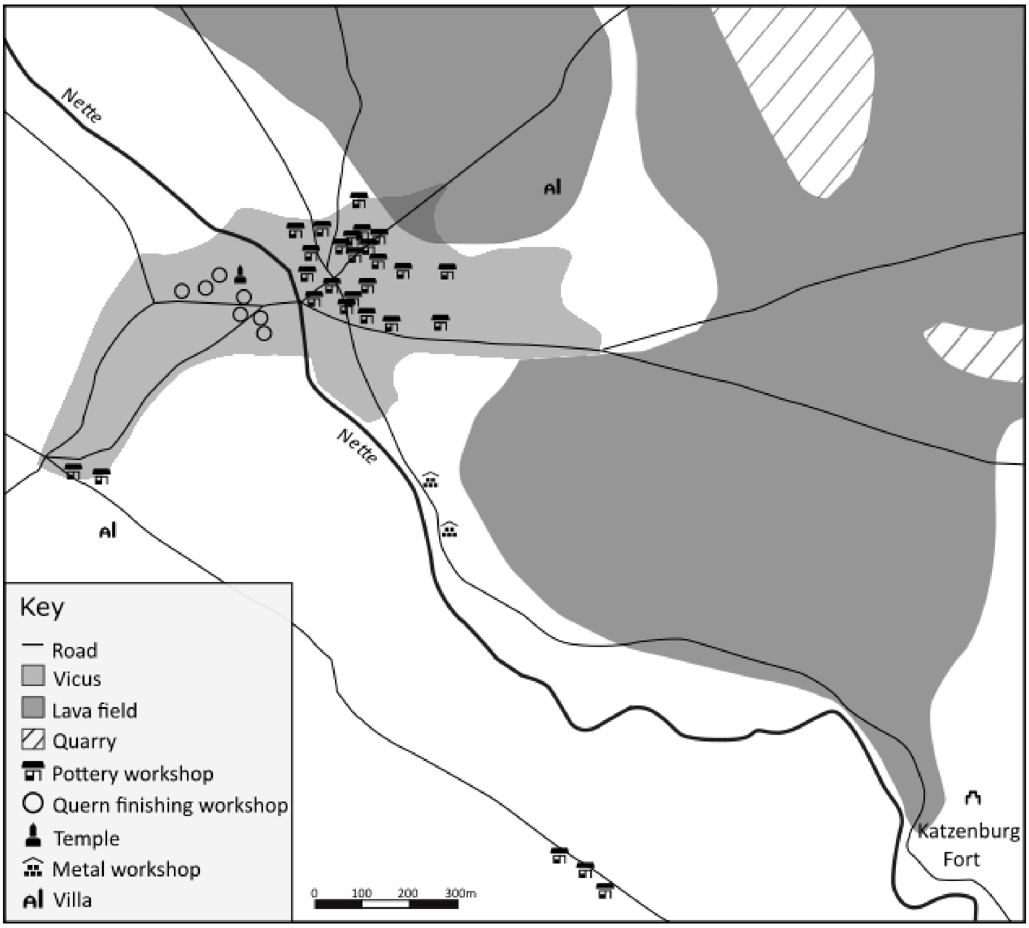


Figure 37- Map of the vicus at Mayen and surrounding area (after Giljohann, et al., 2017, pp. 131, fig 6)

Although details pertaining specifically to Mayen are not known with any certainty, resource management strategies from elsewhere in the Empire indicate that state control of quarries was widespread (Köstner, 2012, pp. 75-76). Organisation of the Empire's resources would have required a degree of investment in the form of knowledge, technology, and human input; this investment would have guaranteed the outputs of such organization, in the form of production of goods, control of resources and the development of experienced workers (Hirt, 2010, p. 9). There would have been different management strategies in place at different times and possibly in different locations, with the scale of quarrying, ownership of resources and organisation of labour being largely shaped by Roman political and administrative circumstances. Examples of such systems of management include the *lex Manciana* and *lex Hadriana,* recorded on an inscription from the province of *Africa Proconsularis* (Scholl & Schubert, 2005). This has been identified by Köstner (2012) as outlining a possible Empire-wide system of rules used to govern land-use; the general underlying principle being that of a leasehold arrangement involving regular payments made by those working the land to the Imperial treasury, managed by the *conductores*. Although there is no specific set of regulations known for quarries, those for mines (*metalla)* are likely to have been applied to quarries also (Hirt, 2010, pp. 4-5) and the word *metalla* is used in classical literature to describe quarries or mines indiscriminately.

Debate exists on how mining and quarrying ventures were undertaken, who the taskforce comprised of, and who the beneficiaries were. Hirschfeld (1905) and Köstner (2012) both discussed the idea that mining was controlled as part of the Imperial estate. Hirschfield determined that there would have been a necessity to keep experienced managers and private owners continuously involved throughout the *principate* due to the level of skill and expertise needed to master the technicalities of quarry management. Köstner (2012) and Rostovtzeff (1957), however, argue for a more rigid set of controls, and that mines and quarries were *ager publicus*; property belonging solely to the emperor without the possibility for private ownership. They determined that large tracts of land and quarrying rights could be licensed to *conductores,* to then be split into smaller plots and leased to *coloni*. Rent would be paid by *coloni* in coin or in kind, in a similar system to that used in agricultural land management. Rent would eventually be turned over to the *procurator* who had complete administrative oversight and collected on behalf of the emperor. Alternatively, Täckholm (1937) suggested that *conductores* were no longer employed in such roles after the late second century AD, when the *procurator* dealt with the leases directly. Täckholm also discussed the idea that there may not have been a general uniform system of management in place, a factor that seems likely considering the different conditions that would have been present across the empire at different times.

This variation appears to have been the case in the Eifel region. Quarries of the Laacher See volcano, used to extract tufa for building material provide evidence, in the form of epigraphy and 'military' material culture at the site of extraction, for direct military involvement in the management of quarrying activity during the early Roman period (*régie directe*) (Giljohann, et al., 2017, pp. 127-128). Such evidence is absent at Mayen, and it seems more probable that a lease system was in operation and a local workforce employed (*régie indirecte*). This is supported by the way that lava was extracted from the Mayen quarries. There are clear divisions between different 'plots' in the form of border strips comprising unworked stone, which would have provided a place for quarrying refuse to be temporarily located as extraction was carried out, thus preventing it from falling into neighbouring plots (Crawford & Röder, 1955, p. 73) (figure 38). If quarry workers were employed as one single taskforce, there would have been no need for such features as the team would have worked together to extract stone as a single unit whilst minimising waste material.

The extent to which the workers were willing participants in these quarrying operations can also be debated. Domergue (1990, p. 456) argues that populations of indigenous people were forcibly resettled to provide the necessary workforce for mines and quarries throughout the Empire, while classical written sources describe the use of convict labour in imperial *metalla*; though these tend to reference the highly prized marble or porphyry quarries under complete state control that also exploited slave labour (Domergue, 1990, pp. 429-430). However, at Mayen where experienced quarry workers were already involved in stone extraction in the pre-conquest period, such major reorganisation of a pre-existing industry would have been detrimental to production and, therefore, undesirable. The main objective likely involved the imposition of control on production and the introduction of taxation, forcing the indigenous population to particpate in the economy by producing a surplus whilst also ensuring the continous supply of querns and millstones necessary to sustain the military. Both Grünewald (2012, p. 81) and Giljohann, et al. (2017, p. 133) argue that burial customs in Mayen from the pre-Augustan era to the middle of the first century AD were predominantly consistent, demonstrating that the population remained relatively unaltered in terms of who was living and working in the region. However, this does not account for members of the population whi may not have been subject to formal burial traditions, such as slaves or convicts. Similarly, the arrival of people with different burial customs may not be represented in within the excavated cemetery area.

Figure 38- Reconstruction of the quarrying process and the division of the quarry face into 'plots' for extraction (Mangartz, 2012, p. 115. fig 39).

This would have changed as production and local population increased, with people drawn to the booming economy of the area and potential earning opportunities. There is some evidence that by the Flavian period the effects of greater population movement were being felt in Mayen. The presence of a Mediterranean influence is seen in burial goods dating to this era. This indicates that a range of different people possibly came to benefit from, and exploited, the valuable resources available (Giljohann, et al., 2017, p. 131). However, such changes could also be explained by the presence of different material culture types in Mayen because of more widespread exchange, and a shift in how such objects may have been incorporated into everyday lives. Nonetheless, that *coloni* were dependent and subject to strict regulations should not be overlooked; the *lex metallis dicta*, *lex Manciana* and the *lex Hadriana* all suggest that lava extraction on leased plots had to be continuous. If a period of ten days expired without the land being worked, it could be reclaimed and redistributed by the *procurator* (Köstner, 2012, pp. 80-81).

Stone extraction: Quarrying process

The extraction of lava at Mayen during the Roman era has left a wide range of evidence in the form of tools (Mangartz, 2012, pp. 4-5; 2008, pp. 58-62), partially worked quarry faces (Mangartz, 2012, pp. 6-7) and roughouts (Hörter & Röder, 1951, p. 15). Parallels between the identified stages of quarrying at Mayen and other quarries in the empire suggest that there was a large degree of correlation between the technologies and methods used in different locations at the same time allowing for a full reconstruction of the process to be established, even for stages where evidence has been less forthcoming. The suitability of the Mayen quarries for quern production lies not only in the properties of the stone itself, but also in the geological formation of the resource as basalt lava columns (figure 39). This facilitated extraction of the stone as the natural dimensions of the columns provided the minimum circumference from which workable quern stone blanks could be produced. This feature was exploited, and lava removed from each column until the circumference of the natural stone increased to a degree that would require the removal of higher quantities of stone to produce uniform sized roughouts; so long as there was sufficient suitably sized stone available in the vicinity, there was no need to overexert to produce roughouts from oversized columns (Mangartz, 2008, p. 62).

Figure 39- Photograph of quarry face at Etringer Lay showing the naturally formed lava columns (Weinandt, 2019).

Stage 1- Preparatory work

A high degree of investment in time, energy and resources occurs during the various stages of millstone or quern manufacture, and workers were not always compensated for this investment due to the high chance that things could go wrong. Preparatory work had the potential to mitigate some of these issues, and though there is no physical evidence any took place, it is highly likely that preliminary quality control checks were carried out prior to the commencement of work (figure 40). An experienced quarry worker would be able to identify faults in the lava, including potentially damaging stone inclusions, and see if the quality of the stone was sufficient for the intended purpose. Lava could also be 'sounded' by hitting it with a metal tool; the frequency of the sound could be indicative of unseen faults in the fabric of the stone, removing the necessity of working the stone prior to discovering non-superficial fissures. Soaking the lava with water could also be used to make faults and fissures more visible and thus identifiable (Mangartz, 2008, p. 64).

Figure 40- Stage 1: Preparatory work (Mangartz, 2008, pp. 65, fig. 18).

Stage 2- Marking out

Measurements were probably taken and marked out using Chalk or old Devonian slate to ensure that the minimum size for a quern could be created from the roughout material. Some excess stone would have to remain on all edges to allow for the stone to be worked further, though in optimum conditions this would be minimal to reduce the amount of work needed to form the quern. In the early Roman period, a groove was incised around the full circumference of the stone, marking the lower boundary between the roughout and the rest of the lava column (figure 41). The groove was a few centimetres wide and deep and is thought to have been created using a 'double point' tool. However, Roman period technology and contemporary processes of stone removal do not require the presence of a groove to be successful, and it appears to be a remnant of pre-Roman stone extraction methods. The 'Celtic groove' was used in Mayen prior to the introduction of iron wedges for stone breaking, and it is thought that quarry workers negotiated their adoption of new technologies and processes by maintaining some aspects of their traditional operations in collaboration with imported Roman innovations. By the second century AD, the implementation of the groove ceased to be significant, and was probably discarded as unnecessary extra work (Mangartz, 2008, pp. 64-68).

Figure 41- Stage 2: Marking out (Mangartz, 2008, pp. 65, fig. 18).

Stage 3- Stone breaking

Iron wedges were used to facilitate the breaking of stone, and to control the separation of the roughout from the rest of the lava column. Small 'pockets' were notched into the stone a few centimetres apart around the circumference at the boundary between the lower part of the roughout and the lava column (figure 42); it is probable that a chisel or chisel insert and a 'Billenhammer' was used to complete this action. In the first century AD, notches were cut into the newly exposed surface of the pre-incised 'Celtic groove'. During the second and third centuries, the pockets were carved into the immediate surface and were smaller in size to accommodate smaller iron wedges than those of the preceding century (figure 43). Iron wedges were then placed into the prepared recesses and lamellae (rectangular plates) inserted into any gaps to produce a secure and tight fit. Using a 'Weckhammer' or other appropriate mallet-type tool, the wedges would be struck in turn to create controlled fissures and separate the roughout from the lava column (Mangartz, 2008, pp. 68-71). Evidence for this process can still be observed at the quarry sites (figure 44).

Figure 42- Stage 3: Stone breaking (Mangartz, 2008, pp. 65, fig. 18).

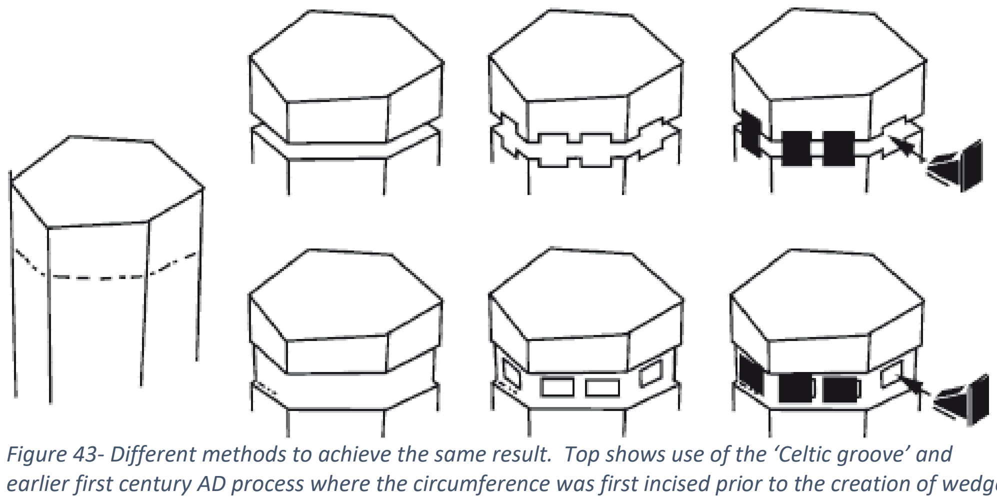


Figure 43- Different methods to achieve the same result. Top shows use of the 'Celtic groove' and earlier first century AD process where the circumference was first incised prior to the creation of wedge notches. Bottom shows slots recessed into the immediate surface of the stone prior to inserts being carved, typical of second and third century quarrying methods (Mangartz, 2008, pp. 63, fig. 17).

Figure 44- remnants of stone breaking technique in Mayen quarries to show how the iron wedges were used in the process (Mangartz, 2008, p. 72).

Stage 4- Shaping the sides

Once the roughout was sufficiently separated from the lava column, a lifting iron or similar cantilever could be used to complete the disconnection and lift or move the block from its original position, though shaping the sides could also have been carried out prior to the complete extraction of the stone block from the lava column. Tool marks indicate that stone removal occurred by moving the tools vertically and so the block could easily have been worked in its original position. Iron compasses were probably used to mark out the intended shape of the final product so that excess stone could be removed from the sides more precisely (figures 45 and 46). One of the many different styles of hammer would probably have been utilised at this stage and wedge hammers correlate well with the tool marks that are still visible on discarded roughouts and other quarry surfaces. This initial shaping of the stone would have been relatively roughly completed, allowing for greater blows and the removal of most of the excess stone (Mangartz, 2008, pp. 71-72).

Figure 45- Stage 4: Shaping the sides (Mangartz, 2008, pp. 66, fig. 19).

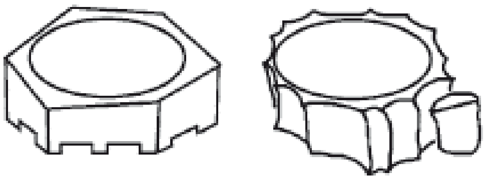


Figure 46- Sketch of how the excess stone would have been removed from the block after being marked out (Mangartz, 2008, pp. 63, fig. 17).

Stage 5- Shaping the top and bottom surfaces

Once the sides of the roughout had been shaped, the reduced weight of the stone would allow it to be moved more readily and turned to generate a better working angle. At this stage, the choice of whether the stone were intended to be a *meta* (lower stone) or *catillus* would influence how the process would continue (figure 47) due to the differing shapes and angles needed to provide the appropriate grinding surface. As with the previous phase, this would have been completed in a rough manner to remove most of the excess stone prior to more detailed work being carried out. It is thought that both this stage and the one prior would have been completed within the quarry as this phase would result in a significantly less weighty stone after completion. It would be more economical to remove as much waste material as possible before attempting to move the roughout elsewhere. Many of the roughouts retrieved from the Mayen quarries are at this stage in the process. Although the shape of the quern stone is beginning to emerge, the shape is crudely developed and requires further finishing (figure 48). This seems to indicate that querns were worked in the quarries until at least this stage, though there may also have been a further surface smoothing stage that may also have taken place in the quarry (Mangartz, 2008, pp. 72-73).

Figure 47- Stage 5: Shaping the top and bottom surfaces (Mangartz, 2008, pp. 66, fig. 19).

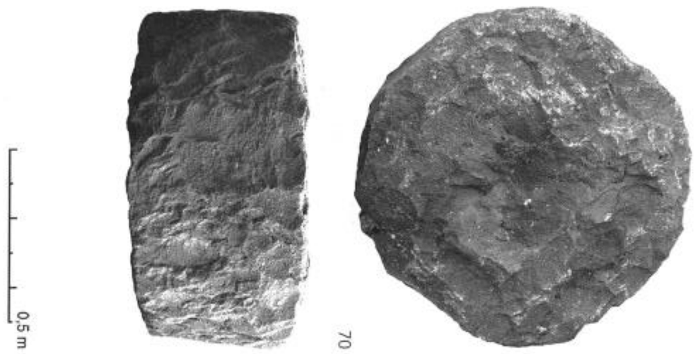


Figure 48- Example of a typical roughout recovered from Mayen quarries. All three examples show that the quern stone shape is beginning to emerge, but that the surfaces are still roughly shaped (Mangartz, 2008, Plate 23).

Stage 6- Smoothing the surface

The final stage that probably took place at or near to the stone extraction site involved further smoothing the surfaces of the roughout to produce a more well-defined object (figure 49). There have been roughouts recovered from the quarry that have reached this more advanced stage of working (figure 50), but these are less numerous than the rough versions seen from the previous phase of manufacture. It may simply be the case that the rougher stages of the process were more 'dangerous' to the integrity of the quern and more likely to produce discards. Small particles of stone working waste have also been found in the quarry itself, which might suggest that finer work was conducted there. However, the issue of redeposition makes it impossible to determine with any confidence, as stone waste appears to have been moved around the site and does not necessarily correspond to activity areas. That there are roughouts from this stage of production suggests that at least some querns were smoothed at the quarry, or that they were worked near the stone extraction areas (Mangartz, 2008, p. 73).

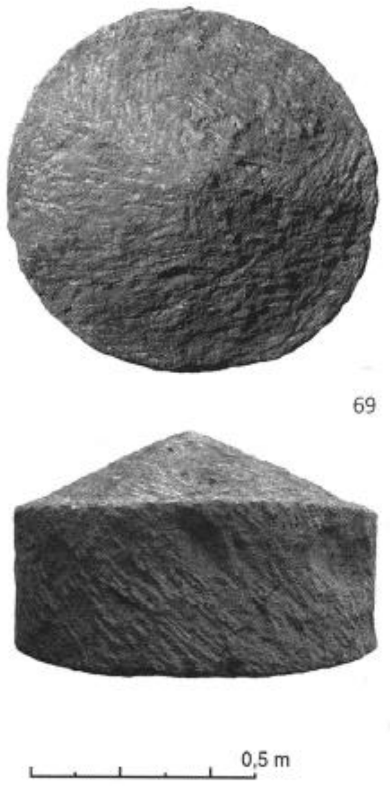


Figure 49- Above, Stage 6: Smoothing the surface (Mangartz, 2008, pp. 66, fig. 19).

Figure 50- Left, Smoothed roughout of a meta retrieved from Mayen quarry site. Tool marks show the direction of working and the smaller size of the tool blade used (Mangartz, 2008, Plate 23).

Stage 7- Transport of stones to 'finishing' workshops

Finally, the quern roughouts were moved from the quarry to the nearby *vicus* or *villae* for further working. This is likely to have occurred primarily by road using draught animals such as oxen or horses pulling wagons, though the specific placement of many *villae* on streams and watercourses in the area could indicate that water transport was also utilised for moving stone into and out of finishing workshops. It should also be noted that the stone workshops of the *vicus* were also similarly situated on the Nette, and that moving stone by water would always have been preferable wherever possible (Mangartz, 2008, p. 73).

Stone extraction: Tools

The catalogue of tools recovered from Mayen quarry sites produced by Mangartz (2012, pp. 57-64) presents a detailed illustration of the types and uses for these objects, with an overview of chronological changes in form and function. In this account, the 'double-point' ('die Zweispitz') has been identified as the standard tool of the quarry worker (Figure 51, 1) as it has been the tool most frequently recovered from quarry contexts, including other quarries in Roman provinces (Dworakowska, 1983, pp. 74-78). Currently, all Mayen examples of this tool have been recovered from pre-Roman contexts, but they are thought to have had a long chronology of use, also spanning the Roman era (Mangartz, 2008, p. 70). The volume of 'Zweispitzen' might relate to a practice of 'hiding' tools at extraction sites instead of carrying them home at the end of the working day (Mangartz, 2008, p. 58). If this was the case, it may reveal how quarry workers perceived the value or significance of specific tools: those that were less replaceable and expensive may have been too important to leave behind, even if moving them was awkward and cumbersome. Furthermore, if the scree slipped and covered the tools overnight, the discretion of the owner would determine whether or not these would be recovered and whether the investment of time would be worthwhile (Mangartz, 2008, p. 57). The possibility that the deposited tools were some form of ritual offering should also be considered a possibility. Tool volumes recovered from the quarry sites cannot, therefore, be taken as representative of the actual quantities and types of tools that were the most significant or useful to the quarry worker.

The larger heavy tools would have been less useful for the up-close work involved in producing quern and millstone roughouts and would probably have been used to remove the overburden prior to such work commencing. These tools include the one-sided pick (Figure 51.15), though no known examples can be securely dated, and the unusually shaped 'pull-hoe' ('Ziehhacke') (Figure 51.16) (Mangartz, 2008, p. 58). Three different one-sided 'wedge' hammers have been found; a "real" wedge hammer ('der echte Keilhammer') with a rounded neck and round shaft hole (Plates 2, 8), a slender hammer with a rounded wedge edge (Plates 2, 9) and a narrow, slightly curved hammer with wedge-shaped edge (Plates 2, 10). Two Keilhammer examples are also shown in figure 52.7 & 8 in both 'sharp' and 'blunt' states, alongside a narrow, curved hammer (Figure 52.9) (*ibid*).

The precise role of these hammers is not fully known, though the shape and form of utilitarian objects is usually strongly indicative of function; the wedge-shaped edges of the hammers show that they were probably used when chipping at the stone to form the shape of the stone object. The 'double hatchet' ('Flächt') (Figure 52.10) has a rectangular handle socket and is a type that is more confidently attributed a Roman date. All other hammers, other than the Keilhammer with its circular handle socket, share this feature, which could be indicative of a chronological disparity. However, there is little evidence to support such a theory and other tools that are assumed to be of a Roman date have also been found with circular handle sockets (Mangartz, 2008, p. 58).

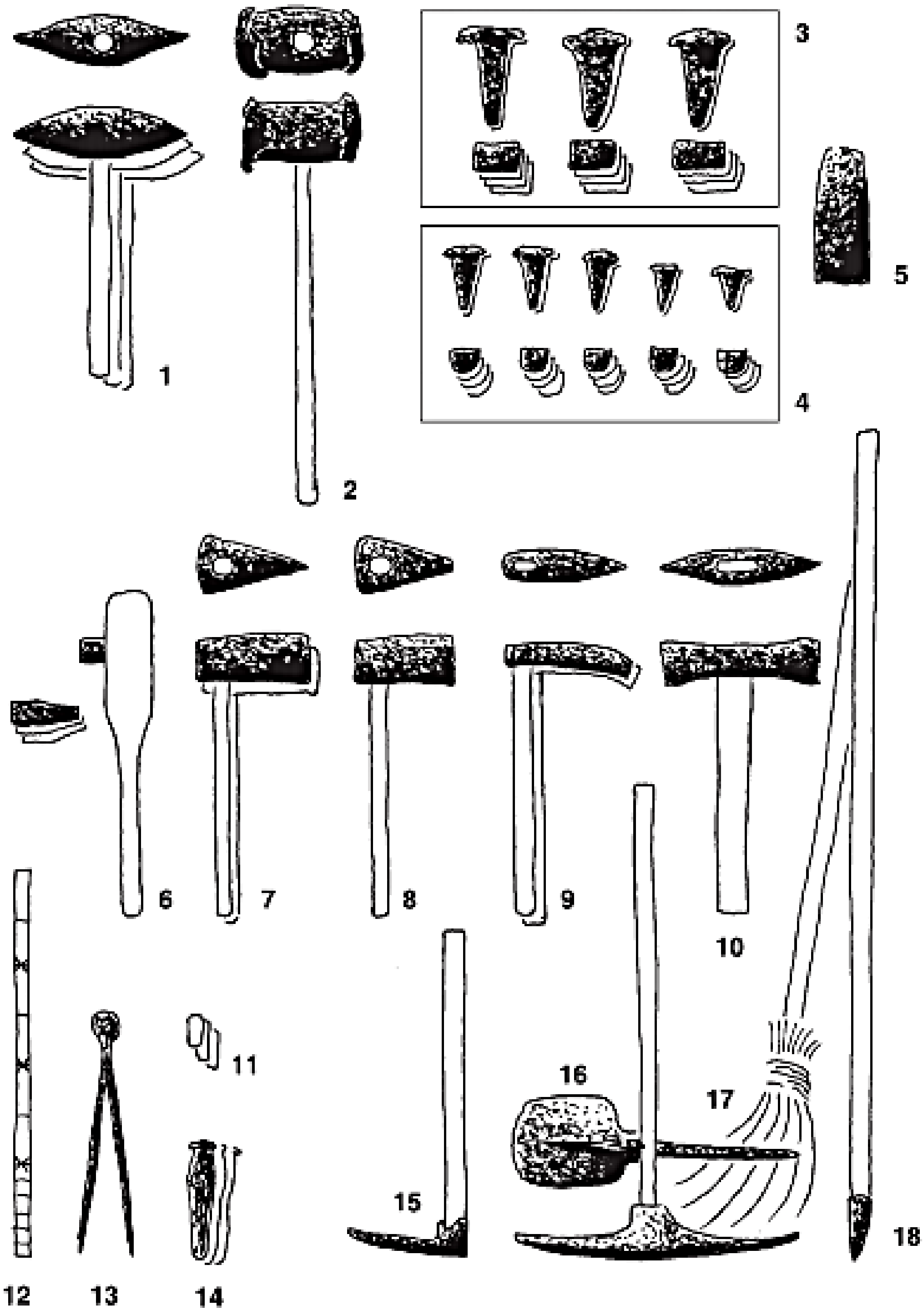


Figure 51- Roman millstone worker 'toolkit' for the Mayen lava quarries, 1:10, (Mangartz, 2012, p. 18). 1-18 are tools used by quarry workers. 6-7 and 9-14 are tools used by the stonemason.

1- 'Double-point', 2- 'alarm' hammer, 3- sets of wedges typically used in the first century, 4- sets of wedges typically used from second to third century, 5- drive wedge, 6- 'Billenhammer' with interchangeable inserts, 7- sharp Keilhammer, 8- blunt Keilhammer, 9- narrow curved hammer, 10- surface evener, 'Flächt', 11- chalk, 12- scale, 13- compass, 14- punches, 15- pick, 16- 'pull hoe', 17- broom, 18- hoisting iron.

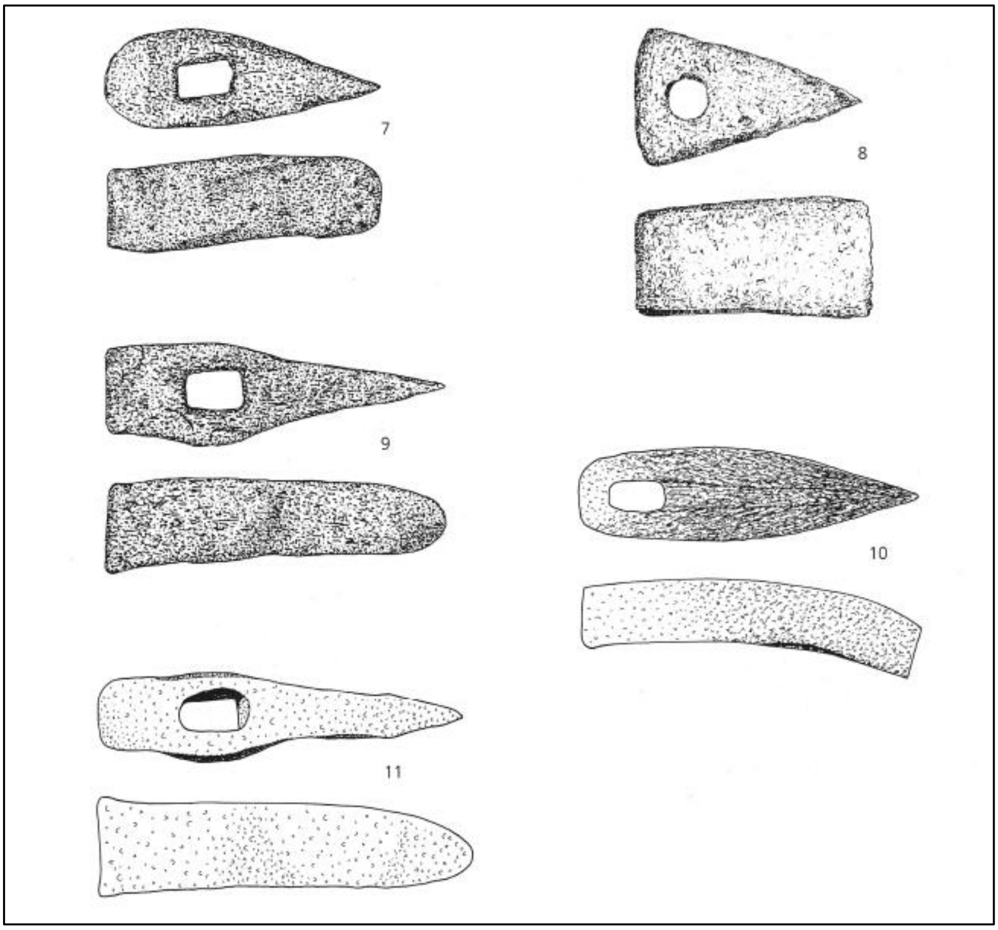


Figure 52- Different wedge-shaped hammer types recovered from Mayen quarries; 8- 'Keilhammer' with a circular shaped handle socket, 9- slender hammer with a rounded wedge edge, 10- narrow, slightly curved hammer with wedge-shaped edge. 7 & 11 are slight variations of those described (Mangartz, 2008, Plate 2).

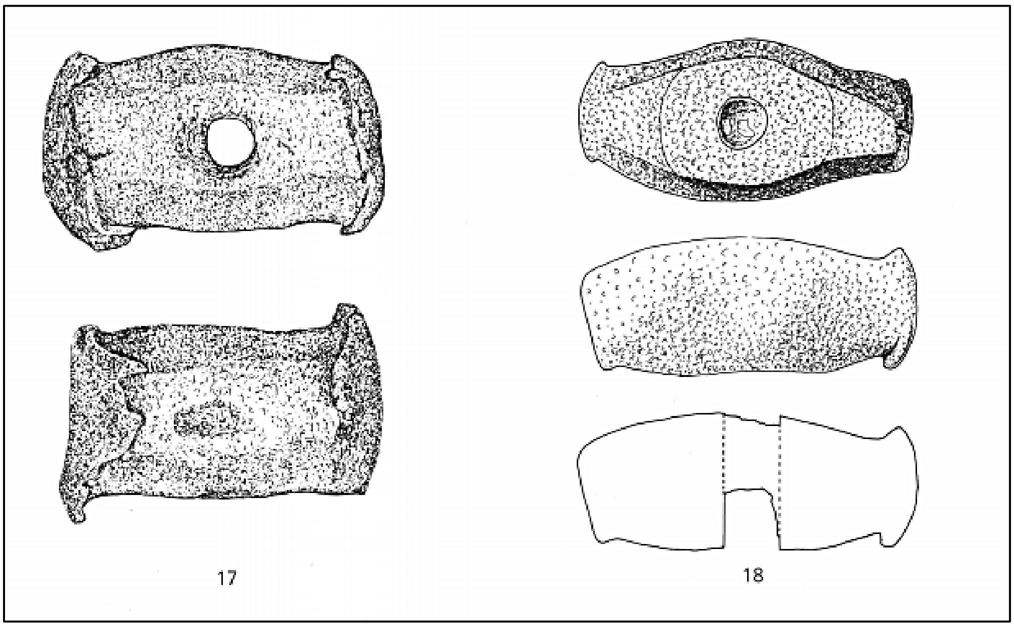


Figure 53- Examples of 'Weckhammer', or 'alarm hammer' retrieved from Mayen quarries. The ends of the hammer are probably bent from hammering wedges into stone as part of the stone-breaking process (Mangartz, 2008, Plate 4).

The ‘alarm hammer’ (‘Weckhammer’) (Figure 51.2 and 48) is a tool that was found alongside the ‘double hatchet’ and is, thus, associated with the Roman era. These would have been used to hammer iron wedges into lava to create controlled fissures, as evidenced by the wear and damage traces on the hammers uncovered (Mangartz, 2012, p. 4). The use of iron wedges to split stone in a controlled way commenced prior to the early Roman period and was a technique used in many other quarries throughout the Empire during and before Roman occupation (Blagg, 1976; Gutiérrez Garcia, 2011; Harrell & Storemyr, 2009). Iron wedges (Figure 51.3-5) are the most commonly found of all tools recovered from the Mayen quarry sites, with a decrease in size from those used during the first century AD (Figure 51.3) to those of the second and third century (Figure 51.4). Special large wedges (Figure 51.5) served to widen cracks that had already formed (Mangartz, 2012, p. 4). At Mayen Grubenfeld an example exists where iron wedges were found *in-situ*, providing a better picture of how the whole process may have been conducted and the tools that were used within the sequence of operation; for example, iron or wooden lamellae (thin plates) were used to fill the spaces between the wedges and the hole edge (Mangartz, 2012, p. 61).

Chisels were also used, though there are only two known examples of such tools that can be categorically labelled as such (Figure 54.19 & 20) due to the flattening of the end surface where they had been struck with a mallet. Other objects that resemble these chisels also exist (figure 54.20 & 21), though these do not show comparative wear that corresponds to use in this way. These are thought to have been used as inserts in a ‘Billenhammer’; a wooden implement with space to insert a variety of different fittings such as these iron ‘punches’. This would have been more economical in terms providing a multipurpose tool for the quarry worker, and more practical with regards to its weight and the ease of blade/insert replacement and maintenance. The concept of such a device has been anticipated from an Iron Age find of a socketed axe (Tüllenbeile), and though its existence cannot be proven, is an imaginative way of explaining the presence of worn chisels that could not have been used in traditional way. Furthermore, studies into the traces of tool marks on millstones from Etringer match the width of these inserts and indicate how these tools had been used (Mangartz, 2008, pp. 60-61).

Moving and lifting the heavy stone was probably made easier with ‘lifting irons’ (Figure 51.18). Though these have not been detected in the archaeological record, there is a general assumption that they were employed as their use is known from other locations of the same period (Mangartz, 2008, p. 70). Other tools include a compass and chalk (figure 51.11 & 13), though Old Devonian slate was also used to mark out measurements to the same effect. Measuring sticks are also assumed to have been employed, though these have not been included in the current finds lists for the period (Mangartz, 2012, p. 4). These would all have been used for creating an evenly sized and wellproportioned roughout. If there was a system of mass production and control over the quality and types of quern or millstones produced, such tools would have been vital for ensuring that standardised requirements were met. Observations made by several researchers conclude that the roughouts that have been recovered from Mayen quarry sites were probably abandoned or discarded as poor quality; these are often retrieved from stone waste dumps and occur in large numbers. The investment of time and energy to create stone roughouts must have been relatively costly, and so their discard could be indicative of enforced systems of standardisation. The quarry worker should have been able to sell any undamaged roughout; querns can be made in many different sizes and forms and lava can also be used to manufacture other grinding implements. That they were discarded in great numbers implies that this was not optional, and that sizes and shapes were managed to ensure they were uniform, creating a high volume of discard. Measuring devices were, perhaps, one way for quarry workers to ensure that they were fulfilling standardised criteria and, thus able to sell their products on.

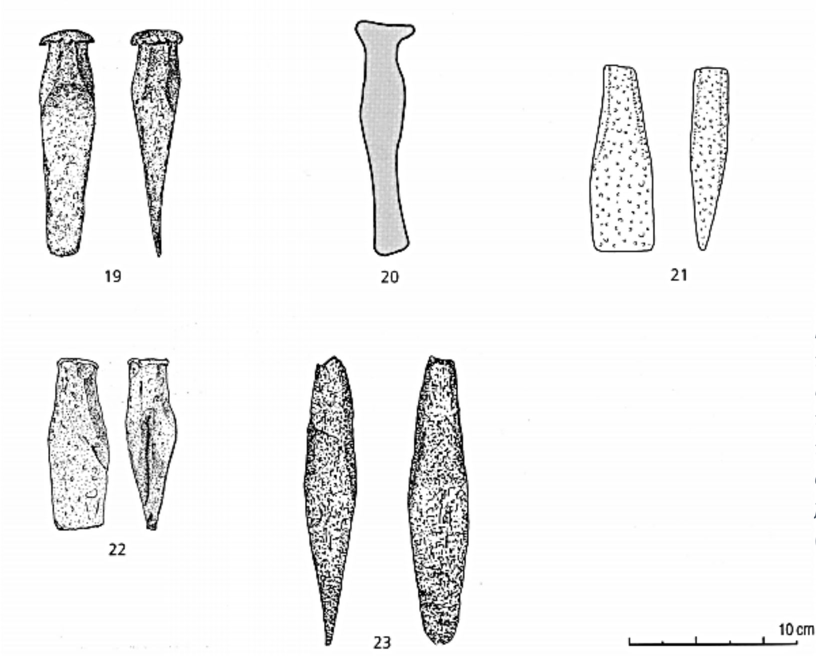


Figure 54- 19 & 20- Chisels that display the use-wear patterns of having been used with a mallet/hammer in the traditional way. 21 & 22- Possibly chisel-type inserts used in a 'Billenhammer'. 23- a longer and similar comparative insert from an Iron Age context at Mayen (Mangartz, 2008, Plate 4).

'Im Winkel': A Possible Quern Finishing Location

The production of querns within the quarries in the Mayen region is known to have only reached a certain stage in the sequence of manufacture, as shown by the incomplete and crudely fashioned roughouts retrieved from there. Although these roughouts left the quarry as identifiable quern stones, their functional and decorative features must have been added in a different location; no waste querns are known from the quarry area with these characteristics (figure 55). Such work may have been carried out at a nearby site, however. The main building of a Roman *villa*, an outbuilding, a late Antique building and multiple drainage structures were uncovered close to the mouth of a stream that flows into the Segbach from the northwest (Wenzel, 2011, p. 131); the site is referred to as 'Im Winkel' and from quern roughouts recovered from the nearby stream, is thought to have been in the vicinity of a workshop where quern stones were 'finished'. There is further evidence of a strong association between the *villa* and quarry in that the fill of the basement of the main building included 21 quern roughouts (figure 56) (Wenzel, 2011, p. 135). The filling of the basement is thought to have occurred around AD 100 (Wenzel forthcoming). The roughouts are of a different production stage from those typically recovered from quarry contexts; some have the beginnings of decorative features or show the work of more specialist stonemasons in the quality of surface smoothing and stone shaping.

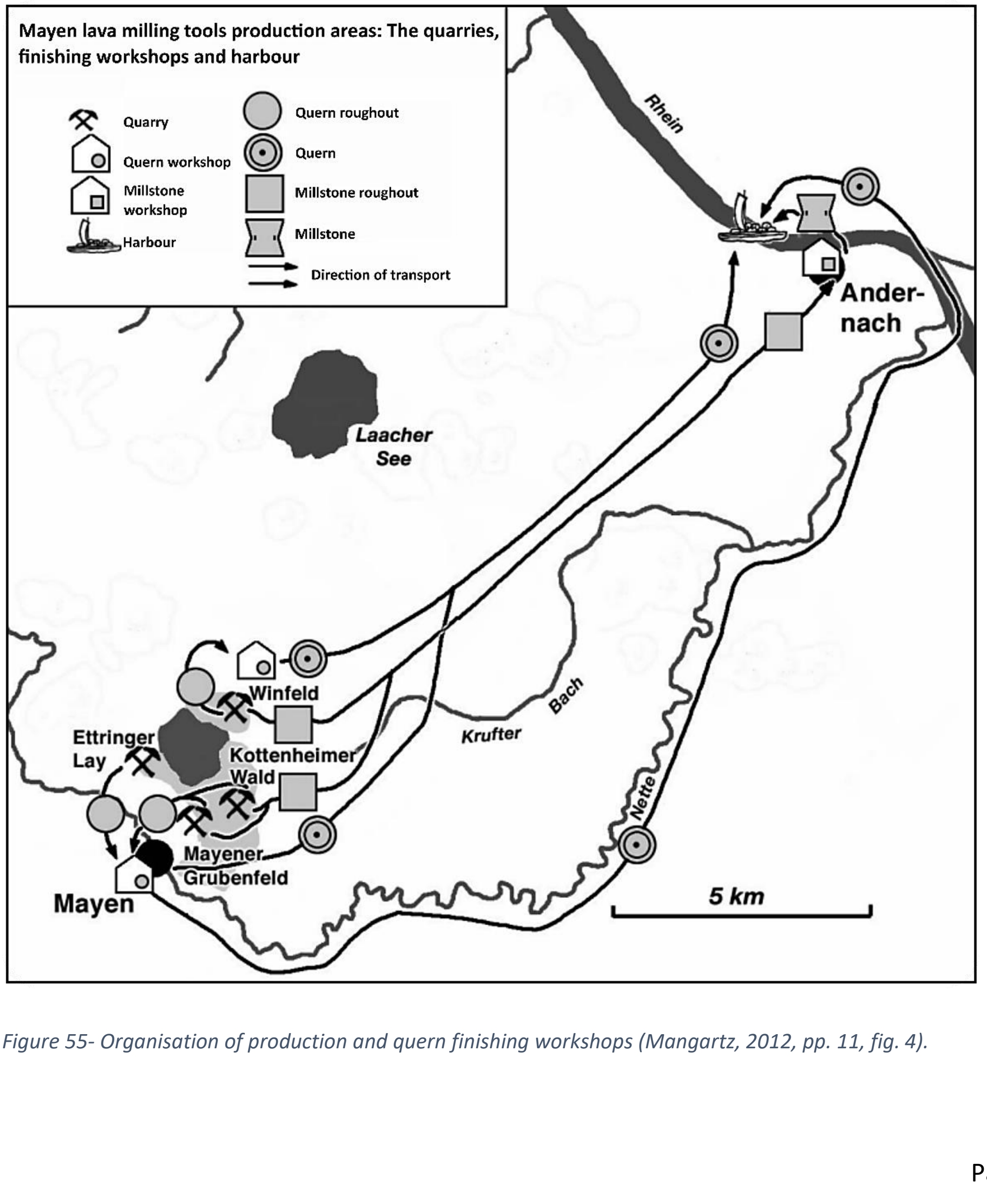


Figure 55- Organisation of production and quern finishing workshops (Mangartz, 2012, pp. 11, fig. 4).

Figure 56- Slot dug through cellar at 'Im Winkel' showing querns in section in the basement fill (Wenzel, forthcoming).

The querns from the basement at 'Im Winkel' were, interestingly, of the early Roman type with no examples of the La Tène *catilli* that are thought to have co-existed with the introduction of the Roman style querns. Although it has been surmised that these were no longer being manufactured by AD 100, there is also the possibility that these were simply not being produced at this specific workshop. *Catilli* of the La Tène type have been recovered from graves at "Nachtigallenweg", Ettringen that date to the third quarter of the first century AD, not too far preceding the filling of the basement at 'Im Winkel' and the deposition of the quern roughouts (Wenzel, forthcoming). However, that querns were curated for long periods of time should not be doubted; production of La Tène types may have ceased well before their final appearance in grave contexts.

Nonetheless, all roughouts from 'Im Winkel' are typically of the Roman style quern in their shapes and emerging features (figure 57); the distinctive concave *catilli* and convex *metae* shapes are clearly identifiable. The presence of a 'kerb' on some of the roughouts is also characteristic of the Roman era lava quern. Most of the roughouts were in the very early stages of processing after having left the quarry (table 2), and there are, unfortunately, few representative examples of querns with identifiable typological features. Furthermore, it must be acknowledged that these objects were discarded for a reason and may not be typical of marketplace-worthy products. This is significant when examining the relative sizes of the querns, which can be explored at various stages of the quern finishing process. Querns were split into 5 stages of finishing from 0-4, with 0 being the least finished and like roughouts from the quarry, and 4 being the most complete with dressed grinding surfaces. It was expected that stage 0 querns would be larger in diameter as there was still excess material to remove from these objects as part of the finishing process. However, there were examples further on in the manufacturing process that were larger than the stage 0 quern roughouts. Therefore, some of the querns may have been discarded as they did not fall within the standardised size range and would have been too small if fully finished.

The annular kerb, which is characteristic of typical Roman period lava querns, was found to be present in at least four of the roughouts recovered and all examples have been described as measuring 5-6cm in breadth; a factor that can and will be compared with the examples retrieved from British contexts. Similarly, the central perforation had been started on three of the 'Im Winkel' quern roughouts (no details are provided with regards to whether holes were completed): Two *catilli* and one *meta*. Unfortunately, only one perforated stone is illustrated, and the details are not very clear, but it does not appear to be a regular circular shape (figure 57, quern 4). The measurements given for the central 'eye' hole in this case is 'up to 7cm'. The measurement for the other *catillus* is 'up to 10cm', perhaps indicating that the perforation is also not circular but similarly sub-rectangular, whilst the *meta* perforation was 'up to 7cm'. As perforations for *metae* tend to be conical and wider at the base end, this measurement could be relevant for any part of the hole's diameter and cannot, therefore be used in comparison with British material.

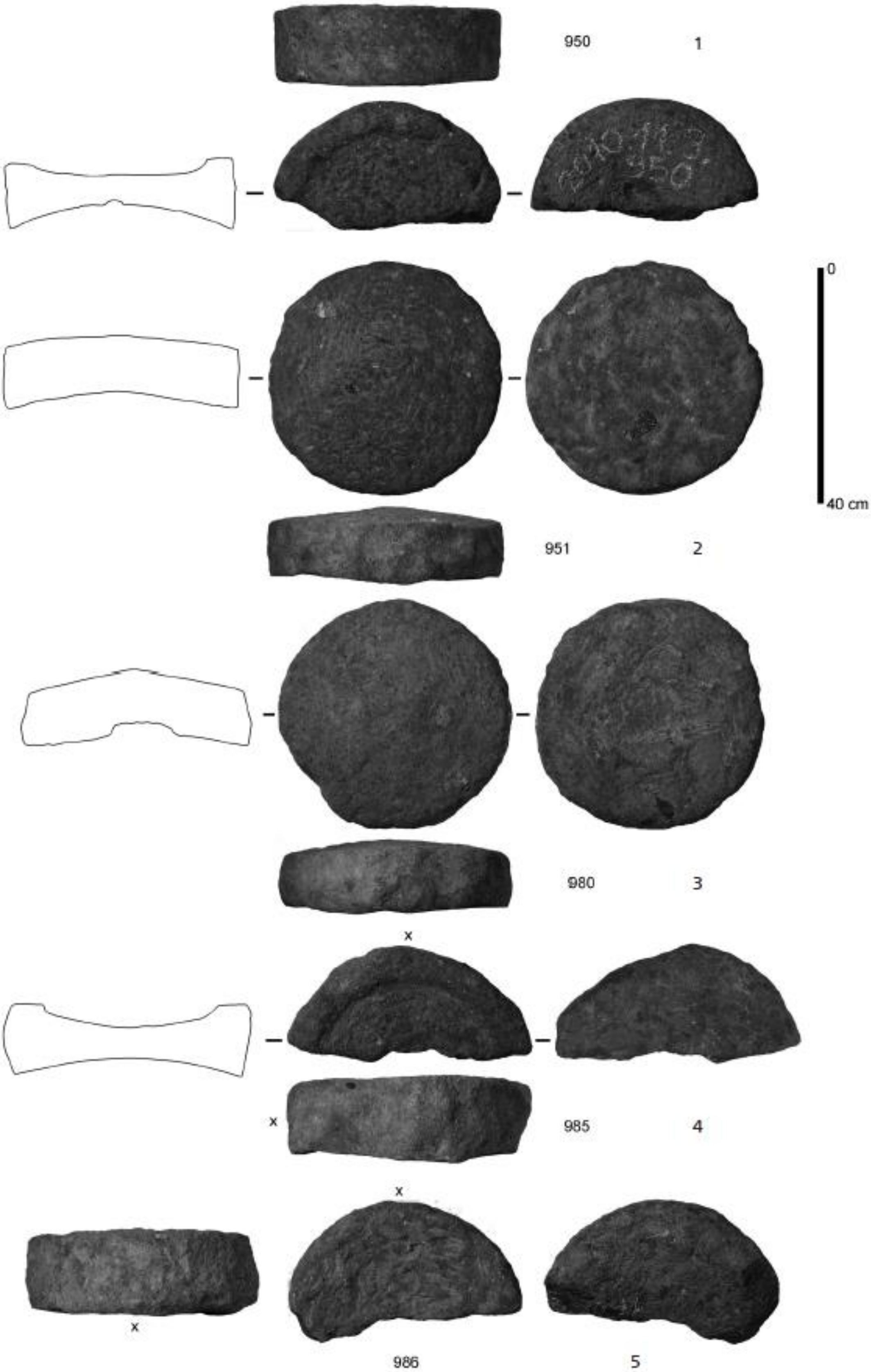


Figure 57- Some of the partially finished querns recovered from the site an 'Im Winkel' (Wenzel, forthcoming).

Table 2- Summary of the quern roughouts recovered from 'Im Winkel'. Data taken from Wenzel (forthcoming).

	Illus Nº Cat Nº	*Upper/Lower Stone?*	*% Complete*	*Thickness (mm)*	*Diameter (mm)*	*Weight (kg)*	*Stage of Finish**
Illustrated	**1. CAT 329**	Lower	100	120	420-450	30	1
	2. CAT 781	Lower	100	100	420	30	1
	3. CAT 782	Undefined	100	120-160	435	40	0
	4. CAT 949	Upper	100	70-90	370	27	2
	5. CAT 950	Upper	40	110-120	390	13	2
	CAT 951	Lower	100	95-105	400	25	1
	CAT 980	Lower	100	90-100	390	23	1
	CAT 985	Upper	40	120	420	12	3
	CAT 986	Undefined	<40	135	400	15	0
Not Illustrated	**CAT 984**	Undefined	50	130-160	450	31	0
	CAT 987	Upper	20	105	390	8	2
	CAT 988	Upper	40	120-145	410	14	1
	CAT 1006	Lower	100	105	400-420	28	3
	CAT 1007	Lower	100	120	370	27	1
	CAT 1152	Lower	100	90-110	430	29	1
	CAT 1153	Upper	50	120-130	440	15	3
	CAT 1187	Undefined	100	110-150	450	37	0
	CAT 1303	Undefined	100	120-160	460	40	0
	CAT 1310	Upper	60	80-145	440	27	1
	CAT 1360	Undefined	100	120-170	390	29	0
	CAT 1361	Undefined	100	120	370-420	24	0
	CAT 1362	Lower	70	170	460	41	1

*Stage 0- Similar state to a roughout from the quarry, as arrived in the workshop.

Stage 1- Shaping has begun to take place, convex or concave depending on the intended quern part.

Stage 2- Addition of annular kerb and/or top surface crosshatched decoration added (top stone only).

Stage 3- Central perforation added/attempted.

Stage 4- Grinding surface dressed.

The precise location for the quern finishing location near 'Im Winkel' is thought to be a grove in the forest approximately 100m south of the *villa* site. At this site, strategic small-scale excavation has revealed several finds dating to the La Tène and Roman era alongside quern roughouts and a large quantity of stone working debris. The lava debris was found in a distinctive layer and is thought to be evidence of an activity area. Magnetometer survey results indicate that this debris is likely to be spread in a wide area around this location (Wenzel, 2011, p. 139), though further excavation would be needed to verify this. Unfortunately, the quern roughouts recovered from this location have not been available for study at this time. It is hoped that further excavations will be planned in the future at this site and the quern roughouts studied in detail to enhance our knowledge of these key research questions.

The Roman Economy and the Role of Stone Within it

The aim of this section is to carry out an in-depth examination of the most significant economic considerations relating to the way in which lava querns and millstones were manufactured, transported, distributed, used, and discarded. This forms a very large part of the wider investigations into the role of imported lava querns in Roman Britain, and it is necessary to consider the most useful theoretical and methodological approaches to examine and interpret the material in question. To achieve this, the chapter will begin with a discussion on the development of economic theory within the disciplines of history and archaeology. This will include the most recent and current approaches being used to investigate material culture of the Roman Empire and a debate of their relative advantages and disadvantages. Distribution analysis and its applications will then be considered, alongside a review of what is currently known of the North Sea trade during the Roman era. These ideas will be applied to what we currently understand of the Roman stone trade as a means of providing a 'backdrop' to the quern industry and the known socio-economic behaviours associated with similar materials. The concluding summary will discuss the general theoretical viewpoints and approach to data analysis that will be utilised within the thesis when tackling economic factors involving lava querns and millstones in Roman Britain. This will be employed to generate an overview of what can already be determined of the economic role of imported lava querns in the province and wider empire, thus creating a theoretical and methodological approach for dealing with the unanswered questions related to this material.

Past Perspectives and Current Approaches

Interest in the ancient world is not a modern phenomenon and British and European identity has often been conflated with that of the Greco-Roman era due to widespread appreciation and replication of the art, literature, and architectural styles of antiquity. In many ways, the perpetuation of the Greek and Roman 'ideal' throughout the 18th into the 20th centuries generated a fascination in the European west for classical studies which, in turn, was used to legitimate claims of a shared developmental history with that of the classical world (Hingley, 2000, p. 11). Renaissance ideology promoted an association between the classical world and the idea of civilisation, social evolution, superiority and colonialism (e.g., Gibbon, 1997), while the socio-economic conditions of the Roman world were often paralleled with that of the contemporary world (e.g., Haverfield, 1912). It was within this context of 'imperial discourse' that classical scholars began to investigate a relationship between the modern and the ancient world in terms of economic and social change (Hingley, 2000, pp. 5-15).

Early theoretical developments exploring such themes predominately focused on the concept of linear development and a socio-economic 'evolution' (Bang, 2008, pp. 17-21), with classical society and economy acting as the precursor to a civilised western world. The general view was that the highly civilised Greco-Roman world expanded and then collapsed dramatically, followed by centuries of economic regression where socio-economic evolution was forced to begin again. Bücher (1893, pp. 85-150), aimed to dismantle this view, and classified the Greco-Roman period as consisting of a household economy, the Middle Ages as a city economy, and the Modern period as a national economy (Bang, 2008, p. 19). Developing this viewpoint, Max Weber (1960, orig. pub. 1924) attempted to understand economies by examining the variability between political, social and production systems within different societies to identify the characteristics of different economies, resulting in the generation of a typological model to contest the previous linear approaches (Bang, 2008, pp. 19-21).

Subsequent developments saw challenges to the idea of economic collapse in the later Roman period, as increasing amounts of archaeological evidence was being used to prove that strong signs of continuation existed in numerous instances (Bang, 2008, p. 22). As part of this changing perspective, Jones (1964) suggested that trade, which was formerly considered as a significant part of the 'civilised and advanced' Roman economy, was not as fundamental as previously thought and had, therefore, a very different role to that within modern economies. As a predominantly agrarian-based economy, Jones suggested that trade was not the most reliable indicator of economic change and should not be used to prove socio-economic decay during the later periods of Roman rule.

Worldwide political events of the middle to latter part of the twentieth century influenced the emergence of new ideas. After the Second World War huge social and economic changes and significant socio-political events altered how people perceived and experienced the world around them, thus guiding new ideas on economic models of development. Many changes in understanding predominantly arose from contemporary philosophical debates surrounding decolonisation, cultural relativism and 'Third-Worldism' (Bang, 2008, pp. 24-25). Thought moved away from the idea of economic homogeneity in the Roman world and began to consider the disparity between different parts of the empire, and how and why these differences may have existed. 'Core and periphery' models began to take precedence over notions of homogenous linear economic development, creating more nuanced examinations of ancient economies where power, autonomy, agency, and opportunity were both variable and significant (for examples, see Gledhill (1978), Kohl (1978), Frankenstein & Rowlands (1978)).

One of the most influential classical scholars belonging to the earliest generation of this movement was Finley (1999, orig. publication 1973) who cemented the concept that 'market central' economic theory was of no use to those investigating the economies of the past. He concluded that the economy was governed by social concerns, such as civic ideology and status, and that the 'rational' economic motivations used to regulate the markets in modern times were not applicable to the Roman era. The predominant theme was that of a 'consumer city' economy (Erdkamp, 2001, pp. 333-334). In this model, the cities of the empire were maintained and grew wealthy primarily through taxation and rent payments generated from agricultural production (Mattingly, 1997, p. 205). Smaller contributions in the form of trade, financial services, manufacture, locally traded crafts, and the production of commoditised goods within the cities were supplied by the socially marginalised: slaves, freedmen, and foreigners. These activities were considered to be beyond the remit of socially acceptable sources of financial gain and had little to offer those who wished to maintain or increase their status; land ownership was more financially and socially sustainable as a means of generating revenue and for establishing recognised elite status (Finley, 1999, pp. 76-78).

This approach heavily influenced successive scholarship (Bang, 2008, pp. 24-25), and has been instrumental in the development of interpretive models such as 'core and periphery'. However, despite influencing a new generation of thought, the economic principles underlying Finley's 'consumer city' paradigm have also been widely contested. The discipline has seen a lack of consensus regarding the fundamental aspects of how we should approach interpretations of the ancient economy; often referred to as the modernist vs primitivist debate. This largely stemmed from opposing notions that the ancient economy was, or was not, related and comparable with modern economic phenomena. Though the discussion has continued in the twenty-first century (see the various papers in Mattingly & Salmon, 2001 for examples of both sides of the debate), the foundation of the dispute occurred when Finley and Bücher's approaches were dismissed as 'primitivist' by supporters of the theoretical viewpoint of those such as Rostovtzeff and Meyer who were strong advocates for the alternative and pre-existing 'modernist' perspective who stressed the modern and fundamentally capitalist nature of the ancient economy (Bang, 1998).

Although modernist arguments saw a revival in the later twentieth century (Bang, 1998; 2008, pp. 28-33), it is generally agreed by many historians and archaeologists that the differences between the ancient past and present are too numerous for comparisons between them to generate much nuanced insight (Bang, 2008, pp. 30-34; Erdkamp, 2014; Velde, 2004). To separate current experience from interpretations of the past, scholars have instead drawn upon very different periods and cultures within human history from those experienced by contemporary society. Examples include the use of Chinese Imperial history (Hopkins, 1980, p. 121; Whittaker, 2004, pp. 191-192; Saller, 1982, pp. 111-116) and Indian and Middle Eastern bazaars (Bang, 2008) as a means for comparison. These studies have not aimed to draw direct comparisons, but instead to investigate the 'otherness' present in the archaeological and historical record and to explore how and why differences or similarities may have occurred.

The use of economic models within the discipline has been heavily criticised by those who believe that archaeologists should test theories, hypotheses and paradigms using data. The consequence has been a body of scholars who insist that ideas such as Finley's 'consumer city' model have greatly simplified the nuance and complexity of ancient economies. However, it must be recognised that simplification is always necessary for communicating, conceptualising, and contextualising what is a multifaceted, intricate, and complex abstract entity. Bang (2008) discusses this idea and also argues that many of the debates regarding Weber and Finley's theory of a consumer city have failed to fully disprove the model or have simply produced variations of the same concept (for example, Horden & Purcell, 2000; Parkins, 1997; Neeson, 1991; Hartmut, 2006).

As yet, there is no consensus on what constitues the most valuable approach and it is the responsibility of the archaeologist to determine how best to interpret the data before them. The most recent approaches to exploring the Roman economy have been largely developed with these ideas in mind and with careful consideration of previous work and current debates. As an alternative to the application of uniform logic to all economic behaviour across time and space, there has instead been a focus on examining what the past is able to reveal in 'evidence led' approaches. Quantification and analysis of the distribution of a variety of material culture types on both regional and national scales is just one way of achieving this. The Oxford Roman Economy Project (OxREP) is an example of an institutionally organised scheme that aims to collate and organise mass data of this kind to correlate distributions and volumes of archaeological material with ancient economic activity. Associated studies have included investigations that aim to quantify the use of coinage in Roman Egypt (Howgego, et al., 2013), the presence of fish salting infrastructure (Wilson, 2007a), the uptake of watermill technology (Wilson, 2007b) and Egyptian evidence for transportation (Adams, 2007).

A large part of the project involves making mass data of this kind more widely available to other researchers via an online database of Roman material culture distribution. By assembling information in this way, it becomes possible to correlate and differentiate between distribution patterns and try to understand how and why these occurred. This can be conducted using a broader perspective from which it becomes possible to incorporate consideration of other types of material culture, different economic behaviours, regional, cultural and social variation, political circumstances and change over time. Realistically, a single dataset would not occur in economic isolation, and interpretations can try to address some of the nuance and complexity that is often absent in investigations involving only one object or material type. Parts of this thesis will form a similar contribution towards a larger cohesive understanding of the Roman economy using distribution data. In turn, certain data and information produced by the Oxford Roman Economics Project can be harnessed and utilised to facilitate understanding of the role of lava querns and millstones in the wider Roman economy. A similar approach has also been adopted by the Roman Rural Settlement Project in terms of the quantification and classification of settlement, environmental and finds data, including the presence or absence of querns and millstones, from Roman rural sites in Britain. Again, the data collated as part of this project can be utilised and applied to this research on lava querns to generate a broader context of understanding concerning the socio-economic significance of these specific objects. How this will be dealt with will be discussed in greater detail in Chapter 3.

Distribution Analysis and Mechanisms of Exchange

The use of distribution analysis to examine ancient economic interactions is one method of investigation that has been used extensively within the discipline and can be helpful in defining the kinds of relations that operated between different groups across space and time. That different forms of economic interaction and mechanisms of distribution existed is a well-established and recognised concept. Polanyi (1968, p. 250) categorised three types of economic transaction: reciprocity, market exchange and redistribution. Reciprocity involves gift or equivalent exchange, used to establish and cement social or political connections as demonstrated by a range of different anthropological studies (Burridge, 1969; Firth, 2012; Malinowski, 1926). As this mechanism of distribution relates strongly to personal connectivity, it is identifiable from the presence of material culture types at locations where there is no specific need or demand. For example, if there are querns of non-local stone types in use in regions where there are local sources of stone and quern production of the same or similar quality/function (see Shaffrey, 2006, p. 69-70). Distribution in these areas would be sporadic and not conform to the ‘normal’ supply and demand networks.

Market exchange tends to be associated with commercial and profit-making situations, where goods are exchanged for coin or items of greater value. With regards to querns, this form of distribution would largely depend on the cost of transporting such large and heavy objects from the source. If a profit were to be made on these goods, the value of their sale could not be exceeded by the cost of their movement. This will be discussed in greater detail in the next section. Finally, redistribution involves a central agent via whom goods are distributed, such as centralised warehouses or state-controlled resources. This is largely controlled by the society and the structure of the community in which it operates and sees a controlling body determining how goods are distributed according to the employment, status, or position of the recipients (Greene, 1986, pp. 46-47). Distributions for this form of economic mechanism would show as clusters and concentrations of the material in specific areas, including the source and centre of redistribution; with none, or low volumes, in others.

Identifying these forms of movement using distribution is, however, not straightforward. Some distribution patterns can be interpreted as having been caused by any of these mechanisms, and it can be difficult to pinpoint how or why particular dispersal patterns may have occurred. It should be acknowledged that all three mechanisms may have been involved in the distribution of any one material culture type to varying degrees, and that these may have also changed over time. This adds a level of complexity to interpretations that can only aim to explore possibilities and variations in economic behaviours. Furthermore, these mechanisms only consider the economic 'needs' of the populace, with little consideration for social or cultural 'wants', or how these factors interact. Although reciprocity involves a more personal means of acquiring material culture, our method for justifying such methods of procurement depends largely on economic rationalistic explanations; if there is no 'need' for an object but it is present, it must have been a gift; though there may have been a social need for the specific object, creating the motivation to obtain it by other means and disrupting the 'rules' regarding how and why goods were distributed.

Interpretation of the demand for goods should be concerned with the balance between 'need' and 'want', as material culture is not simply functional or without meaning. Many objects fulfil both social and functional roles and these both would have been significant factors in terms of demand and distribution. It is not sufficient to explain 'irrational' distribution as being the result of social reciprocal exchange of goods, with 'rational' distributions caused by purely economically motivated exchange or redistribution. The interplay between 'need' and 'want' can greatly disrupt distributions in terms of how we would define 'normal' economic behaviour, and it blurs the distinction of how we identify and differentiate between exchange mechanisms. However, by considering the worldview of participants in the economy and by examining the socio-cultural and functional role of the material culture in question, it is possible to discuss the possible ways that goods and materials moved around the empire, the interactions involved, and the reason for these behaviours. Therefore, the aim for this research will be less focussed on defining the mechanisms in operation, and more on understanding how and why certain distributions of lava querns came about.

As previously discussed, the socio-political and cultural aspects of Roman period life have been considered by some, such as Finley (1999) and Bang (2008), to have played a hugely significant role in the economic life of the empire. Political elites had more social power than entrepreneurial endeavours, while state institutions and imperial administrative personnel also held greater economic agency than the rest of the population. 'Directed trade' was a means by which people of entitlement could move goods around the empire without the need for participation in ordinary systems of exchange. Trading activities subjected merchants to high personal cost and risk, factors that had less significance to those who could, and did, use their status, political or institutional affiliation to avoid usual barriers to exchange. Directed trade, to an extent, falls under the 'redistribution' category of Polanyi's three mechanisms of exchange and is thought to have been one means by which the military community was supplied.

Manufacture or provision of certain items may have been solely for the use of the military and taken directly from the production location to the place of consumption, bypassing other status, cultural or social groups within the chain of supply. Alternatively, provisions could be taken as taxation or rent from those producing goods for commercial reasons. These goods would be removed from the 'market' and transported directly to where needed by the military. However, supply of objects or materials did not necessarily require a central redistribution location to operate. It is thought by Evans (2002, p. 482), based on the supply of wine to military sites, that organisation may have been decentralised and conducted on a more localised scale by the fort quartermasters.

Evidence for this method of exchange already exists in the form of studies that demonstrate or consider the social distribution of material culture using archaeological evidence. One example of this includes the distribution of Black Burnished Ware 2, BB2 (figure 58) (Tyers, 1996b). This type of pottery is densely distributed in the area surrounding locations of manufacture, on Hadrian's Wall and the Antonine Wall, with very little present in other areas of the province. It appears that though the pottery was consumed locally, there may have also been directed trade between the producers of this pottery and military consumers (*cf* Gillam & Greene, 1981). Coarse ware pottery manufactured in Roman Britain did not often travel far from its production location, meaning that the long-distance movement of BB2 to military sites on the frontier is unusual. As the military were able to avoid many of the usual impediments to free movement of goods around the empire, such as taxation, customs duties or transport availability (to be covered in more detail in the following section), the risk or cost

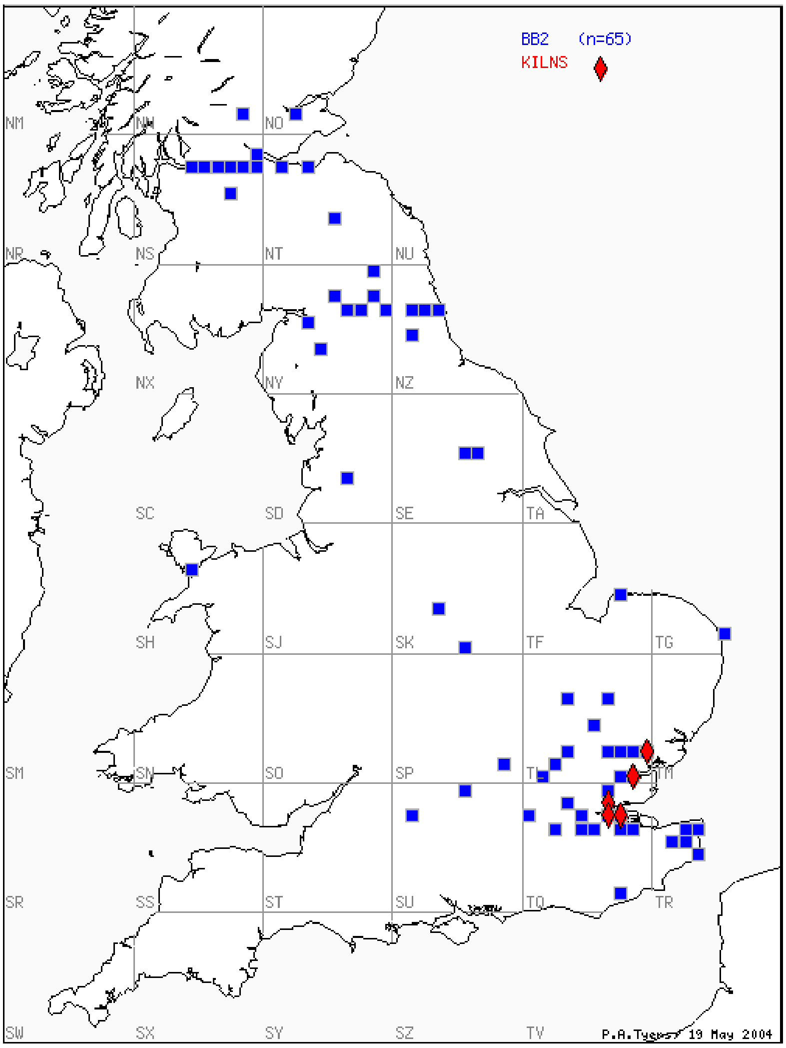


Figure 58- Distribution of BB2 pottery in Roman Britain, including production locations (Tyers, 1996b).

of these ventures would not prevent exchange so long as there was a genuine need or desire for them. Therefore, goods required by the military saw a greater degree of movement across larger distances, ignoring the economic 'rationality' that capitalistic ventures would ordinarily display in distribution patterns.

Unfortunately, evidence of this kind of movement is limited to the types of material that survive well in the archaeological record, ceramics being the most prevalent (e.g., see Tyers (1996e) for distributions of Colchester mortaria). Although pottery is a good archaeological indicator to prove that directed trade existed, the household function of ceramics may not have been the primary reason for their movement, and it is important to recognise what the motivations may have been. Pottery was used to hold, and transport imported food, drink or oil, and can be an indirect form of examining the movement of organic substances, such as amphorae used for wine or olive oil (Peacock & Williams, 1986). Other similar but less archaeologically visible necessities, such as cloth, grain, slaves, and other foodstuffs are highly likely to have been used to supply troops under similar arrangements. For example, environmental evidence of non-locally produced foodstuffs has been used as direct evidence of systems of trade and movement of goods (Bastow 1999), while proxies, such as evidence for pests associated with specific foods (Buckland, 1981), can also benefit analysis. The use of historical written accounts, such as the Vindolanda tablets, can further elaborate on the kinds of goods that were moved through directed trade (for example, Pearce, (2002)). However, a great deal more care is needed for to generate a better understanding of how directed trade operated within the province and the wider empire, and the scale to which it existed. This requires the inclusion of a wider range of different material culture types alongside that of the ceramic evidence. Lava querns and millstones have excellent potential for this kind of investigation.

Transporting Goods

When using distribution analysis to investigate the Roman economy, it is important to consider the role of transportation in these distributions. Local and regional economies were heavily influenced by the types of transport that could be used to reach them as this had implications on travelling times and costs. Unlike modern economies which have largely managed to overcome the obstacles of distant trade and interconnectivity through technological innovation, for ancient economies this was potentially a serious barrier. Geography and topography were critical factors in terms of connectivity, though the significance of a location to state interests was also a considerable element. It is generally agreed that goods, and especially bulky objects, such as querns, must have travelled via water as much as was reasonably possible. Bang (2008, p. 134) argues that transport by water was most important when moving products that were low value and high volume, for example grain, as transport cost is more critical to secure a return of investment. There have been several studies that have quantified the cost of transportation using classical texts, and these indicate that it was nearly always much more economical to move goods via water, and that sea transportation was the cheapest option (e.g. Duncan-Jones, 1977, pp. 366-369; Künow, 1980, pp. 21-23). However, greater risks were involved in transport and travel by sea.

Studies examining the costs of transportation only address the matter in terms of pure economics and it should be acknowledged that human behaviour does not always follow these rules, or that costs were as simple as is often assumed. Travel by the coast or waterways would not always have been feasible or necessarily desirable. The possibility of shipwreck was always a threat, to the extent that seasonal changes in sea conditions and weather would have made some routes unviable at certain times of the year. Added to this was the threat of pirates and being caught-up in warfare (de Souza, 2008; Omerod, 1997). Bekker-Nielsen (1988, p. 149-150) argues that although Romans saw sea travel as an essential task, they also perceived it as a huge risk completed with reluctance amid a fear of drowning and/or loss of cargo.

There are other less visible costs that should be taken into consideration, for example, customs duties or harbour taxes. It has been suggested by Lane (1966) and Steensgard (1981) that the payment of customs duties would have totalled much higher than the costs associated with transportation. Customs officers were known to extort extra fees under the guise of customs duties and such exploitation of traders has been documented in classical texts (Sijpesteijn, 1987, pp. 90-91; Malmendier, 2002, pp. 98-116). However, there was a degree of restraint controlling the extent to which customs officials could manipulate imperial customs systems, as a halt to trading activity was not beneficial to any party. Customs tariffs and exploitation of the profit of merchants had to be reasonable to ensure that trade was worthwhile and continued to operate (Bang, 2008, p. 225). Nonetheless, these added costs to the transportation of goods via the sea should not be overlooked.

Although dated much later than the period being investigated, Roman maritime law from the *Code of Justinian* shows us possibilities in terms of legal recourse relating to the funding of sea trade. Vessels could be contracted out to provide transport for commercial purposes and the prices to do this must have been high, with no guarantee of return or of quick return on investment. Merchants could pay for this using a loan from an underwriter who would, in return, receive a percentage of the profit from sale of the cargo (Anderson, 2009, p. 83). These ‘transmarine’ loans are known to have also existed in a similar form during the Greek period (see Murray (1936) for translations of Demosthenes, Private Orations p. 175-315), and it is likely that comparable systems were enforced throughout the Roman era. The person who took the burden of the risk depended on the type of loan agreed, and there were circumstances whereby either the creditor or the debtor could be fully responsible for the risk of loss (Anderson, 2009, p. 201).

Therefore, there had to be some form of guarantee in the face of uncertain risk to incentivise private investment. The underwriter would wait until they had multiple traders involved, on occasion as many as 50, to form what is known as a *societas*. They would then purchase a small share in the company to spread the risk and form a joint liability for costs with other investors (Anderson, 2009, pp. 196-199). It seems probable that the underwriter would only loan money to those who were guaranteed to pay it back, meaning that only the merchants who had the right connections, status and well-established secure finances could benefit. What is interesting about the system is that a reliance on a much wealthier, higher status individuals was required to pay the initial capital for these journeys. That person was almost always going to profit from their investment, while the risk was largely borne by the merchants. The system incorporates a degree of reliance on the wealthier classes for commercial activity to take place, showing the important role of status within the economy.

Although most of these issues relating to the high-risk venture of sea trade are highly applicable to commercial activity, it is necessary to be remember that commercial ventures were not the only means by which goods were moved around the empire. As previously discussed, distribution of various material culture types shows that ‘directed trade’ can be associated with military and Imperial agendas. In such cases, the physical risks of sea transport were just as high as those for any other voyage: bad weather, poor sea conditions, risk of shipwreck. However, unlike commercial ventures, military and imperial authorities had prime access to what they required to fulfil their needs and greater autonomy with regards to risk management. Further to this, harbour taxes, administration fees, customs dues, the cost of ‘safe passage’ from *pax Romana* and tolls could all be avoided by the military, the political elite or if the correct people were known and the best connections established (Bang, 2008, pp. 202-238). All this created greater ease of goods movement and allowed military needs to be fulfilled via whatever means were deemed to be necessary.

The river system was another important means of water transport and may have been less seasonally constrained than that of other transport methods. Goods could easily be moved downstream using currents, or less easily sailed or dragged upstream using draught animals or people. Low water levels in summer may have been an issue, though this is likely to have been mitigated by using flat-bottomed boats/barges, the type of which is well attested for the Roman period. Dangerously fast currents after periods of flooding in winter, or the freezing of rivers in extreme periods of cold would have presented other problems. However, when compared to temperamental and potentially dangerous sea conditions, and weather sensitive roads throughout winter, river transport may have presented a reduced risk and a more flexible schedule that extended beyond the summer months. The extent to which fluvial transport was utilised in Roman Britain is not fully known, but the creation of artificial waterways, such as the Foss Dyke, indicate that they were significant (Pearson, 2006, pp. 97-98). Modern industrial era changes to river systems and the canalisation or alteration of fluvial routes has complicated the picture in terms of how these may have operated in the past. However, ORBIS (2022), which presents the results of the Stanford Geospatial network model of the Roman World, has produced data relating to the cost and time of river transport for a limited number of fluvial routes in Britain. These can be compared with that of sea and road transport. For example, ORBIS calculates that from Petuaria (Brough-on-Humber) to

Eburacum (York), river transport presented the cheapest route, but use of the road system for this journey was both faster and shorter. The data shows that several different factors may have been involved in the decision-making process with regards to the best transport route to use. This probably depended on the extent to which the movement of goods was time sensitive, such as for perishable goods, and the value or bulkiness of the products being moved.

The alternative to transport by water was to move goods via road. Road travel costs were generally much higher, though the situation would have differed depending on circumstances, and bad weather would have made roads impassable during the winter months. Further to this, the threat of bandits and robbers could potentially jeopardise overland routes (Blumell, 2007). Although the cost of transport should not be overlooked, it would not always have been a barrier to long or short-distance exchange of goods via road, and the significant role of road transport has become increasingly recognised in studies of the Roman economy (see Horden & Purcell, 2000, Chapter 9). Evidence for substantial use of the Roman road network can be related to directed trade arrangements associated with the military. Military site location would have been strategic to local political requirements and not necessarily near transport routes via water. Therefore, transport by road would have been essential in such cases and would not have been an obstacle when connecting with the wider military network.

The many forts situated along Hadrian's Wall that were not connected to navigable river systems demonstrate that the Stanegate and later Military Way must have been fundamental supply routes. The establishment of these, and the many other roads built across the empire, were major construction projects and show a great deal of investment in overland connectivity. Finds and environmental evidence recovered from northern military sites show that there was no lack of access to imported or 'luxury' goods. The Vindolanda tablets especially paint a vivid picture of how military demands for vintage wine and fish sauce were fulfilled to allow 'Roman' standards of living to continue at the frontiers for those who could afford to do so (Bowman, 1974, p. 367). However, the tablets also indicate that there was a dependency on everyday foodstuffs, such as grain, being brought into the site from external sources, suggesting that the movement of goods must have been relatively regular and common. Therefore, it was not only the smaller and high-value goods that were being moved over land for to fulfil military needs; the low value high bulk goods were also being moved in this way.

Road construction projects were often carried out by the military (Xeidakis & Varagouli, 1997; Zaharia, 2013), with significant roads created wide enough for two carts to pass in opposite directions (for example, at Castledykes the road was 5.8m wide (Maxwell, 1976, p. 96), while for the

‘North Cheshire Ridge’ the agger was 18m wide (Jermy, 1990, p. 284). See van Tilburg, 2007, pp. 15-32 for a more detailed view). Such state involvement indicates that roads were a vital part of the provincial infrastructure, creating viable routes for the movement of goods over land, while also improving communication and connectivity. The continuous movement of carts and wagons would also provide the opportunity for the trade or exchange of merchandise, perhaps of a more commercial nature. These could ‘piggyback’ with the military contracted goods along these channels. Consequently, imported goods could find their way to such sites via the same routes but for different economic reasons. The presence of the military, therefore, may have acted as a catalyst for other forms of trade to exist and be economically and/or practically viable. Other landlocked sites that were not primarily military, such as Silchester, also enjoyed a wide range of imported and exotic goods that must have been brought some distance via road. Stone objects, such as imported lava querns, are also prolific and demonstrate that the significance of a particular site within a wider socio-political and economic landscape would also have determined connectivity and access, and that transport by road was not always an impediment in a variety of circumstances and for a range of different reasons.

‘Piggyback’ goods are worthwhile considering in greater detail as this means of movement may have had a significant role to play in a variety of exchange mechanisms. It is important to remember that the presence of a particular type of material at a specific site should not be taken as being evidence of prioritised trade of that item. For example, pottery was transported to Byzantium, not as the primary product, but as a secondary exchange item that travelled with the grain tribute (Thomas, 2014, p. 203). Similarly, the exchange of goods for commercial purposes via water and the movement of private possessions may have also been greatly eased by exploiting military contracts. Tax avoidance and cost reductions would have been some the most beneficial aspects of this system, and it is possible that a large volume of goods was transported in this way (Evans, 2017, p. 159). Distributions of other trade items from the Mayen region, such as ‘Mayenware’ pottery should be examined to identify if other goods were piggybacking with lava querns, or if the lava querns were piggybacking with these items. This should be explored in terms of volumes and locations in Britain. By doing this it could be possible to distinguish between the desired, and possibly contracted items from the commoditised objects. Geographical and social distributions could reveal how the goods are piggybacking. For example, if Mayenware pottery is found with lava querns at a military vicus, it is likely that these were being transported with military contracts but, perhaps, not as contracted goods.

In terms of connectivity, in general distribution patterns of imported goods show that the south, eastern and south-eastern coastal regions of Roman Britain were more engaged in exchange with other parts of the empire, both in range and volume of imported products. For examples, see distributions of pipeclay figurines (Bémont, et al., 1993, fig. 110), Argonne Ware pottery from northern Gaul (Tyers, 1996c) and Hemmoor buckets from the Rhine provinces and Belgica (Morris, 2010, p. 119). These distributions demonstrate the importance of location with regards to the access to imported goods. Although inter-coastal trade was not a new phenomenon, as shown by the distribution in Britain of Pascual 1 amphorae from Iberia prior to AD 43 (Tyers, 1996a) (Figure 59), the scale of imports increased after the Claudian invasion. It is often argued that pre-AD 43 imports in south-eastern Britain were consequences of the invasions by Caesar and Roman occupation of Gaul. Relationships in terms of exchange, trade social and cultural interaction are likely to have intensified because of increased contact with the Roman world, while those in the south and south-east of Britain were much more likely to have such interactions due to proximity. Further to this, the taking of hostages during the Caesarean invasions (Sheldon, 2002, p. 82) and the establishment of client kings could have been the beginnings of small-scale Roman political control over some regions, and these circumstances would also have yielded much greater contact between Rome and Britain prior to colonisation (Creighton, 2000). Therefore, the location of coastal southern Britain relative to the continent had a significant role to play in the distribution of imported goods from both an economic and social perspective. Pre-existing political, trading, and social relationships gave these regions a ‘head-start’ in terms of providing ideal circumstances for the transportation of imported goods via known coastal routes to, possibly, more welcoming coastal regions.

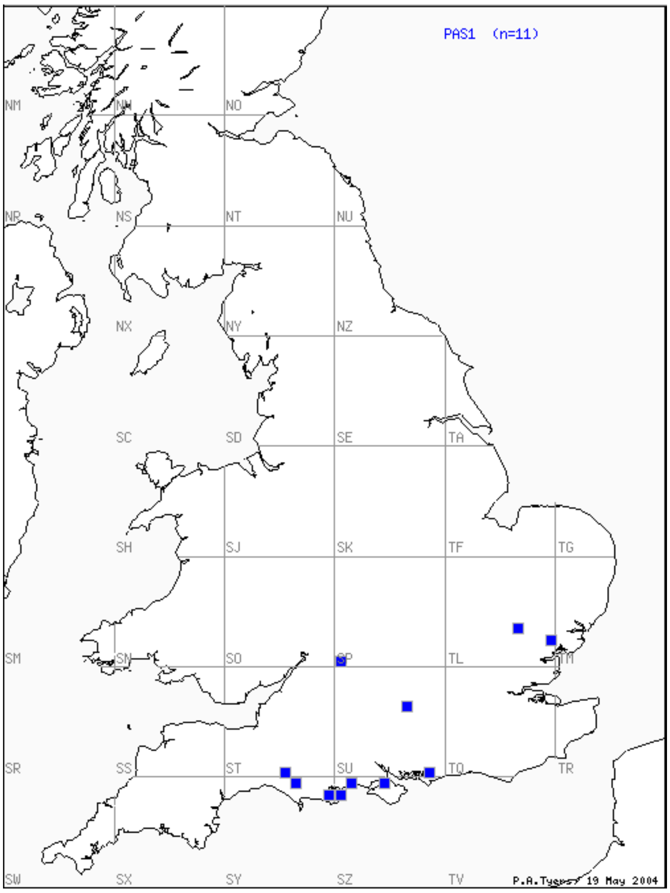


Figure 59- Distribution in Britain of Pascual 1 amphorae from Iberia prior to AD 43 (Tyers, 1996a).

Trade Routes for Imported Goods: North Sea Trade

Many studies that examine distributions of Romano-British material culture tend to focus solely on movement and use of goods within the province; an approach that is highly informative when considering regional identities, and how and why items manufactured in Britain were moved (for example: nail cleaners, (Crummy & Eckardt, 2003), pottery (Tyers, 1996e), copper alloy vessels (Lundock, 2015)). However, lava querns and millstones were imported items and must be considered within a wider context of trade and exchange networks within the empire. Although the provincial distribution will reveal a great deal about how these objects were used and transported, it is vital to explore the routes and methods by which they entered Britain to better interpret such distribution patterns. As these objects are thought to have predominantly been sourced from the Eifel region of the Rhineland, the particulars of the North Sea trade form a vital component to our understanding of how and why these objects found their way to Britain. As the role of lava querns within the North Sea trade is little understood due to the absence of any systematic study of Romano-British distributions, it is important to examine the evidence that we have for the import and export of other goods along these trade routes to understand how lava may fit into the broader picture.

It must be remembered that in terms of exchange with the continent, the movement of goods would have occurred in both directions and journeys were potentially profitable regardless of that direction. From a commercial viewpoint and in terms of economic efficiency relating to market exchange, any saleable or useable cargo would have been preferable to an empty ship. Therefore, the distributions of goods made or grown in Britannia and found on the continent is as valuable as the distributions of imported goods in Roman Britain. Even unladen ships would have required ballast to sail, and material would have travelled across the sea regardless of whether it retained any commercial value or use. Evidence for the use of ballast in the Roman sea trade has been suggested by Peacock *et al.* (2007) using the presence of basalt from Yemen found at the Egyptian Red Sea ports of Berenike and Myos Hormos. The ballast, it is argued, was brought due to ships bearing a lighter cargo of incense on the return journey between Egypt and Yemen (see discussion on Fishbourne Palace, Appendix 3 for mention of ballast at Chichester Harbour).

There is some speculation that Mayen lava, in the form of broken lava querns, travelled to Britain as ballast, though this has not been proven (see discussion of the querns from 1 Poultry, London in Hill & Rowsome (2011)). There are also several publications that state that Mayen lava was brought to Britain unworked and was finished at centralised distribution points, such as London, York, and Colchester. Shipwreck data is often quoted as showing that lava querns were shipped in unfinished form, with evidence of 'roughouts' present in the cargo of sunken ships. It is true that quern roughouts have been found at shipwreck sites, yet none have specifically mentioned Roman period Mayen querns or millstones. One such example involves a wreck dated to 140/150 BC at Isla Pedrosa near Gerona (Catalonia), which was found to contain 59 unfinished sandstone querns (Mangartz, 2008, p. 208). With regards specifically to Mayen lava querns, the Graveney shipwreck at Whistable, Kent (Fenwick, 1978, pp. 131-173) is the most frequently referenced example, though this has been dated to the Medieval period. The evidence at Mayen suggests a different manufacture process, where the finishing stages were carried out away from the quarries at high status villas and in the vicus, meaning that they were likely to have been shipped as finished products. The high level of standardisation is another argument to suggest that centralised production and finishing was occurring at Mayen, as multiple and distant finishing locations would have produced a greater variety of different types and styles. Whether finished or unfinished querns were branded as ballast may have been significant in terms of taxation and harbour fees as this would have affected commercial profitability. Regardless of how they may have been classified, it is more reasonable to consider lava querns and millstones as a combination of saleable ballast and exchangeable goods, as there is no way of fully knowing their role as part of a ship's cargo or the extent to which they were commoditised as potentially taxable imports.

The export of grain to the Rhineland from Britain possibly helps to explain the shipping of lava ballast or finished querns back in the other direction. The invisible nature of grain in the archaeological record makes it difficult to identify whether this may have been the case, and the absence of other recognisably British exported goods of high volume in Germania helps to support such theories. The transport of querns as part of the return journey from the delivery of grain is also speculated for the Mediterranean regions of the empire (Williams-Thorpe, 1988a; Mangartz, 2008, p. 208). Strabo, writing in the pre-conquest period lists other products that have been moved in the opposite direction to the querns, such as cattle hides, hunting dogs, slaves, and metals; none of which are easily identified as British products in German contexts. Similarly, salt and oysters, all of which were produced at scale in Britain, may have been exported to the Rhineland (Morris, 2010, p. 38). Without the physical evidence that goods were exported from Britain to the Rhineland, it becomes difficult to substantiate theories that suggest a market exchange system for querns. This does not mean that such systems of exchange did not exist, but the absence of evidence makes the concept purely speculative and creates difficulties in demonstrating how and why a commercial lava quern trade may have operated. From a more positive perspective, the lack of evidence for imports into the Rhineland does not negate the presence of exports of lava to Britain for military purposes. The transport of querns by the state would not have been governed by the need for profit and considerations of the cost of movement would not have been as significant as that for commercial endeavours.

Regardless of whether there was movement of goods on both directions, it has been established by Morris (2010, pp. 1-2), that there were three different maritime systems that governed the 'catchment areas' for exchange between Britain and the continent during the Roman period (figure 60). The system that relates to lava querns is the 'southern North Sea and eastern Channel system', which incorporates the Rhine delta to the Seine, and covers the south-eastern and eastern coast from Portsmouth to the tip of Scotland at Thurso and the Orkney Islands. The crossing associated with this maritime system was focussed on the Strait of Dover, predominantly determined by geography in terms of shorter crossings and coastal routes (Morris, 2010, p. 151). Although exchange via this route is considered by Morris (2010, p. 1) to be 'coherent', he does acknowledge

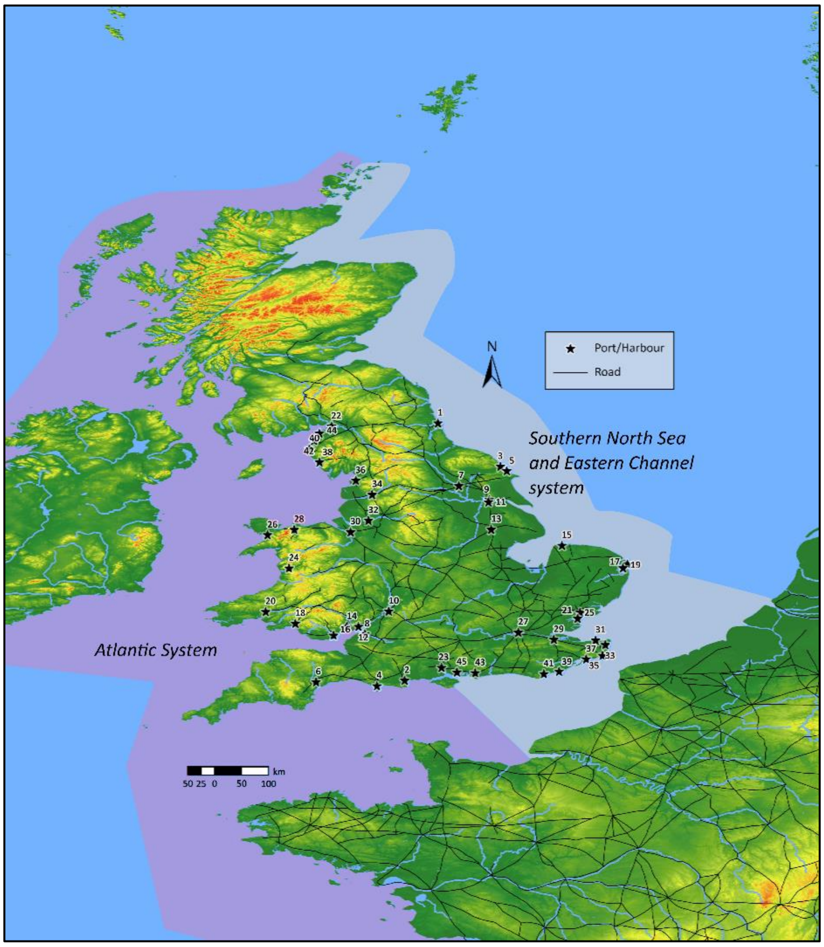


Figure 60- Maritime systems in the North Sea and English Channel (after Morris, 2010, p. 2).

that there is some degree of overlap between the southern North Sea and eastern Channel system and the systems on either side.

In terms of connectivity as part of the southern North Sea system, Morris (2010, pp. 151-154) illustrates that this was not consistent or continuous in all periods of Roman rule and offers detailed discussion of changes seen and possible reasons for these changes. Shifting political and economic circumstances were responsible for periodic changes in the operation of coastal trade systems. As previously discussed, exchange relationships between the south and south-eastern areas of Britain and the continent existed prior to the Claudian invasion, chiefly explained by newly established political affiliations after the invasions of Caesar. These operated via both the Atlantic and the southern North Sea systems. Gallo-Belgic pottery and coins are found in Iron Age contexts of south-eastern areas of Britain alongside evidence of olive oil and wine. The scale of this connectivity increased in the post-conquest period, especially with regards to the southern North Sea system, and saw a huge range of different imported produce enter Britannia, such as wine, fish sauce, samian pottery and lava querns. Any goods assumed to have been sent in the opposite direction are thought to have been largely archaeologically invisible. The movement of goods occurred as a means of fulfilling military supply needs, and because of changing social needs and wants in a 'Romanising' province. Military contracts, state control of goods via taxation and private trade are thought to have been the principal mechanisms of exchange at this time and movement of merchandise was facilitated by the presence of the Roman military in the Rhineland. The presence of the military in both Britannia and Germania would have acted as an economic stimulus, increasing the wealth and consumer culture if the areas in which troops were stationed.

By the late second century and until the mid-third century, exchange along the southern North Sea system decreased dramatically, possibly due the utilisation of goods from more localised sources. Debasement of coinage, changing tastes and the Antonine plague may also have been factors that created the downturn in long-distance trade. From the mid-third century onwards, connectivity becomes more difficult to trace. Coinage is seen to enter the province via the southern North Sea system, which could indicate that there was an increase in the volume of 'invisible' goods, such as grain, being exported from Britain. The third century crisis may have stimulated this change and created a greater dependence on British agricultural production than there had been previously. As soldiers were moved to more critical areas of the continent, reduced troop numbers in Britain may have created a food surplus that needed to be redirected elsewhere in the Empire. Commercial endeavours relating to these changes may have contributed to this influx of cash. Mayenware and Eifelkeramic pottery were also entering Britain from the Rhineland during the third and fourth centuries (Tyers, 1996d), and though the exchange of lava milling tools is more strongly associated with the early Roman period, the possibility for a continuation of lava imports alongside pottery from the Mayen region should be considered.

These conclusions, although plausible, should be tested and explored using the results of this study involving lava querns. These objects were included in Morris' (2011) study of the North Sea trade, though distributions have only included sites in Essex and the north-west Barbaricum (pp. 78 and 122 respectively). More detail is needed to determine whether lava querns and millstones follow the maritime systems outlined by Morris (2011) and whether there are exceptions. How and why these exchanges occurred should be addressed alongside consideration of the changing political, social, and economic circumstances that occurred throughout Roman rule.

The Economy of the Stone Exchange in the Roman Empire

To date there has been no systematic study completed on the role of the lava quern trade in Roman Britain and there is no contemporary written evidence to indicate how it may have functioned. Therefore, in determining the specifics of the lava quern trade in relation to the economy of Roman

Britain and the wider empire, it is worthwhile first considering what is currently known more generally about the stone trade of the period. This will help to identify similarities and variances between different stone types, regions of the empire, chronologies and social groups. Research in this field has predominantly focused on decorative stone, such as marbles and porphyry, that had a high aesthetic value and were often extracted as part of imperial projects (for examples see Ward-Perkins, 1980; Ward-Perkins, 1992; Fischer, 1998; Herz & Wenner, 1981). However, more recently, there has been more of a focus on the broader stone trade with the inclusion of less decorative elements; utilitarian stone objects and building materials (Russell, 2013; Hayward, 2009; Reniere, 2018; Pearson, 2006; Allen, et al., 2003). As many of these stone types are more difficult to provenance due to macroscopic similarity, increasingly sophisticated scientific techniques have been employed to generate a better understanding of distances transported from the source, scale of manufacture, distribution of use, socio-economic value and the role of these materials within the Roman economy (for example, see Reniere (2018), Hayward (2009) and Picavet, et al. (2018)). Furthermore, the inclusion of these more 'mundane' materials has given a much broader sense of the more typical economic behaviours associated with stone extraction and movement, as these are the fabrics that were used in greater bulk than any of the decorative varieties.

It should be acknowledged that the function and significance of stone in the Roman world was much more dominant than it had previously been in many regions. Jongman (2007, p. 609), described building and construction as one of the most important non-agrarian economic activities of pre-industrial societies. Therefore, not only did the demand for good quality stone increase in many territories of the empire, but the value and importance attached to suitable sources was also much higher. In Britain, a province that did not have a strong tradition for building in stone during the Iron Age, this change in demand would have caused fundamental developments in, what had previously been, small-scale exploitation of stone sources. This is not to say that stone was not harnessed prior to the Roman period, or that indigenous Britons were not aware of the best sources for their requirements. Querns, whetstones and other ground stone tools are well-attested in the archaeological record from pre-Roman contexts and building in stone did also occur, especially in upland areas (Young & Simmonds, 1995; Harding, 2009, pp. 90-91). These examples show careful selection and utilisation of stone to suit a variety of purposes, though most were sourced and used locally. Smaller stone objects and tools travelled considerable distances, for example, querns of Lodsworth stone (Peacock, 1987) and Old Red Sandstone (Shaffrey, 2006, pp. 64-65) saw extra-regional distributions. However, most stone was generally used close to the supply, especially if it was required in bulk.

From an economic viewpoint, the scale of exploitation, organisation of labour and transportation of stone must have changed significantly as a result of an increased demand in the Roman period; both in terms of monumental and decorative stone, but also utilitarian stone required for building projects and ground stone tools. However, change was not immediate, did not remain consistent, and there was not necessarily an instant increase in stone exploitation in the post-invasion period. Most areas with a natural geological deficit of good building stone continued to use traditional building materials and methods, and domestic structures were still predominantly built using timber. Public or military buildings were not automatically built using stone in the first instance, though stone building remains tend to survive much better in the archaeological record and can obscure traces of earlier phases of timber construction (Pearson, 2006, pp. 15-16). Vindolanda, for example remained an earth and timber fort until approximately AD 130 (Birley, 2009), while Colchester legionary fortress was initially constructed from timber buildings with ramparts of clay blocks and sand (Crummy, 1977, pp. 65-67). Different areas of the empire required stone for building projects at varying scales and at different times (Daguet-Gagey, 1997; Jouffroy, 1986, pp. 233-237; Russell, 2013, p. 17; Faulkner, 2000), demonstrating that there were different socio-cultural requirements, economic reactions and behaviours associated with the exploitation and use of stone for building.

This variation is also true of different regions within Britain. Regional differences in use and exploitation would depend heavily on the local presence or absence of a good suitable stone supply, and on the local knowledge of such sources. The regions of Iron Age Britain that had a greater tradition of stone use for building tended to be in upland areas and places where good quality and abundant stone was readily available, and these practices continued into the Roman period (Pearson, 2006, p. 15). In other regions, it may have taken a degree of investigation and prospecting for newly arrived officials and settlers to find suitable materials for their needs at a reasonable distance. This may have been an initial barrier to the use of stone in some areas of the province, and there is some evidence to suggest that some of the earliest stone structures relied more heavily on non-local or imported material as part of state-funded or elite building projects. For example, Fishbourne Palace, used a range of ‘exotic’ stone brought from the Pyrenees, Italy and various non-local areas of Britain (Peacock, 1998, p. 1), while the triumphal arch at Richborough was built using Ditrupa limestone and Marquise stone from north-west Gaul alongside marble from the Carrara quarries of northern Italy (Pearson, 2006, p. 24). In the earliest post-conquest period, it is therefore possible that only Imperial and state-funded projects had the means and resources to utilise stone, as it had to be transported from known sources.

A deficit in skilled workers may have provided a similar barrier during the earlier post-conquest era, especially considering that different skills are required to work different types of stone. Some aspects of stonework and quarrying do not necessitate a great level of ability, though there is a degree of knowledge and technical expertise required to manage such operations. Furthermore, for successful stone-working or quarrying to take place, there is a requirement for suitable tools and qualified workers to produce and maintain them (see Blagg (1976) for stonemason tools and Mangartz (2012) for those used in quarrying). More intricate work with decorative stone or the production of more complex items with multiple stages of manufacture would also have required more skilled workers. It is unlikely that such craftspeople and managers were extant within the indigenous populations of the newly conquered province and there would have been a reliance on the skills of the colonists and invading forces. The Temple of Claudius at Colchester built around AD 54, despite being a state funded project with fewer economic barriers, was built using a mixture of septaria, beach flint and mortar, brick and tile (Crummy, 1997, pp. 59-61). The lack of good local stone could justify such a choice of materials, though a delay in the development of quarrying may also have been a factor (Pearson, 2006, p. 21).

The use of foreign craftspeople in early projects utilising stone is almost certain, and it seems that both skills and stone were initially brought from further afield; for example, the style of construction of the Temple of Sulis Minerva at Bath must have relied on the skill and expertise of workers from outside of Britain (Barry, et al., 1990, p. 171), as did the proto-palace at Fishbourne (Blagg, 1980, pp. 28-29) and there is no evidence to suggest that these people remained to train successive stonemasons after these projects were complete. In a province where stone-working was previously virtually absent, these people would have been in great demand and well compensated. Employment opportunities of this kind may have quickly filled with others keen to profit from their craft, and the distinction between military and civilian architecture demonstrates that there must have been further demand for workers that were outside of direct state interest (Blagg, 1976, p. 152). However, the role of the military for providing both a skilled and non-skilled workforce should not be underestimated, and many foreign skilled craftspeople are likely to have been military personnel (Pearson, 2006, p. 21; Hayward, 2009, p. 108). It seems unlikely that any such deficit in the workforce would have remained the case for long, as there would have been many incentives for the military to develop and train the necessary skills that may otherwise have been absent or in short supply (Evans, 1994, pp. 146-147; Blagg, 1980, p. 39). Alternatively, skilled personnel could be relocated and reposted depending on the specific needs of a project and used to guide and train others until the project was at completion (Blagg, 1980, p. 39). However, access to this source of labour and skill would have been heavily restricted to those projects beneficial to the state. The level of control and exploitation of stone sources exerted by military and state powers is evidenced at quarries that are known to have been used to build Hadrian's Wall (Bidwell, 1985, p. 4; Dobson &

Breeze, 2000, pp. 30-31), and also for the construction of the Saxon shore forts (Pearson, 1999, pp. 110-111). These were large-scale projects that were completed in relatively short periods and the requirement for a well-trained, disciplined, skilled workforce could easily have been met using military labour and expertise.

Means, resources and restrictions are very important consideration for all aspects of stone use and exploitation, and it should not be assumed that all people had the same access to materials as others. How exactly quarrying and stone extraction operated in Roman Britain is poorly documented, little understood and widely generalised in terms of what is known from other areas of the empire. There is no reason to suppose that there was always a heavy degree of direct state intervention or monopolisation, and it is probable that many quarries were operated in less controlled conditions than those that generated highly prized marble or porphyry. Unfortunately, as these are the quarries that are more heavily researched and documented, they are often drawn upon to explain all quarrying in the wider empire, even though they are clearly not representative examples. Although there may initially have been a higher level of state regulation in Britain, such as that evidenced at the Purbeck quarries (Pearson, 2006, p. 115), different periods may have seen quarries privately owned, belonging to and managed by the local municipality, managed by the military, or administered on behalf of the Imperial Estate (Pearson, 2006, p. 41).

Quarries from elsewhere in the Empire show a range of different management strategies, some of which may have occurred simultaneously within the same quarry. However, it is difficult to differentiate between what may have been imperial and non-imperial activity and this becomes especially blurred if different systems were operating at the same time (Ward-Perkins, 1980b, p. 37). Nonetheless, there is reason to believe that private profit was potentially made in some of these endeavours. For example, at the quarries of Dokimeion (Turkey), inscribed blocks indicate an accounting system whereby quotas of stone may have been produced to fulfil a contractual obligation in return for a fixed fee or to cover rent payment 'in kind' for use of the quarry (Hirt, 2010, pp. 296-297). In cases involving rent payments, surplus stone may have been available to sell; stone usage in non-state funded projects could be used to argue that these arrangements existed and that not all stone was directed solely for imperial consumption. An example of this can be found at Göktepe, Turkey, where black marble extended beyond imperial use and into other markets and regions outside of the empire (Attanasio, et al., 2009). Contracting work out in this way would have been a productive method by which stone could be quarried for the state with little effort, expense, or input. The labour force, skills necessary and much of the management of the quarry could be supplied by external contracts and overseen by the imperial administration. However, this should not be considered as necessarily providing the potential for entrepreneurs to profit. Contracts and rights to quarry would have been managed and limited by the authorities (Hirt, 2010, pp. 267-271), a process that would have been selective and based on the investment potential of the individual and their status. Possibly the best way to examine quarry ownership and the rights to access potential profits from extraction is to assess where the benefits from such operations were directed. The extent to which areas local to the quarries gained from development and investment can be a good indication of who profited from such enterprises, as can the presence of villa estates.

Another important aspect of quarrying in Roman Britain to consider is the scale of such endeavours. There are no known quarries within Britain that can be considered as comparable to the extent of some of the quarrying operations in other provinces, such as Egypt. Unfortunately, later post-Roman exploitation of good quality stone in Britain has obscured the evidence of Roman activity in many of the areas where larger volumes of stone must have been extracted, such as the Jurassic rocks of Lincolnshire which were widely used (Pearson, 2006, p. 52). Nonetheless, from the scale of quarries currently known, it seems highly likely that most operations would have been irregular, intermittent or isolated to occasions when stone was required for specific needs. Extraction may have occurred on a seasonal basis or have employed a special taskforce to complete the necessary work. The timing of quarrying activities could be arranged to maximise the labour of rural workers, without harming agricultural production. An example of quarrying to demand can be found at Vindolanda; a military graffito or graffiti at the nearby sandstone quarry site at Barcombe Down shows that soldiers were employed to carry out extraction work, while a coin hoard dated up to the Hadrianic period suggests when this took place. Stone from the quarry was used to construct several phases of the stone fort (Bidwell, 1985, p. 4), though from the scale of extraction there is no indication that large volumes of material surplus to requirement was ever removed (Pearson, 2006, p. 52).

Stone artefacts saw wider distributions, as these had more of a commodity value than building stone, though heavier and utilitarian stone objects, such as querns, were still relatively restricted in terms of distance and range of distribution. The reason for wider distributions probably relates to the skill and labour input required to make such items, as opposed to the perceived value of the stone itself. Although stone was a precious resource, it was also abundant in many locations and unless specific qualities or properties were required of the stone, there was little reason to incur the expense and time delay that would have come with the transportation of stone from further afield. This was not the case when it came to imperial or military requirements, as it was possible to bypass some of the most restrictive social and economic hurdles relating to the acquisition and transportation of stone.

The Lava Quern Trade in Continental Europe and Britain

Although this is the first nuanced study on the lava quern trade and how it related to life in Roman Britain, there has been much more work in continental Europe that can be used to assist interpretations within the context of this study. Some of the most extensive research completed so far has included the production stages of the lava quern lifecycle. This is invaluable information, as it highlights ways that lava querns may have played a role in the economy of the Roman world (see previous section on lava sources). Furthermore, social factors relating to extraction and labour organisation can help explore how and why economic conditions and behaviours relating to the lava quern trade may have come about. Provenance analysis has also been used to explore distribution of lava querns sourced from Mayen, and to examine the distinction between distribution regions of Mayen lava and that of similar vesicular lava from the Massive Central area of France. This information will be used to assist interpretations of lava quern distribution in Roman Britain and to understand the reason why certain distributions exist.

Distribution of lava querns and millstones in mainland Europe and provenanced examples in Britain

The development of geochemical analytical methods used to provenance lava has greatly increased the visibility of the Mayen lava quern trade and has helped illustrate the ways in which this may have operated. To date, most provenance work of this kind has involved querns and millstones recovered from contexts on mainland Europe, though an interest in 'Pompeian style' millstones of lava has resulted in a small number of these undergoing analysis in Britain. The most significant research relating to the provenance analysis of Mayen lava was completed by Gluhak & Hofmeister (2011) who determined that there was a 'catchment area' within which querns from the Eifel region were distributed. A 'competing' trade involving querns manufactured from lava sourced in the Massif Central region, France, had a separate distinct distribution that bordered that of the Mayen querns (figure 61). Mayen lava was found in Kempton as the most southern area of distribution, Magdalensberg to the south-east and Mirebeau to the west. Massif Central querns were in the regions of Besançon, Bibracte and Bassou (Gluhak & Hofmeister, 2011, p. 1614). Though this does not provide us with a complete and full picture of distribution and the resolution could be improved, it does provide a new way of considering the specifics of the trade involving Mayen lava and how this related to another similar product. However, as the analysis was completed with the aim of exploring the extent of distribution, there is a lack of information relating to the volumes of Mayen lava at each of the locations. The investigation also does not include querns of other stone types and there should be recognition of the fact that these would also have had a role to play in consumption and distribution.

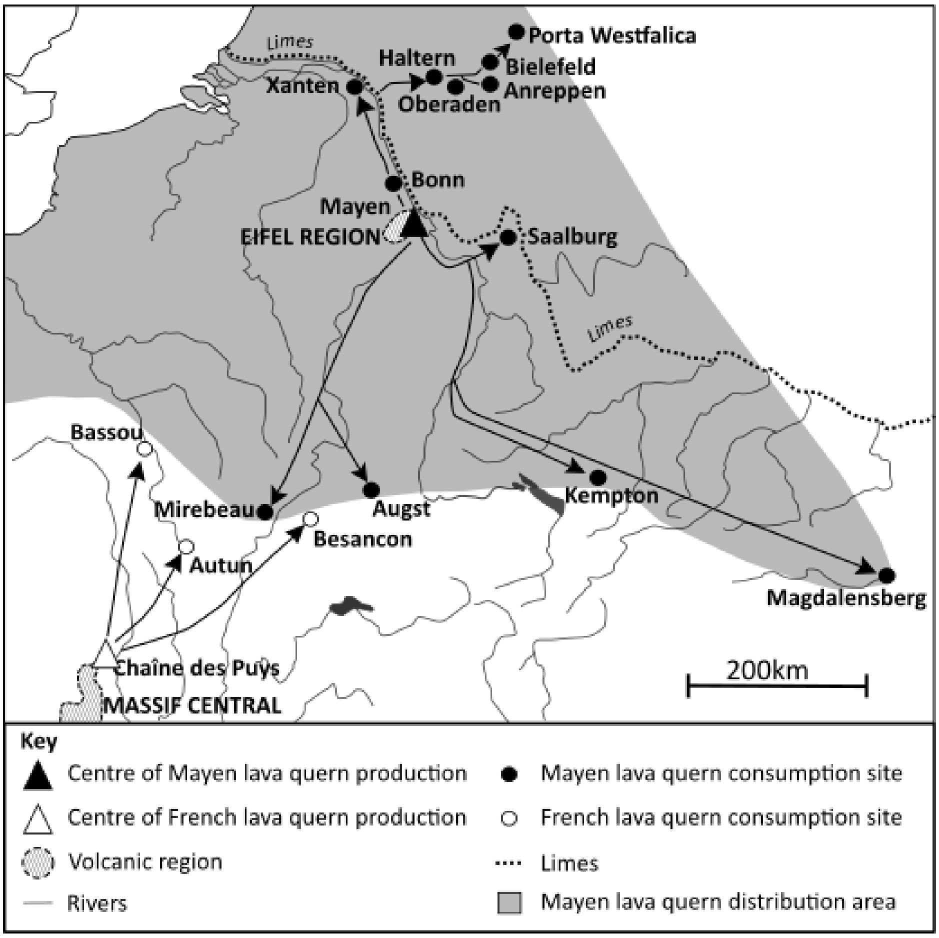


Figure 61- Provenanced lava quern distribution (after Gluhak & Hofmeister, 2011, p. 1617).

A similar study that included Mayen lava querns from Roman northern Gaul by Reniere (2018) reached some similar conclusions to that of Gluhak & Hofmeister (2011) in terms of distribution. It was found that 35 of the 37 querns sampled were of Eifel origin and that the study area was well within the catchment area for the trade. The ratios of querns and millstones from each of the Bellerberg lava flows was very similar to that detailed by Gluhak & Hofmeister, though as previously detailed, the timescale of consumption was different for the Ettringer Lay lava and there could possibly be a pattern in the social distribution of use relating to this timescale (see section on previous research on the geology of Mayen lava). Furthermore, two querns were found to have possibly been of Hochsimmer origin, which is a lava flow located east of the Bellerberg volcano. Although this source has been previously identified as a Roman extraction area, it had been assumed that this had only been used for building stone. That lava querns were exported from previously unknown quarries in the Eifel area demonstrates the importance of completed geochemical analysis and shows that there are other intracies to the trade yet to be identified.

Applying Economic Considerations: Roman Britain and the Lava Quern Trade

The previous summations and discussion have encompassed a good overview of what we currently know and understand of economic theory, the stone trade during the Roman era, lava extraction, quarry management, quern and millstone production and consumption. It is now necessary to consider how this information can be utilised within a socio-economic approach to put the lava trade into some form of economic perspective. It is clear from an examination of the stone trade within the wider empire, that the political elites, military, and imperial administrative powers had a considerable advantage over the rest of the population when it came to economic decisions and agency. In many ways, the empire was very much an economy of status. Trade appears to have been another avenue through which the elite could financially benefit, though only through the risk and hard work of merchants who were at the mercy of the imperial administration. That trade occurred is not under dispute, though the extent to which commercial operations had the ability to expand and grow is debateable, and the importance of commercial exchange in the wider economy should be considered carefully.

In considering the lava quern trade in Roman Britain, it seems highly unlikely, at least in the earlier Roman period, that lava querns were traded in Britain as part of 'free trade' for commercial gain. As the Britons already had querns and knew how to make them, there was no financial advantage in transporting large and bulky items over large distances to what was unlikely to have been a particularly receptive market. However, the yet unproven assumption that the first Mayen lava querns were introduced by the military could still prove valid. The earliest Roman Mayen querns along the *limes* have been recovered from military contexts and show that the military had early access to the lava source, or at least to its products. Therefore, Mayen querns were already established within the military and by AD 43, production of these objects was reliable, large-scale, and accessible. As the military were able to bypass all rules, taxes and restrictions that applied to commercial trade, the influx of lava querns post-invasion is likely to have been initiated by the military. This will be investigated and examined further in this thesis by systematic social distribution analysis to establish whether the earliest uses of lava querns occurred within military contexts.

However, it was not only the military who arrived in Britain after the conquest of AD 43. There would have been an increase in population from other settlers; including military families, administrators, and other colonists. All these people needed to be supplied with the necessities for life, including querns. Although the skills required to produce these more complex tools was clearly present within the population prior to the invasion, as long-lived objects, querns may not have been produced on a large scale. There is no standardisation of Iron Age querns that indicates that organised, high-volume production existed during prior to the Roman era and local types usually had limited distributions. It is also possible that new settlers in the post-conquest period lacked local knowledge with regards to suitable stone sources for the production of querns, and that there was an immediate deficit in the number of available milling tools needed to fulfil the growing population's food processing needs. Although speculative, it is worth considering whether there was an initial requirement to import querns in the form of a finished, or nearly finished product as a result. If this was the case, it is unlikely to have remained a permanent or long-term reason for such imports. Other socio-economic aspects of life in the province may have had more of a role to play in the sustained use of imported lava querns, such as a preference for lava and its associated milling properties.

To explore this idea, the chronological change in lava quern volume and social distribution will be a vital form of analysis. Furthermore, it will be worthwhile to incorporate the presence or absence of indigenous type non-lava querns into any considerations of distribution, as these will show the extent to which these were still being produced and used. The Iron Age quern quarries that were still generating products into the Roman era must also be mapped alongside these distributions to see how relative distance from indigenous quern production areas affected the demand for lava and its subsequent distribution.

Chapter 3. Methodology

Before commencing with the investigation into the social and economic significance of lava querns and millstones in Roman Britain, it is first necessary to set out the theoretical approach that will be undertaken during the study. Initially, this chapter will set out the method for exploring lava milling tools using a socio-economic framework, which will then be followed by a focus on the main theoretical approach, object biography.

A Socio-Economic Approach

The most fundamental aspect of Finley's ideas, and the method used to develop the consumer city model, focused on the socio-political nature of how the economy functioned. This included a consideration of the privilege and value attributed to the political elite over that of entrepreneurs, and the siginificance of elite consumption and the role of slavery and religion (summarised by Bang, 2008, p. 33). Further to this, imperial institutions goverened by politics, such as the military and legislatures, played a vital role in how the economy operated and should be included in such considerations. It is this perspective that I aim to incorporate into the discussion on the lava quern trade[1] in Roman Britain. There are a variety of reasons for tackling the material in this way and though the theoretical basis is largely derived from the works of Finley, none are specifically linked to either primitive or modernist debates. Fundamentally, the intention is to use a socio-economic approach with the justification for doing so supported by the fact that although the economy is an abstract concept, it is a human phenomenon. Economies do not exist in isolation from people, they are created, operated and function because of their actions and intervention, consciously or otherwise. As archaeologists, we examine the human traces of that economic activity and it is this that leads our interpretations. Bang (2008) utilised this approach in his examination of the Roman economy by drawing attention to similaities between the Roman economy and that of large pre-colonial empires, such as The Mughal and Ottoman Empires. Bang presented a strong argument that these economies operated under different conditions to that of modern economies, with a strong emphasis on the importance of social connection, culture, status and politics. The study by Bang (2008) provides an excellent example of how a socio-economic approach is able to interpret literary and archaeological evidence to better understand the roles and relationships of people and objects within ancient economies. Further context on this approach and a more in-depth discussion of the Roman economy can be found in Chapter 2.

[1] The term 'lava quern trade' is defined here as refering more generally to economic activities related to lava extraction, production of lava querns, transportation, distribution and consumption and does not imply a bias towards interpreting economic behaviours specifically related to trade.

The unique context of Roman Britain within the empire is another reason for applying such a method for investigation. As a frontier province, its location at the edge of the Roman world would have affected economic development and engagement with the rest of the empire (Mattingly, 1997, p. 213). The limited classical texts that mention Britain appear to illustrate that it was not considered to be a hub of social significance in the minds of the writers of the period. However, politically and economically it may have played a vital role, evidenced by a strong military presence and the sheer number of military personnel stationed there. The 'frontier-ness' experienced by those living in Britain, and the degree to which this was apparent and realised, would have affected the nature and extent of economic activity in a distinctive way that does not correlate to other parts of Roman territory in the same manner (see Gardner (2017) for detailed discussion of people's experience of frontiers in Roman Britain).

Furthermore, by adding a human element to the taxonomy of economic interactions, reciprocity, redistribution, and exchange (Polanyi, 1977, pp. 35-36), we can acknowledge that these actions cannot have been carried out in a comparable way in all areas of empire spanning huge geographical distances with such a broad social spectrum and variety of lived experiences. Temin (1980) identified these interactions as the result of individual economic behaviours and a consequence of external and internal influences. Personal autonomy and the speed of change in the external environment were distinguished as being the factors that influenced how economic interactions took shape; low personal autonomy and a slower pace of change in the external environment resulted in 'customary' behaviour and reciprocity; when autonomy is neither at a high or low level and there is a fast pace of change, 'command' behaviour was employed, resulting in redistribution economies; high autonomy and a slower pace of change creates 'instrumental' behaviour in the form of exchange, including market exchange. Although this is a simplistic view of human behaviour and was used more as a way of support the argument for a market economy, it does serve to emphasise that each person and institution had a variety of different internal and external factors that would have affected individual or group economic behaviours, and as a result, the wider economy also. To fully explore economic considerations, it is necessary to identify the behaviour present within the context it occurred and consider the circumstances that may have been involved.

The methodology chosen here will investigate relationships between the object (lava querns) and human behaviour: including that of imperial institutions and the state, different socio-economic groups, within different regions and chronological periods. It will be an evidence-based examination of the types of economic activity that were present, while considering how and why they may have existed. The approach does not assume one particular economic paradigm, but will utilise a range of different ideas and economic models to make comparisons and as tools for contextualisation. I will use large-scale data to do this, quantifying the presence absence and volumes of lava querns and millstones from around the province. This will help to determine whether regionality, geographical or topographical location was a factor in the supply and use of lava querns within the province. In terms of Morris's (2010) martime systems of exchange, it will be possible to test the theory that goods were distributed within separate route systems, and that these were economically impacted at different times during Roman rule. Furthermore, I will include an investigation into the presence, absence and volume of lava querns in terms of social distributions and site type to examine how these objects may have 'spread' between supply routes and been moved around Britain under different personal, commercial or political motivations (cf. Eckardt, 2005). Relationships between forts and their hinterlands, between urban centres and rural locations, between ports and surrounding settlements and towns can be visualised using mapping software to contextulise and conceptualise connectivity, including both social and economic interactions.

In terms of food production, distribution analysis has the ability to show us how how food processing activities may have been organised on a regional and provincial scale. The idea that urban centres were reliant on the rural hinterland for food production does not necessarily relate to how food processing was structured. The inter-relationship between food production, processing and consumption could provide interesting insight into the broader workings of the Roman economy and illustrate the role of social status and location in determining a person's involvement in food systems. How lava querns functioned within these systems is also of significance. As imported objects, not all people would have access to, or wanted to have a lava quern. Often classed as being technologically better than querns of indigenous stone types, there is an assumption that these were desireable and more efficient tools. They may have been used by individual familial groups due to being the most preferred or most accessible means of daily food processing, or used in mass food processing activities to supply flour to larger towns, settlement or communites. Therefore, how and why these objects were distributed in particular ways could potentially unveil the relationships that people had with lava querns and how they fit into everyday life for people living in the past.

Evidence for lava querns in Roman Britain may allow for conclusions to be drawn in terms of specific patterns of economic activity or behaviour relating to the material. However, these will not necessarily be representative of the economy of the empire as a whole and the expectation is that a range of different economic behaviours will be present across different regions, social groups and periods. The reason for this relates to the relatively unique fact that stone, in the form of lava querns, was transported over large distances, resulting in widespread distributions in Roman Britain; a situation that is unparalleled on this scale with any other utilitarian stone object. The lava quern will serve to demonstrate the variability that ancient economies had, adding to a growing body of evidence that can be used to create better models and ways of understanding the ancient economy. These different behaviours are just as significant when it comes to understanding how economies operated during the era and will contribute to broader insight into this area of research.

Object Biographies

This study will utilise an object biography, or object lifecycle approach, where the different events in the life of objects, typically from manufacture to discard, can be explored to understand the histories, or biographies, of objects during the various processes that they undergo. As rooted in social anthropology, objects are an important part of the lived experiences of people, they should not be considered as static but rather that different points in their 'lives' need to be examined and understood, looking beyond original purpose and function to how past people may have related to them (Appadurai 1986; Kopytoff 1986). Even though object biography has been dismissed by some as a theoretical approach itself, it is generally agreed that it provides an effective way of thinking about archaeological material culture, so long as its use is theoretically informed (Burström, 2014, pp. 68-70). Object biography may be better defined as an object-based approach that examines synchronic past processes of practice and behaviour relating to those objects (Salisbury & Rebay-Salisbury, 2017, p. 26).

Most studies of that apply the object biography approach consider the different stages of an object's 'journey' alongside associated changes in meaning that are renegotiated from manufacture to deposition (Smith, 2016b). The significance of these journeys is emphasised by Joyce (1999) and Joyce and Gillespie (2015), who discuss the importance of detailing the movements of objects, their circulation, exchange, and itineraries. By doing this, the whereabouts of objects can detail aspects of economic, ritual, or personal exchange (see also (Gallardo, et al., 1999; Hamilakis, 1999; Peers, 1999; Saunders, 1999; Seip, 1999). Mode of exchange and specific origins or movements can help form perspectives relating to the meaning of objects and their value. However, object biographies should not be thought of as a linear concept according to Joy (2009), as there is a tendency to focus on the chronological changes that occur in the biography of material culture, which fails to explore the intricate web of human-object relations that can occur. Gosden and Marshall (1999) maintain that it is these connections that furnish an archaeological object with its meaning, importance, and role in present-day interpretations.

The complexity of such relations has been presented by Swift (2012, p. 202), who examined the reuse or recycling of Roman period bracelets as rings in the Late to Post-Roman era in Britain. This process of repurposing is described as a 'moment of object transformation' creating 'divergent life histories' for objects, extending object use-lives in different forms with different meanings; transcribed, correctly or incorrectly, from the meanings of the objects they have been formed from. In some analyses, biographies of objects post-discard have also been considered, such when they have been identified as heritage objects or reused in a modern-day context (Brien, 2019, pp. 37-38). Similarly, Herva (2005) discussed the concept of 'invisible object afterlives', whereby the breakage and deposition of an object does not necessarily signify the end of its use-life, while Joy (2009) considered the concept of object reincarnation; when objects continue to exist outside of the cultures or civilisations that once understood their meanings and functions and they take on new identities (see also Eckardt & Williams, 2003; MacGregor, 1999).

Practical Aspects of Data Collection, Recording and Analysis

This section aims to set out the more practical aspects of how the dataset will be generated with an overview of the tools, both digital and physical, that were used to collect, store, and analyse the data for this study. This is so future work can replicate and reassess the results and interpretations generated here. Both lava and non-lava milling tools were recorded as part of the research, with lava milling tools recorded as individual objects alongside associated site information, such as location of site, deposition context and context date. Sites where milling tools were present, but none of lava were also recorded. For these sites, the number of other milling tools present were recorded alongside location and site type data. For some case study sites, individual non-lava querns were also recorded, but these were kept separate from the lava dataset. The number of objects recorded, and the method of their recording has been summarised in Chapter 4.

Quantification

Quantifying lava milling tools is a tricky process as soil and deposition conditions can result in extreme fragmentation and degradation of the material. A method for quantification had to be established prior to any recording taking place to ensure consistency in the analysis and results. As with pottery, it is possible to quantify the number of querns using quern edge fragments (Orton, 1989). A larger form of a pottery rim chart can be utilised to determine the percentage of quern present by measuring the proportion of edge remaining, thus allowing for a minimum number of querns to be established. However, as the survival of lava quern fragments is dependent on soil conditions and deposition practice, this does not provide a consistent method of quantification across all sites. The fact that the dataset was generated using a large volume of published information and grey literature reports has also meant that quantification methods have relied heavily on the level of description and quantification used by the stone specialist or person writing the report. It is very rare for querns to be measured in this way, and so this could not be fed into my own database.

During in-person data collection, fragmented milling tools were first checked to see if any could refit. If so, some fragments could be grouped and counted as a single object. Where this was not possible, fragments were grouped and counted by archaeological feature. A similar approach was taken for published material, though there was less opportunity to assess whether fragments would refit. Counting groups of fragments by archaeological feature provided the most consistent approach for quantification, and this was information that was most readily available in quern reports. In the data analysis chapters, small fragments recovered from one feature are referred to as 'lava groups', and these groups are counted individually. The method works under the assumption that most pieces found in the same pit/ditch/dump probably belonged to the same object originally. This is not a perfect system, and there are bound to be some issues relating to the degree of fragmentation and spread of material at any one given site compared to another. However, as the quantification of querns and measurements provided in relation to them is so variable across quern reports, it is not possible to refine the process until issues relating to how fragments are recorded has been dealt with. Specific problems relating to the recording of lava milling tools have been discussed further in Chapter 4, while suggestions for future recording methods have been outlined in Chapter 8.

In-Person Quern Recording

Quern dimensions were measured using rulers and callipers where appropriate, while an enlarged pottery 'rim chart' was utilised to estimate quern diameters for fragmented examples that had an identifiable edge and sufficient curvature for this to be practical. Weights were measured using scales, while a hand lens and torch was employed to examine stone surfaces for signs of working, inscription, or dressing. A quern recording sheet was used to manually record the dimensions and descriptions of the milling tools when this was necessary (see Appendix 4).

Digitising the Data and Completing the Analysis

Data for all milling tools were recorded in an Access database that I designed for this purpose. Each lava milling tool was recorded with a unique catalogue number, which are used as a point of reference throughout this thesis. Where individual non-lava milling tools were recorded for case study sites, these were also given catalogue numbers, but these begin with the prefix 'X' to differentiate them from the lava. Similarly, individual site data corresponds to a unique site code, which for the non-lava sites has been recorded with the prefix 'X'. Data was organised in a way that would enable queries to be made across data tables to answer specific research questions. The database and queries used to generate the data for analysis has been provided alongside the thesis as a digital catalogue. Analysis of the location data was completed using ArcGIS, while statistical analysis was completed using both Excel and Minitab.

Imported Lava Querns and Millstones: Applying an Object Biography Approach

Understanding the lifecycle of a lava quern is one of the objectives for this research and it is, therefore, fundamental that this is reflected in the chosen methodology. An object biography approach has been chosen, which will be applied to describe the life cycle of lava milling tools for relevant case studies in this thesis. These descriptions will be used to identify the potential network of connections that existed between these objects and people living in the Roman world and their subsequent meaning and value. The biography of a lava quern or millstone has been reduced to five main stages of analysis that describe significant and illustrative events or processes in the life cycle that might produce unique indicators or general patterns of evidence for human-object interaction. These comprise manufacture, distribution, primary use, reuse/modification, and deposition. Although this has been presented in what appears to be a reductive linear chronological format, it must be noted that a logical structure for analysis and communication of results must exist to provide a means to contextualise and conceptualise the outcomes. However, it is recognised that stages of the quern or millstone lifecycle can occur out of this implied sequence or happen simultaneously, and that interactions are not constrained by the way that they have been presented in the analysis. For example, a quern stone might be manufactured, exported to Britain, distributed, and then modified prior to its primary use. It could then have undergone various stages of remodification to extent its primary use life prior to deposition. The exact order of each biography 'stage' can be difficult to reconcile with the material evidence, and it is recognised that organising the analysis in stages may result in detailed and complex biographies becoming simplified. Yet this does not restrict the opportunity to understand interactions that may have occurred between people and querns to produce the observed material effects.

Although the focus will predominantly be oriented around the primary use, re-use/modification and deposition stages of a quern's lifecycle, there is also the potential to explore aspects relating to technological innovation, typological changes and production technique or design that relate to the initial manufacture of the object, and to modification. The methodology for examining lava querns and millstones within each of the lifecycle stages will be explored here, providing details for recording methods, observations and measurements that will be taken to investigate specific research questions relating to the material and its interactions with past peoples.

Manufacture

As previously detailed, there is evidence to suggest that querns were finished close to the quarries and the workshops for these finishing locations appear to have been split between two different centres; the *vicus* at Mayen (Mangartz, 2008, pp. 74-75) and *villae* at rural sites surrounding the quarry (Giljohann, et al., 2017, p. 133) (see Chapter 2). The fact that the Mayen querns imported into Britain were highly standardised supports the idea that they were centrally produced. However, it is possible that variations in this specification exist, possibly due to chronological development, or because of the different quern finishing centres in the vicus compared with the *villae*.

Figure 62- Top stones of two lava querns recovered from Vindolanda. Although differences are subtle, the kerbs are slightly different widths, the crosshatch design is inscribed at different angles, and the central eyes may have had different shapes (CAT 0048 right, 0014, left) (permission to use images thanks to Vindolanda Trust)

The clear form of standardisation at Mayen means that differences in finishing are unlikely to be very prominent, though subtle variation may still be visible (figure 62). Although the research did not make it to publication, Chapman (unpublished) identified two basic types of lava quern that were distinguishable by diameter and the way in which the rynd was fitted (see Buckley & Major, 1983 for mention of this work). I will, therefore, examine the diameter of the top and bottom stones, the presence or absence of kerbs and the width of this feature alongside original handle hole and central perforation shape, size and rynd fitting for upper stones. As grinding surfaces get worn and redressed, there will be no advantage to exploring the dressing on grinding surfaces, though the presence or absence and angle of the crosshatch design on upper stones (*catilli*) will be recorded/compared. However, any differences in these features will only be significant if they occur within similar periods. Therefore, the success of this approach will be determined by the sample size and the degree to which secure contextual dating is available. It is also expected that there will be chronological-typological variation, which will be difficult to differentiate from deviations produced by different finishing locations unless very precise dating information is available. Residual finds or recycled querns make this a difficult issue to address, and this will be further complicated by the non-linear nature of technological change (Bijker, 1997, pp. 6-9); if one source of centralised production did not exist, there may have been multiple and various changes to the design and appearance of a lava quern occurring simultaneously in different locations. However, the frequency, chronology, and presence of 'differentness' may give some indication of how the manufacturing industry was organised.

The following areas will form part of the investigation into the Roman period manufacture of lava querns:

- Examination of the dominant features of a lava quern- diameter of top and bottom stone; the presence or absence of kerbs; the width of this feature; original handle hole shape and size; central perforation shape and size; type of rynd fitting for upper stones; the presence or absence and angle of the crosshatch design on upper stones.
- Chronology of typological change.

Distribution

In analysis at an individual site level, small-scale spatial distribution of finds may not present the best way of exploring the identities of those living at particular site, though such studies should not be completely overlooked. These distributions probably relate less to the social practices of the inhabitants, and instead correlate more significantly with the deposition and disposal locations of used querns once they could no longer serve their primary functions. People do not necessarily dispose of their rubbish within the confines of a specific location and disposal can sometimes be far removed from the use and social context to which it may have belonged. Querns cannot be interpreted as being the subject of casual loss in the same way that smaller objects are, and there are many other factors to consider when using spatial data to produce inferences. Any interpretations made must consider the issue of deposition vs. use context, redeposition, reuse and residuality.

Redeposition should be considered when determining chronology; as objects of stone, querns were often moved to places where they could be recycled as bulk building materials. Therefore, at some sites where there is a high volume of this type of reuse, spatial distribution will relate more to locations of refurbishment and occur at specific times when building work was being carried out. Any broken or worn querns that were available at the time of building would have been incorporated into the structures. The dating ranges assigned to such querns will, therefore, be assigned to that phase of building or refurbishment activity, and this tells us that these querns were likely to have been inactive as functional milling tools at this time. To not to have been incorporated into structures in any previous construction phases, the quern was probably still operational. Therefore, it would be logical to assume that most querns were probably last in use during the phase immediately prior to the date of their disposal context. This must be held in mind when interpreting the data; chronological spatial distribution will relate more to a sequence of disposal relating to phases of construction, as opposed to context of use within a precise dating range.

With regards to the national distribution of lava querns, it should be relatively simple to collate spatial data for this level of analysis. Although there is an expectation for there to be a large volume data available to show the presence or absence of lava querns at individual sites, it is predicted that this will not regularly be of a very high level of detail. Excavation reports can often be inconsistent in the types of details that are recorded about these objects, though we can anticipate that there will be, as a minimum, general context information, chronological data and a record of the number of objects recovered. A summary of the site and its findings is also usually involved, allowing for the site type to be determined in terms a broad social context. Although other information will be important for the analysis of other life stages of a lava quern, the basic data that is generally present in most excavation reports will be sufficient to use as part of distribution analysis on a macro-scale.

Therefore, it should be possible to include the whole dataset for this specific topic. The aim is to utilise GIS to produce distribution maps of the Roman Britain to allow for this data to be visualised more easily. This can be manipulated to also incorporate the chronological and social distribution of these objects, whilst still considering the spatial distribution in relation to these variables. Significantly, there will also be a need to include within this data the sites that have querns present, but do not have any made of lava. This will enhance the spatial data and create visible and meaningful distributions in terms of what the data can tell us: How lava querns circulated, when how and for what reasons.

However, it is necessary to recognise that, in terms of military use, the way in which querns were moved around the province throughout their use-lives could have affected their spatial distribution.

If lava querns were part of a century or legion's military equipment, there is a strong possibility that they were taken on campaign and were transported during troop movements. As objects fundamental for the preparation of daily food, querns would have been vitally important for an army on the move. As grain can be stored for much longer than flour without spoiling, there is a tactical advantage to only grinding the necessary amount of grain as and when it is needed. This would help to maintain food provision in foreign territories with poor supply lines. Disposal for the military would occur wherever the quern became unusable as a milling tool. At times when the military were highly mobile, such as the earlier period of Roman Britain, lava querns may have been disposed of in a variety of locations where their use may not have held any long-term meaning. Temporary camps would have seen a high influx of military personnel remaining for a short period of time. Deposition of querns at these locations would not relate to domestic occupation, and it is unlikely that soldiers would form a deep cultural connection to temporary surroundings for ritual deposition to be common. This is in direct contrast to what might be expected of a 'domestic' quern, which would have strong associations with social context, place, and culture.

As an overview, the following aspects of distribution will be examined:

- Volume- Using spatial data on smaller site-based scale where available for case studies and national distribution on the macro scale, volumes will be investigated by location. Volume will be recorded by the number of individual quern stones present. Fragments that are not identifiable as belonging to one object will recorded as a single quern stone if recovered from the same feature. Sites that have querns present but none of lava will be included to show where there is also an absence recorded.
- Chronology- This will be recorded as precisely as possible from the excavation report to allow for the data to be manipulated differently if necessary. For now, date categories will also be allocated as: very early Roman, AD 43-100 (VER); early Roman, AD 43-150 (ER); mid-Roman, AD 151-250 (MR); late Roman, AD 251-410 (LR); very late Roman, AD 351-410 (VLR). Spatial data will be used to see how distributions changed over time. There is some overlap with the categorisation of periods, but the very early and very late Roman groupings are to allow for the differentiation of objects with narrow date ranges from those with wider ranges at the earliest and latest parts of the Roman period. These may help with interpretations relating to the start and end of lava milling tool imports in Roman Britain.
- Site type- Site types will be assigned on a general scale: rural, urban, military, military/urban, unknown, other.

Primary use

Use-wear analysis offers the potential to reveal some details about how people interacted with querns, how their bodies were used as an extension of the milling tools and the human-object relationship. Tools are usually created in a form to suit intended use and the features of its configuration allow us to assume certain movements based on the way the human body is able to engage with it. Experimental work can help to reveal how wear patterns may have been achieved, though it is necessary to appreciate that an object can be used in many different ways and hold multiple meanings or functions. The user of the object does not have to conform to the intentions of the manufacturer and can use it in very different ways from those that it was designed for (Swift, 2017). Furthermore, ethnographic studies show the range of possibilities that exist in terms of the range of movements applied to tool use, and how these can be socially and culturally determined. The same tool can be used very differently by separate groups of people, and it should not be assumed that there is a standard practice that applied across all periods, locations and people.

Figure 63- Using a rotary quern to mill barley in Tibet (anon, 1938). Many traditional societies still use rotary querns to process grain and can give us an impression of how these tasks may have been performed in the past. Here, the quern is rotated using the right hand.

One way of looking at quern usage and use-wear traces is by examining the degree and extent of wear on the grinding surface. This can be correlated with handle placement to appreciate methods by which grain may have been processed. Although lava querns are generally referred to as rotary, it should be remembered that this is a term that we have applied to modern interpretations of the artefact. The name rotary quern implies a particular kind of movement, and it is true that rotary-type querns still in use in traditional societies are largely rotated (figure 63), though this does not necessarily apply to a highly variable past. There is a suggestion that some rotary-type querns in

Britain and Ireland were, in fact, oscillated (Shaffrey, 2019, pp. 394-395; Heslop, 2008, pp. 53-55) (figure 64), and this has also been claimed in association with the use of lava querns (Röder, 1953). Whether a quern was oscillated or rotated, operated using the left or right hand, used in a fixed position, or moved would all affect the traces of wear on the upper and lower stones differently. A summary of these variables and their outcomes on wear traces can be seen in table 3.

Table 3- Summary of wear traces and possible ranges of movements that they might reveal. Note that 'before the handle' refers to wear being clockwise from the location of the handle and 'after the handle' refers to wear being anticlockwise from the handle location.

	Direction of movement	Top stone wear	Bottom stone wear
Unfixed quern position	Oscillated	Both before and after the handle	Even wear
	Rotated both ways	Both before and after the handle	Even wear
	Clockwise rotation	Before the handle	Even wear
	Anticlockwise rotation	After the handle	Even wear
Fixed quern position	Oscillated	Before and after the handle	Uneven with specific heavy area of wear
	Rotated both ways	Both before and after the handle	Uneven with specific heavy area of wear
	Clockwise rotation	Before the handle	Uneven with specific heavy area of wear
	Anticlockwise rotation	After the handle	Uneven with specific heavy area of wear

However, this situation would be further complicated if several people used the same quern on different occasions and did not use the same motion as each other; this is especially the case when thinking about the dominant hand that may have been used to complete the movement as it may not have been consistently rotated in one direction. Similarly, in modern societies that make use of rotary querns, some are operated by two people at the same time and from the same handle. This appears to ensure that there is a continuous speed and force applied during rotation and means that grain can be fed continuously into the quern as it is used. There is also the opportunity to swap between left and right hands whilst maintaining movement and to rest them at intervals. This would mean that the maximum force applied to the bottom stone would occur in two places depending on where the people operating the quern were positioned. Further to this, mending of a quern, such as to replace a worn handle, or modification to enable it to be used differently to its original design, all would have consequences for the wear traces present on a quern stone.

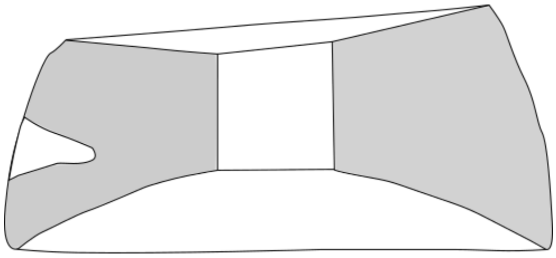


Figure 64- Typical indigenous pre-Roman rotary quern top stone with uneven wear, possibly from oscillating motion. This is often found to occur on both the top and the bottom stones. It is worthwhile to note that the heavy wear has occurred anticlockwise from the handle slot (after Curwen, 1937).

The stones that can reveal the most evidence for method of use will be those that are recovered as pairs, as this allows for the wear traces of both top and bottom stones to be examined in correlation with each other. However, finding paired stones is very unusual and there will rarely be the opportunity to study a sufficient number from any one site. Furthermore, the fragmentary nature of the evidence means that it is difficult to obtain a full picture of wear patterns on any one piece of quern. Therefore, there is no simple systematic approach for examining how querns were used that can be applied to all material remains. I am only able to describe possibilities and probabilities and there is no direct way of proving that wear traces can be attributed to specific intentions or movements. Nonetheless, the lava querns will be examined in an attempt to identify what the wear traces can tell us about their use.

A simpler measure can be taken to examine the extent of use for a lava quern or millstone, and this would be of the thickness of the stone. This must be taken at the edge of the stone to ensure consistency, as different parts of the stone can wear differently, and it is important to be able to compare measurements across datasets. Similarly, upper and lower stones must be compared separately, as the edge is the least worn part of an upper stone, but the most worn for a lower stone. This will provide a means by which the supply and perceived value of lava querns or millstones might be explored between different site types, chronologies or regions.

The final aspect of primary use that is worth considering is the prevalence and type of decoration or personalisation visible on the querns, both lava and non-lava. Although it is not expected that this will be a common feature, it does yield fascinating insight into the meaning of querns to those using them and their role within the household. As lava querns are primarily associated with military use, it will be interesting to see if inscriptions or decorations only directly relate to such uses, or if more personalised identification of these objects also existed. In Collingwood and Wright (1992) 'The Roman Inscriptions of Britain, Vol 2, Fascicule 4', a total of twenty inscribed querns are recorded, twelve of which are made of lava. These were recovered from the following locations: Binchester, Vindolanda, Holt, Carlisle, Balmuildy, Chester, Carvoran, Castleford and Ebchester; all of which housed forts, except Holt, which served as an industrial area where there is strong evidence for a military presence. These inscriptions have been interpreted as being military in nature, even when the letters present cannot be relied on to make such an affirmation. They tend to be read as cohort or century numbers and names, which most identifiably are. Others have been subject to some level of assumption as to their meaning. There is one example, from Carvoran, that appears to be the end of a name in the singular genitive case, and which may relate to personal ownership (Collingwood & Wright, 1992, p. 98). This is a more personal example of a quern inscriptions, and it is expected that there are others that have not been recorded or published. It is possible that 'military' lava querns are more likely to be investigated for the presence of inscriptions, and so these have dominated the published examples.

In summary, the following variables will be examined wherever possible:

- Identify the method of use where lava querns occur in pairs using use-wear analysis. For individual top and bottom stones, explore the possibilities of the range of movements that they may have been subjected to by examining wear traces before or after the handle slot/s.
- Compare the measurements for upper and lower stone thickness between different site types, locations and chronologies.
- Investigate lava quern inscription- the type of inscription and message being conveyed, the placement location of the text on the object and the social context, in terms of site type, in which the quern was deposited.

Re-use/Modification

There are a variety of different ways that querns can be reused and some correlate with the final stages of the quern lifecycle, deposition, and disposal. For example, if a quern is incorporated into a structure, flooring or into earthworks, this can be classified as belonging to both the reuse and final deposition stages. For the purposes of analysis and interpretation, these forms of recycling will be investigated within the discussion on deposition, though the blurring between stages of the biography is recognised here. Instead, reuse will focus on the material signs on querns or millstones themselves for evidence of how they may have been reused. For example, differential wear patterns that indicate that a stone was utilised for sharpening or processing activities different to that of its primary function as a milling tool. This could constitute a purely economic interaction between person and object, with the form of reuse determined by the material properties of the lava. Such reuse may also refer to the socio-cultural meanings associated with the original object or material and its utilitarian function. However, it is more difficult to determine other forms of reuse that may have had more symbolic or non-tangible roles that leave no physical traces. The exploration of reuse is, therefore, limited to that which is identifiable from the evidence present in the archaeological record, though other uses should not be ruled out as having possibly existed.

Therefore, it will be necessary to examine wear traces other than those associated with primary use to see if there is any way of isolating secondary wear from these. As primary use tends to make use of relatively consistent movements to provide the grinding process necessary for quern function, it should be possible to identify secondary use wear. Wear on surfaces other than the grinding surface could also be indicative of alternative use, though these may have occurred while the original function of the quern was being performed, or once the object had ceased to function as a quern. The properties of lava make it an excellent stone type for grinding, processing, or sharpening activities and many wear traces can be attributed to this type of occupation. However, it is difficult to determine precisely what type of pursuit was being undertaken to produce such an effect as any one of these might produce very similar kinds of wear. Nonetheless, if querns are often reused in such a way, it can reveal details relating to the kinds of activities that were taking place at the site and the extent to which they were carried out. An industrial site or area would probably have a much higher level of reuse for this type of endeavour, though this would also be the case for a region that was not well-supplied with local stone suited for such purposes. For example, at Silchester, where there is a deficit of natural stone sources and considerable industrial activity, there is a high level of stone reuse for sharpening and processing; more specifically, roof tiles of Brownstone or Pennant Sandstone (Allen, 2018, pp. 156-158).

Modification, which has been included within the same stage of the object biography as reuse, can occur at any point during the quern or millstone lifecycle, and does not have to conform to any specific sequence. For my purposes here, modification is defined as any alteration to the design, form or specification of the originally manufactured quern or millstone. Due to the high levels of standardisation for lava querns, this may be relatively clear where modification involved alteration to the stone. For millstones, this may be less obvious as there is no one standardised type with which to make comparisons. As there is currently no typology for the British lava querns (see Chapter 2), care must be taken not to confuse different typological characteristics with features related to modification. In most cases, repetition of types would be expected to occur within the wider dataset, allowing for types to be separated from more unique modified examples. It may also be possible to identify a sequence of changes to a quern stone, and isolate changes that must have developed post-manufacture. For example, if the kerb has been cut through to attach a different type of fitting, the fitting must have occurred after the addition of the kerb.

Processes and interactions that involve modification will be considered in terms of the interactions that may have occurred between people and the quern/millstone. Was the modification added to improve the primary use of the milling tool, or to change it completely? Was the aim to extend the use-life associated with the original function? Modification can completely alter the human-object relationship through investment in materials, time, and skill, or through changing function, value or meaning. These ideas will be discussed in relation to the physical evidence observed.

To summarise, the following aspects will be explored in terms of reuse/remodification:

- Traces of wear aside from that on the grinding surface.
- Location and extent of alternate signs of wear- can a specific type of repurposing be identified or speculated?
- Level of reuse in consideration of local geology, location and social context (military, urban, rural etc.)
- Identification of possible signs of modification
- Discussion of the possible reasons for modification according to socio-economic context.

Deposition/Disposal

There are two factors that should be considered when examining final disposal or deposition of lava querns; where they were finally placed (findspot) and the condition of the object when this process occurred. The location of disposal can be investigated on multiple scales at an intra-site level; there is the immediate context of the find, such as within a pit, ditch or wall; the placement within that feature, such as the top or the bottom; and the social context of that feature, such as domestic, ritual or military. There may also be particular types of find associated with the quern; if recovered from a pit, for example, with articulated animal skeletons or complete pots, which might suggest ritual deposition as a possible interpretation. Unfortunately, the precise placement of an object within a feature is rarely recorded. It is, however, sometimes possible to extract this information if the sequence of context data, such as a Harris matrix, is available within the excavation report, and if multiple contexts were recorded for a feature allowing for there to be differentiation between top, middle and bottom. Similarly, consistent recording in terms of social context is not always present, as there is a degree of complexity involved in forming such interpretations. Furthermore, re-deposition and relocation of objects should always be a consideration, both with regards to the physical location of the find as well as its social context. Nonetheless, where possible location and social context will be explored in the hope that the data will reveal whether there are significant patterns to the disposal of these objects.

Reuse of milling tools in construction have been included within the stage categorised as deposition. This includes deposition within walls and foundations, incorporated into earthworks or as paving and flooring, both internal and external. This type of reuse may simply have been the recycling of good quality and readily available stone, as is also seen with other stone types during the Roman era. Whether or not there was a socio-cultural dimension to this particular method of reuse is difficult to determine, though its prevalence and the ways in which stone is incorporated might introduce the probabilities of this having been the case, as has been identified in studies of stone reuse in other periods (Eaton, 2000). Again, context information will hopefully provide some indication of whether this occurred.

The condition of querns when they were deposited or disposed of is also important and can be related to considerations of 'value'. As querns are very unlikely to have been subject to accidental loss, disposal in most cases would have been a deliberate action. The extent of wear can, therefore, reveal perceived value attached to the quern; heavy wear prior to disposal might show great significance attached to its primary role as a grinding tool. This significance can relate to both economic and social value and can help us explore possible supply systems and tool choices made by those who specifically used lava querns to complete milling activities. It is worthwhile to consider whether querns of non-lava types had a similar degree of wear when they were disposed of and what this might tell us about different meanings and values attached to these objects.

Overall, the categories that will be recorded for the benefit of examining deposition will include the following:

- Type of feature quern recovered from- pit, ditch, structural etc.
- Social context from where quern was recovered. This can be examined using deposition context- type of structure or role of associated feature- e.g., boundary, domestic, religious etc.
- Extent of wear of quern on the grinding surface.
- Percentage of quern present.
- Whether any quern pieces refit with others from the same context/area/site.

Chapter 4. Making Flour the German Way: Analysis of Lava Quern and Millstone Use Across the Province

Introduction

Prior to examining the lava quern and millstone data from rural, urban, and military sites, this chapter explores the full dataset to identify province-wide patterns. This can be achieved using the same approach that will be applied in the thematic chapters that follow, by exploring object biography (see Chapter 3). However, as this will be done using the data produced for all sites, individual objects and individual object biographies will not be the focus of this discussion. The aim is to produce a general picture of lava quern and millstone types, distributions, use and discard across the whole province and to scrutinise what this can tell us about life in Roman Britain. One of the current issues relating to the ways that lava milling tools are dealt with in excavation reports is that interpretations relating to quern and millstone use are rarely correlated with data from other sites, which limits our view of lava use on a local, regional, or provincial scale. The data from an individual site needs to be put into context with what is happening elsewhere if we are to identify socio-cultural meaning or economic significance, as this can highlight similarities and differences between varying site types and geographical locations. This chapter will not only provide a means of comparison for the thematically generated datasets in this thesis, but it will also provide the data that will allow future assemblages to be subjected to similar comparisons to produce more nuanced interpretations of lava milling tool use in the province.

The Dataset

The full dataset consists of 2,707 lava milling tools from 564 sites in Roman Britain. A total of 1192 objects were identified as quern stones; 299 of which were lower or probable lower stones, 551 were upper or probable upper stones and 342 unidentified. Millstone numbers were significantly lower at 79; upper or probable upper stones totalled 35, with 16 lower stones, and 28 unidentified (figure 65 and table 4). Added to this, 601 sites were recorded where milling tools were present, but none of lava, making a total of 1,165 sites in the dataset.

Data was collated from a variety of sources:

- In-person data collection using archived material was conducted for the bulk of the case studies, including 18 sites: Chichester and 11 sites in its hinterland, Verulamium, Vindolanda, Corbridge, Housesteads, Binchester and Chesters. The querns recorded for these sites comprise 301 lava and 127 non-lava examples.

- Excavation monographs, county journals, and 'grey literature' reports from developer funded excavations, to include 910 sites. Much of this data was compiled with the help of the Rural Settlement of Roman Britain database.
- Data extracted from Ruth Shaffrey's personal database collated over her career in commercial and research archaeology. Of the full dataset, 232 sites were from this database.
- A small volume of data was taken from online collections from museum archives with detailed records and images of their querns. Five sites were recorded this way.
- Data was recorded, stored and analysed using an Access database whereby all lava milling tools were recorded using unique catalogue numbers. These have been used throughout the thesis as a way of cross-referencing the dataset.

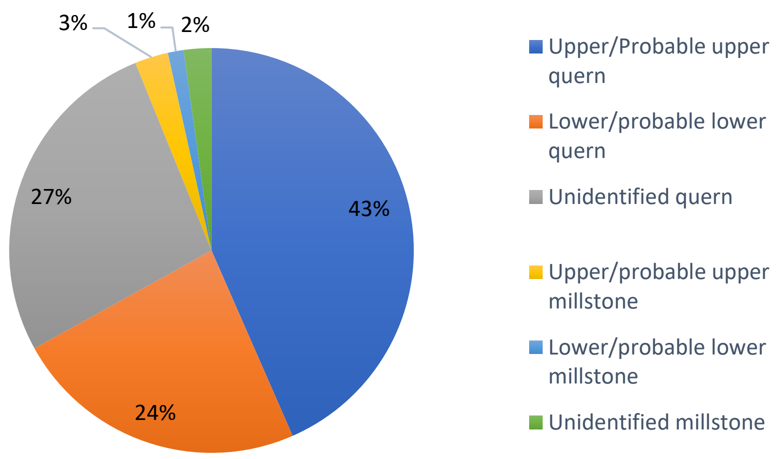


Figure 65- Chart showing the breakdown of querns, millstones, and unidentified lava in the assemblage according to whether they are upper or lower stones (T= 1271).

Table 4- Data for figure 65, showing the breakdown of querns, millstones and unidentified lava in the assemblage according to whether they are upper or lower stones

Type of stone	Nº Examples
Upper/Probable upper quern	552
Lower/probable lower quern	299
Unidentified quern	342
Upper/probable upper millstone	34
Lower/probable lower millstone	16
Unidentified millstone	28
TOTAL	***2171***

As with all large datasets, the way that this dataset has been compiled must be understood prior to making interpretations using it. One of the most significant issues relates to the regional density of information collected. The regions shown here are fairly arbitrary and are used here to highlight the potential issues in the data. As a large part of the data was compiled using Ruth Shaffrey's database, milling tools from the south-east of England have been extensively recorded as this is the region where she predominantly works. This detail is not replicated in other parts of Britain and the sparsity of querns in other regions (figure 66) cannot be taken to signify a lesser presence of milling tools overall. Further to this, as developer funded excavation reports were used to form the bulk of the dataset, areas of more intensive construction and development are more heavily represented in the data, which includes much of the south of Britain and London. Access to excavation data has also created some challenges in terms of regional representation. As much of the data collection took place during Covid lockdowns, some less accessible county journals have not been checked, which has led to sparse data in those counties. Similarly, stone type for querns is not always recorded and lava is not always quantified. It was found that the method of recording and the detail presented often related to the commercial unit completing the work, which created further regional bias in terms of where usable data existed. This has been mitigated as much as possible by recording sites with milling tools, but none of lava, as this highlights where gaps in the data exist.

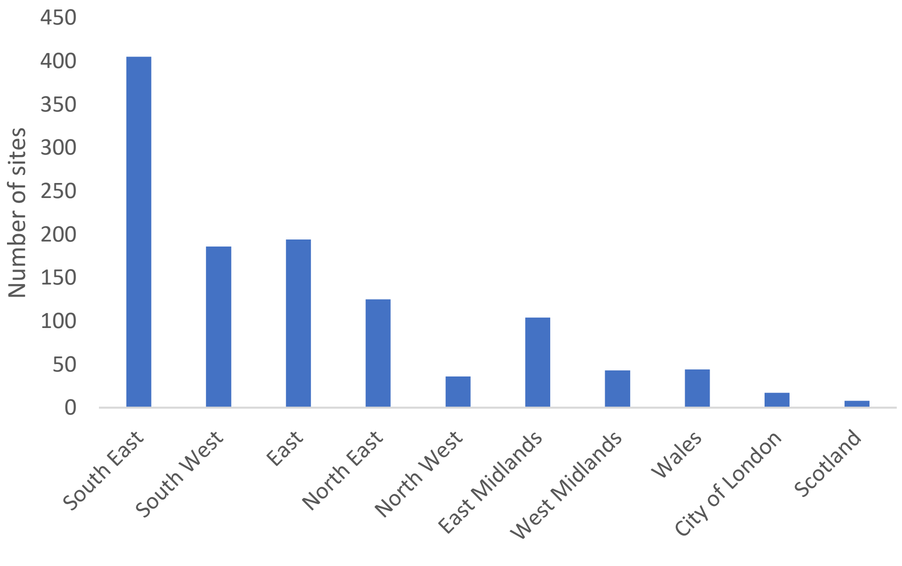


Figure 66- Chart showing the number of sites recorded within each region in Britain (T=1165).

The dominance of rural sites in the dataset is a similar issue when considering the way that data was collated. Although rural sites are prevalent across Roman Britain, these have received more attention in the data collection phases of this research than urban or military sites. This is simply due to the availability of data during lockdowns and the online accessibility of rural data due to the work of the Rural Settlement of Roman Britain project. At a time when museum, archive and even library visits were not possible, data collection was able to proceed for rural sites, but this has created a possible bias to the dataset. Of the 1165 site recorded, 942 were identified as rural sites, 78 as urban, 73 as military, 6 as military/urban, 3 as other and 63 as unknown (figure 67 and table 5). Even post-lockdown, urban and military sites have not been examined in the same level of detail as the rural sites in the database. For example, it was not possible to get timely access to the collections at Colchester and London, where the most prevalent use of lava is likely to have occurred. These are very significant locations that should form the focus of any future work into the urban use of lava milling tools.

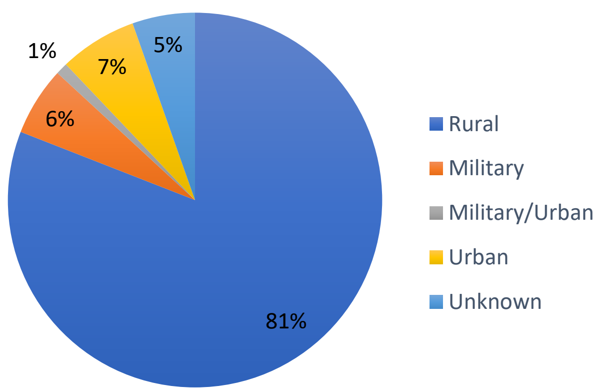


Figure 67- Chart showing the breakdown of the site types included within the dataset (T= 1167).

Table 5- Data for figure 67, the breakdown of the site types included within the dataset.

Site type	***Nº included in dataset***
Rural	942
Military	69
Military/Urban	12
Urban	78
Other	3
Unknown	63
Total	1167

The final potential problem in creating the dataset has involved the quantification of lava, which is rarely conducted systematically. It is likely that some error has been introduced to the data and that this will be skewed to show a greater prevalence of lava at sites where fragmentation was common, or reuse that involved spreading stone across multiple contexts. More detail pertaining to this issue has been discussed in the methodology (Chapter 3), but it is necessary to mention here that the highest incidents of fragmentation and reuse appear to have occurred in the east and south-eastern parts of Britain. Bearing all these considerations in mind, the next section will examine the data in five steps: manufacture, distribution, primary use/reuse and deposition.

Manufacture

Elements of manufacture that can be explored for such a large dataset must be those that are regularly captured in excavation reports. Although some inaccuracies and inconsistencies must be expected when comparing data that has been gathered from numerous sources, the volume of data involved should mitigate much of this. Features that have been included that relate to manufacture include:

- Diameter of the stone,
- Width of kerb,
- Handle types,
- Rynd chase types.

It has not been possible to investigate all the common features of a lava quern, such as central hole shape and size. This is because there are many typical characteristics of a quern that can be removed due to wear, reuse or from mending and this has been observed with several examples that are likely to have begun their lives as standardised lava querns. Good examples of this can be found in the Vindolanda assemblage (Chapter 7). These altered features do not relate to actual typological characteristics or the outputs of the manufacture process. Care has been taken, therefore, to select common features that are less likely to have been altered and that can be compared easily.

Diameter of Stone

The diameter of the stone was the most common feature of a lava milling tool to be recorded across the dataset, with 607 objects complete enough for this measurement to be taken. The smallest was a miniature quern from the A14 road scheme excavations in Cambridgeshire measuring 210mm (CAT 1483), while the largest was a millstone measuring 910mm from Syndale Bottom in Kent (CAT 0856). The range of sizes represented is, therefore, broad. However, most of the data show clear standardisation and very similar sizes. The few examples that deviate from this standardisation stand out clearly from the bulk of the data (figure 68). At the upper end of the scale, this occurs at 500mm, which provides the clearest point where a division can be draw between hand operated querns and mechanically driven millstones. There is more ambiguity for those milling tools with diameters below 500mm that are larger than the standard quern. These can only be defined as millstones or quern stones if evidence relating to the mode of operation exists on the stone (Shaffrey, 2015, pp. 73-78).

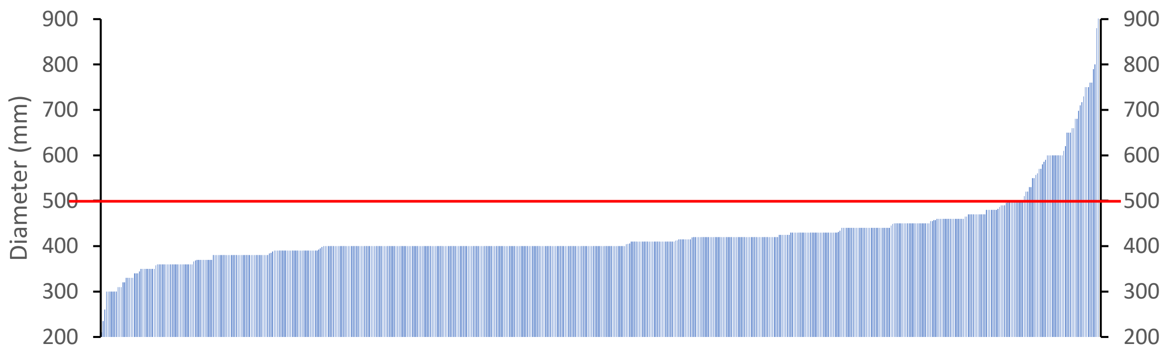


Figure 68- Chart showing the diameters for all lava milling tools for which this measurement has been taken, with a red line marking where the difference between a quern and a millstone is most clear. (T= 607).

If probable millstones are removed from the chart, we can leave known quern stones and the more ambiguous milling tools that have not been identified as either a quern or millstone (figure 69). Again, this emphasises the extent of standardisation that is present in lava querns from Romano-British contexts, with 50% of all querns and unidentified milling tools falling into a diameter range of 400-420mm, shown within the red lines on the chart. Any lava milling tools that fall within this range can confidently be referred to as a quern. Those in the upper and lower 25th percentiles for diameter sizes and appearing to the right of the rightmost red line and to the left of the leftmost red line, show less conformity to this standard. Though some room must be given for inaccurate and estimated measurements, it is likely that those in the more extreme ends of these groups were specialist tools. Some of the larger examples may have been smaller millstones or larger sized querns, possibly made to order for specific requirements. The possibility for some of these to be lava milling tools not produced in the Mayen region must also be considered. Miniature querns or millstones (see Chapter 6) may have also been manufactured specially or created from waste

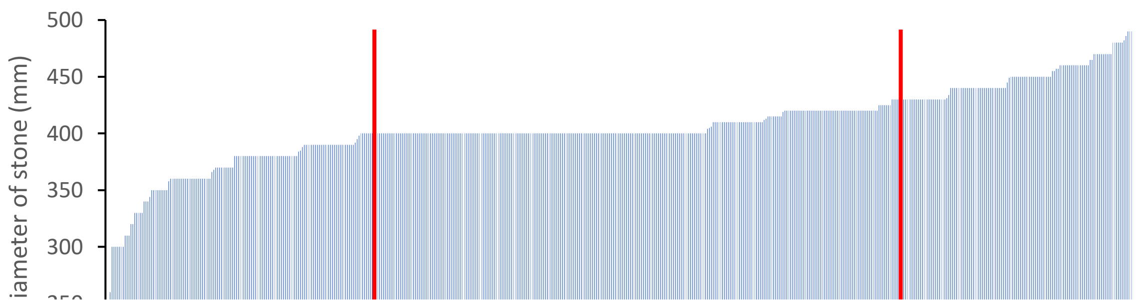


Figure 69- Chart showing the diameters of all lava querns and unidentified milling tools from Britain. The 25th and 75th percentiles have been indicated with red lines to demonstrate the extent of standardisation in the dataset (T= 553).

material in Britain to fulfil requirements that were not met by the quern producers in Mayen, or by other lava milling tool production areas that may have been supplying Britain.

Width of Kerb

The raised annular kerb that is found on the top surface of upper lava querns and some lava millstones manufactured at the Mayen quarries (see Chapter 2) is a feature that is often remarked upon and measured in excavation reports. With the high level of standardisation for lava querns, it would be expected to be relatively consistent in its dimensions. However, my observations have shown that the kerb is sometimes very prominent, and sometimes almost indistinguishable, with a variable width (figure 70). The role of the kerb appears to have been to strengthen the sides of the stone where the elbow handle socket was fitted. By this logic, one would expect for there to be a correlation between the width of the kerb and the size of the stone, but no such relationship can be discerned from the data (figure 71).

Any relationship between the handle fitting and the kerb width is difficult to identify as evidence for handles is often lacking. From the typology by Röder (1955), kerbs were added to querns manufactured at Mayen throughout the Roman era despite changes in the way that the handle was fitted. Later lava quern types did not actually require the extra strength that a kerb would have offered due to these changes, but kerbs continued to persist as a feature (Chapter 2). It is possible that as the related purpose of the kerb ceased, its presence become more of a suggestion than having any real functional value. In the British assemblage, only elbow socket handle fittings have been observed, and this has led to the assumption that this may have been the only type imported into Britain. However, later types with other handle fittings may also have entered the province, which could explain the variation seen in the kerb data and the observed differences in how pronounced kerbs appear. Preliminary examination of the data does not support a chronological change in kerb width (figure 72), but chronological information for querns is rarely detailed enough for this type of investigation. It is worth noting that the number of querns that displayed the presence of a kerb does appear to have decreased over time. This may be an issue of preservation as late Roman querns tend to be more fragmented, yet it is a pattern that should be explored further.

Another possibility might relate to the quarry of manufacture, as there were three sources of lava that were exploited to produce Mayen querns. Each of these quarries may have produced querns that, though generally standardised, had slight differences. Any correlation would have to be investigated through systematic geochemical analysis and comparison with different features alongside consideration of chronological change. Future measurements of the kerb should be completed as part of standard quern recording practice to help generate a more refined typology of Romano-British lava quern stones.

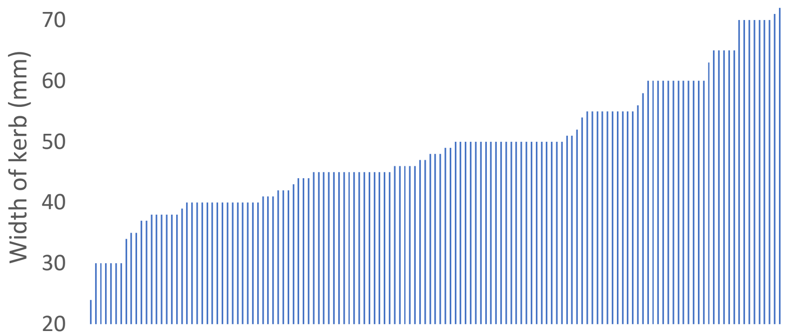


Figure 70- Chart showing the variation of kerb widths for all lava milling tools from Roman Britain (T= 137).

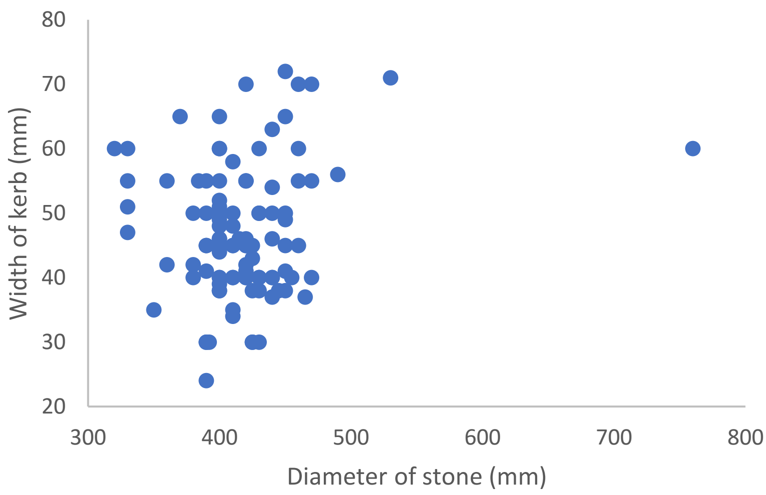
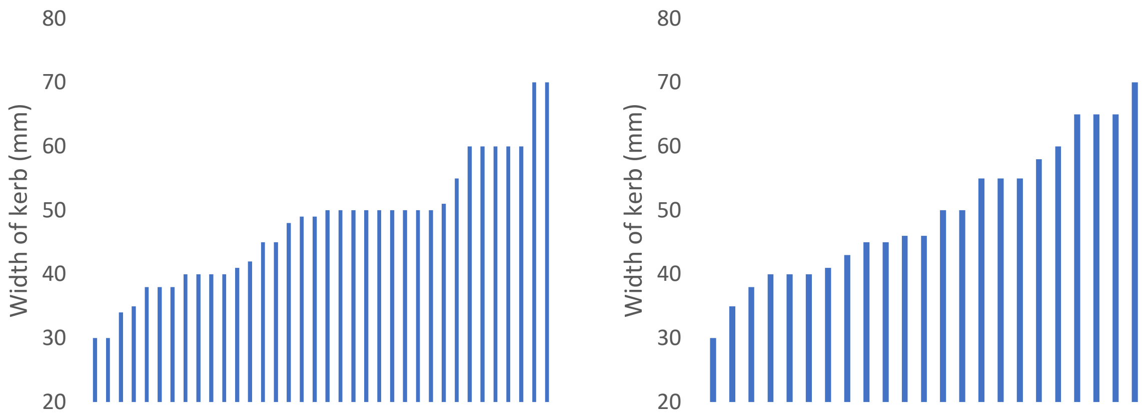


Figure 71- Chart showing the relationship between lava milling tool diameter and kerb width for the British assemblage (T= 103).



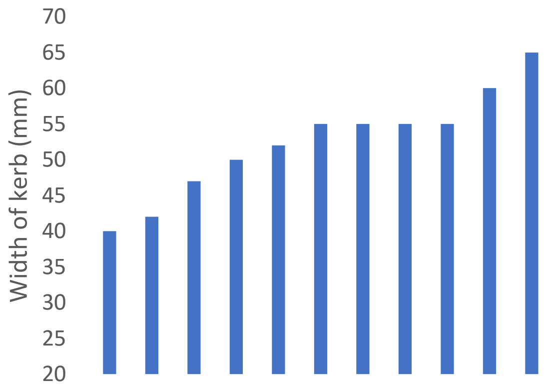


Figure 72- Top left, kerb with from lava milling tools of early Roman date (t= 36). Top right, kerb width from lava milling tools of mid-Roman date (t= 23). Bottom left, kerb widths for lava milling tools of late Roman date (T= 11).

Handle Fittings

Handle fittings only exist on milling tools that were manufactured or adjusted to be operated by hand. Within the dataset they are relatively rare as they form the most vulnerable part of the stone where breakage is most likely to occur. Breakage across the handle socket makes it less visible and harder to define meaning that this feature is less likely to be identified. Sites that had good levels of lava preservation were more likely to reveal handle features and this is likely to have skewed the data considerably as conditions at the northern military sites, especially those at Hadrian's Wall have yielded many well-preserved lava querns that can reveal handle fittings. Sites in the south, especially in and around Kent and Essex, generally produced only poorly preserved fragmented lava. This might relate to a higher incidence of recycling for the lead or iron used for the handle fittings, as fragmentation would provide one way of accessing these fittings. In total, 100 lava querns were recorded that had evidence for a handle fitting, and these were derived from only 33 sites. In particular, Vindolanda yielded 14 examples and the site at 1 Poultry, London produced 34. This presents some obvious problems, especially with regards to the Poultry querns, which are likely to have all been discarded within a short period of time. There is, therefore, much less variety in the sources of the data than is desirable and this must be considered when interpreting the results.

Overall, elbow type handle fittings were the most dominant type, with very few examples of other varieties (figure 73). One possible other type is that of an ‘iron band’, which was observed on two lava querns (CAT 2284, 0032), and were probably employed on three others that lack any evidence for a handle fitting, despite being complete stones and showing signs of wear CAT 0002, 2175, 2179. A further example from Usk (CAT 2347) is described as having traces of iron residue in a band around the circumference of the stone, which may also suggest such a fitting (Welfare & Campbell, 1995). Unfortunately, there is no way of proving that an iron band was used to fix a handle in all cases other than those with the iron band remaining *in-situ* (figure 74), but their use seems likely. A reconstructed non-lava quern in the Clayton Collection at Chesters Roman Fort has been put together to show this format of handle fitting, though how the decision was made to present it in this form should be thoroughly explored to examine the extent to which this reproduction is based on evidence. An iron band was also found adhered to the circumferences of a lava millstone from the Hornet 1994-6 excavations in Chichester (CAT 2511), yet this example cannot be defined as necessarily Roman in date (see Appendix 3). It is possible to argue that the presence of an iron band is not related to mending the stone, which could provide one interpretation. The absence of other handle fittings on the complete querns in this group suggest that the iron band fitting was intended at the point of manufacture.

The two lateral handles were both present on querns retrieved from 1 Poultry (CAT 1919 and 1926). The rest of the large assemblage from this site only had elbow handles fittings, and the lateral handle querns can be dated to the same phase of deposition as these. From this, there is a suggestion that different types were in circulation at the same time, which would help to explain the variation seen in other features, such as the kerbs, that do not currently seem to correlate with chronological change. The strangest examples from across the assemblage include three complete upper stones that lacked any sign of a handle at all, with no evidence for how they may have been rotated (CAT 0002, 2179, 2300), all three of which were recovered from northern military sites. These will be discussed in more detail in Chapter 7, but it should be noted here that all three showed traces of wear. ‘Other’ handle types comprise objects where a handle is mentioned in the literature, but is not described or illustrated (CAT 2417, 0414, 0101).

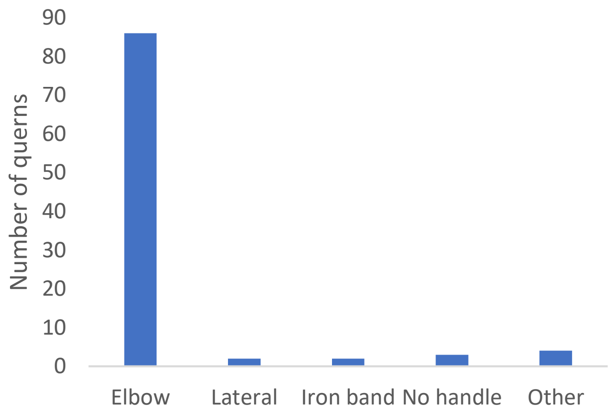


Figure 73- Presentation of different handle types in the whole British lava assemblage (T= 100).

Figure 74- Fragments of CAT 0032 showing the pieces of iron band adhered to the outer circumference.

Rynd Chase Types

As with other mechanical features of a lava quern or millstone, the rynd chase (see Chapter 2) tends to be worn away or broken to the extent that it becomes unidentifiable. Even if evidence of one is present, the grinding surface tends to have been worn right through to the rynd chase, making it impossible to determine if the rynd was fitted in an over or underdrift fashion (figure 75). In addition, particularly in comparison with the data collected for handle sockets, descriptions for the rynd chase and images of this feature are not regularly captured in excavation report data. Consequently, only 45 examples are present in the dataset, most of which were found to be overdrift types, with the iron bar recessed into the top surface of the upper stone. Three occasions were recorded where underdrift rynds were fitted, one of which was identified as a millstone because of this feature, despite having no estimated diameter (Shaffrey, 2015, pp. 67-70) (CAT 0940). The other two underdrift querns have been identified as miniature millstones due to their very small sizes and the presence of features that ordinarily correspond to millstones (CAT 1483, 2679, see Chapter 6). As evidence from Mayen shows that lava querns were manufactured as overdrift types (see Chapter 2), it seems highly probable that the bulk of the dataset comprises this type.

Figure 75- Upper quern stone from Vindolanda showing a worn rynd chase that cannot be identified as having either an under or overdrift fitting (photo by the author, CAT 0030).

Distribution

Overall spatial distribution

Distribution of lava across the whole province can be seen in figure 76, which also shows the distribution of non-lava querns at sites that do not have lava present. It should be noted the sites that did have lava present often also had non-lava querns, but these are not presented on these distribution maps. This is because lava is the focus of the study and the non-lava distributions are simply to demonstrate which sites and regions have been checked. This way, it is possible to note where gaps in the data exist and where a genuine lava absence can be suggested. The number of non-lava querns at sites with lava has been partially captured in the database produced as part of this study. This can be used to produce more complex distributions of lava in comparison to that of non-lava for future research, but as an incomplete dataset, has not been presented here. Distributions in Scotland have also not been presented since data from this region was less accessible during the Covid lockdowns and the few sites identified had the potential to provide a misleading view of lava distributions. Some quern data in Scotland was captured, but the few examples recorded were not positively identified as lava within the excavation reports. Descriptions of the quern fabric are likely to relate to Mayen lava, but this could not be confirmed without in-

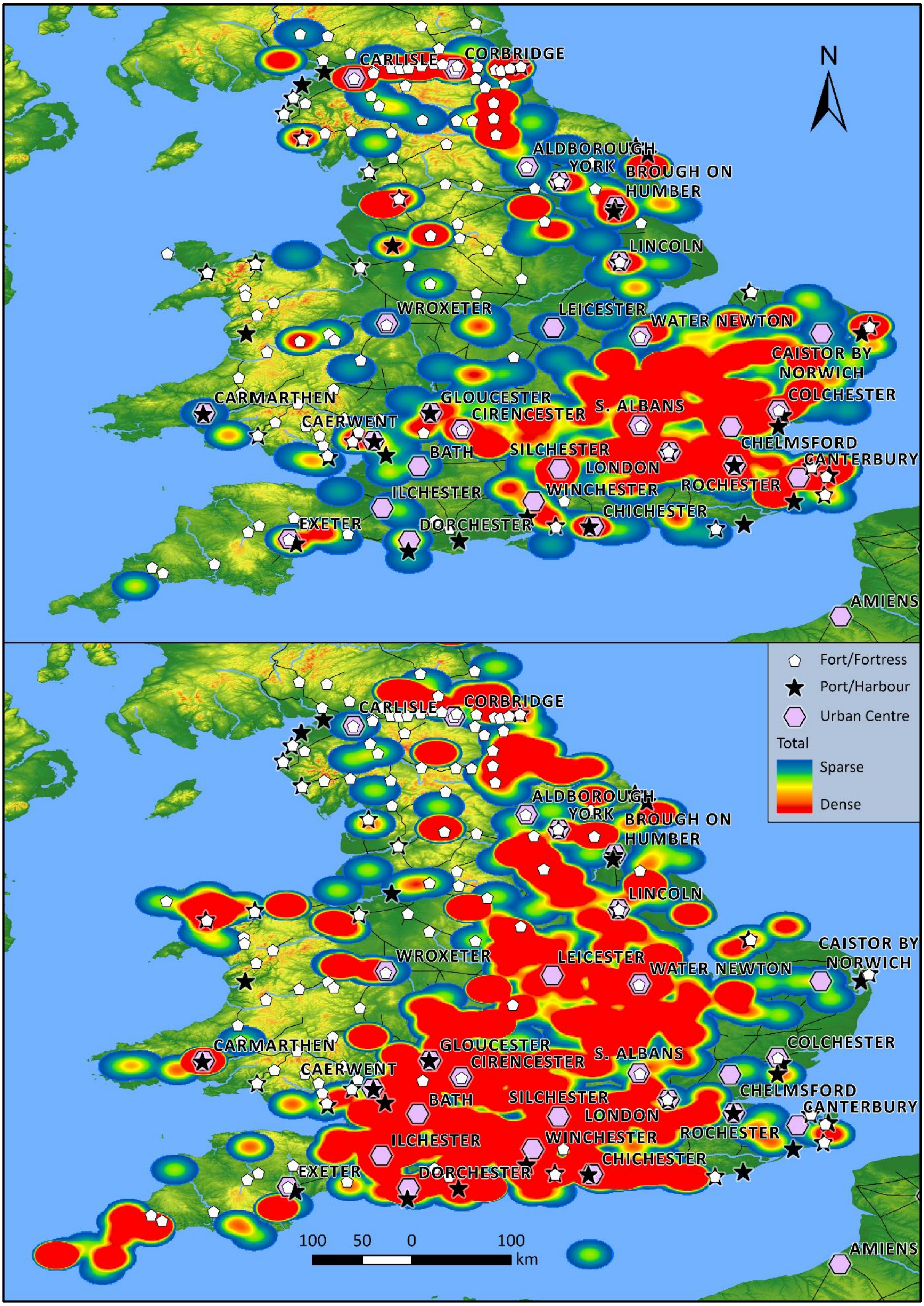


Figure 76- Distributions of lava (top) and sites with milling tools but none of lava (bottom) based on the whole dataset.

person examination. Further work is needed to explore Roman period lava distributions and that of non-lava milling tools in this region.

From the distribution, it is possible to see that there are some strong regional and probable site type associations to the concentrations of lava. Lava is most common in the south-east and eastern parts of Britain, with the largest clusters centred around London and Colchester. Focal areas west of these areas include the Thames Valley and the main urban centres, such as Silchester, Cirencester and Gloucester, with decreasing volumes away from these. Other concentrations are observable around Hadrian's Wall, with some continuation along the line of Dere Street, which is more likely to correlate with the intensity of military activity in these areas. Similarly, in Wales, smaller clusters are visible in the south of the country where fort sites are prevalent. This pattern will be investigated more fully in Chapter 7.

First impressions indicate that non-lava milling tools have a much wider distribution. This is expected, as milling tools were highly significant objects that were used in everyday life and would have played a vital role in food preparation activities. This certainly appears to be the case in certain parts of the province, such as the south-west. However, careful scrutiny hints at a more complex picture. One example includes the region around Hadrian's Wall and Dere Street where clusters of both lava and non-lava can be observed. The centre of these distributions is marginally different, with lava centred on the fort locations and non-lava in the hinterland areas around the forts. This is an important indicator that lava was being consumed on military sites but was not necessarily reaching the surrounding rural areas that were only using indigenous stone.

Similar patterns can be seen around Silchester, Gloucester and Cirencester, though the density of indigenous stone is much higher and 'outcompetes' the lava in terms of how far it extends. As with the military sites, it appears that lava is most concentrated in the urban centres within these areas, with a mixture of lithologies used in the urban hinterland regions. This is interesting as it suggests that urban sites were the focal areas for lava distribution, which allowed for lava to filter into the surrounding rural areas, where take-up did not always occur. The reasons for this and the interrelationship between urban and rural sites will be explored more fully in Appendix 3.

Distribution by Site Type

The addition of the urban centres and fort locations on the map showing spatial distribution has given some indication that the site type may have been an important factor in how and why lava milling tools circulated in some areas and not in others. Therefore, a separate map showing the distribution by site type of sites with lava and only non-lava milling tools has been produced, with a specific emphasis on whether the sites can be classed as military, military/urban, rural, or urban. The site designation has been identified for each location where milling tools were recorded, alongside the number of objects (figure 77).

Initial observations suggest that lava was distributed across a variety of different site types, while a more constrained social distribution occurs for sites with milling tools of indigenous stone types only, with rural sites prevailing over other site types. Though non-lava sites show some distribution at urban and military locations, these are predominantly on the western side of Britain and only small numbers of milling tools are recorded at these places. However, as data is sparse in these areas, it is difficult to know how representative this might be of quern use in general. A much greater volume and density of lava exists at military sites in the north and in Wales, as would be expected from what we understand about the role of lava milling tools as part of military equipment. As was suggested in the spatial distribution, rural sites in the region of military sites in the north and at Hadrian's Wall were highly likely to have milling tools, but none of lava. It appears that redistribution of lava via military sites did not occur in these regions. This may suggest that greater social differentiation may have existed in the frontier region at the time when lava milling tool use was most prevalent and that the rural hinterland of military regions did not have the same access to imported goods as the military community.

A very different pattern of distribution is seen to occur in the south-east, where urban sites appear to have been the vectors of redistribution. Volumes of lava are high at urban sites which are the focal areas of lava use for surrounding urban hinterland areas and rural sites. Distribution of lava may have been 'piggybacking' on mainly military supply routes emanating from London and Colchester. This does not appear to be replicated in the south-west or along the south coast. Although lava does still occur at urban sites in these regions, volumes are much lower and do not spread out to rural sites to the same extent as seen in the south-east. This implies that the south-eastern urban centres were more involved in the redistribution of lava milling tools and that this did not extend to urban centres in a general sense. The eastern coast and its connection to the North Sea trade must have been more significant in terms of access to imported lava products than the site type.

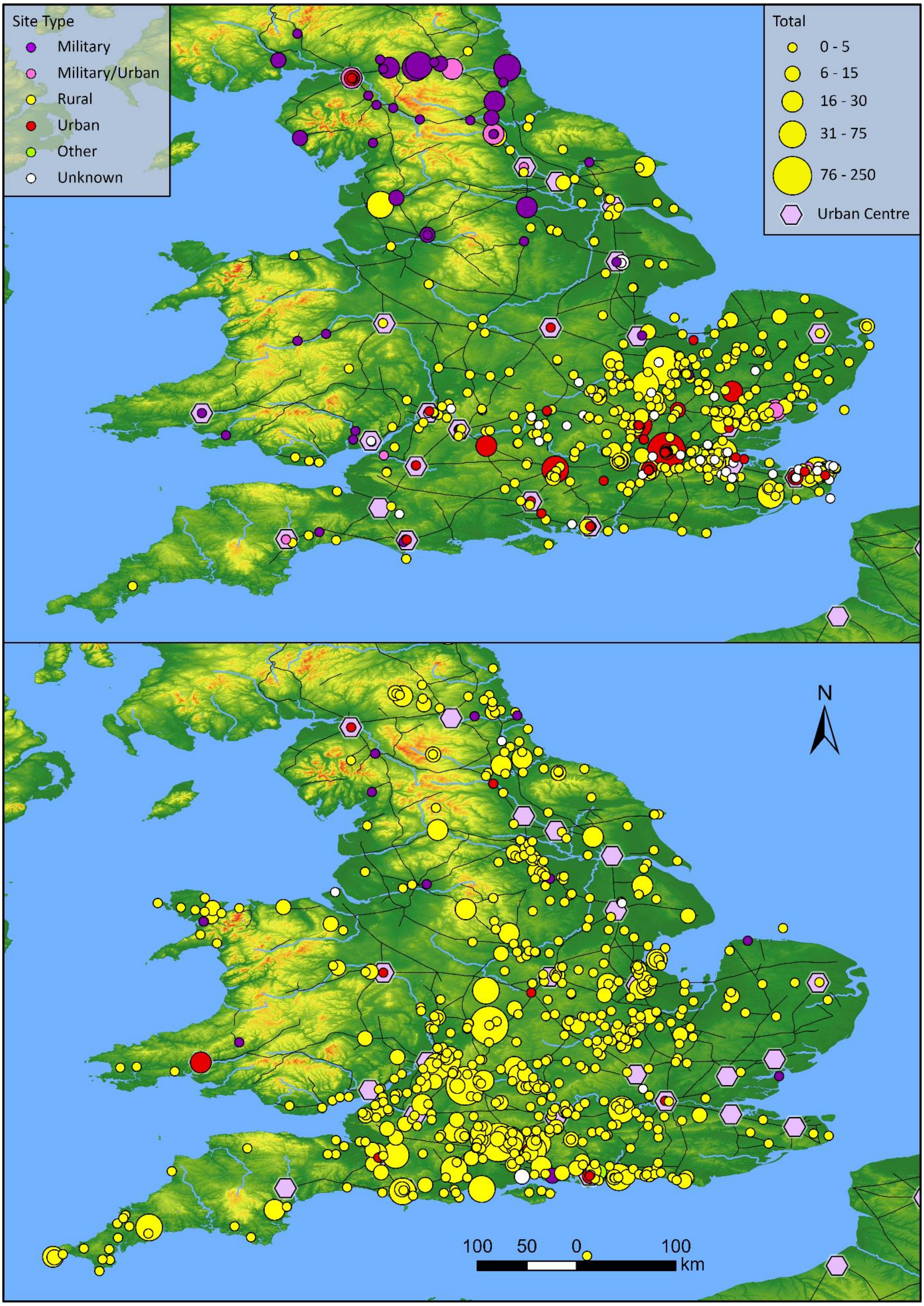


Figure 77- Map showing the social distribution at sites with lava (top) and only non-lava (bottom) milling tools, alongside the number of objects.

Chronological Change in Distribution

The chronology of lava use in Roman Britain is an area of research that has never been examined on a provincial scale. Although observations have been made in the past regarding the initial introduction of lava milling tools to Britain, and assumptions made on the decline of this use, this chapter presents the holistic examination of the data. The maps in figure 78 show the changes by century in the density of lava according to location. It should be noted that some objects were dated across more than one century interval, in which case they were included in more than one map. However, objects were only selected for use in this analysis if their context date fell into a maximum of two date groups. For example, a date of AD 150-250 was included in both the second and third century maps, but a lava quern with a data from AD 150-310 was not included. This was to provide some clarity in the visualisation of chronological change, as this becomes blurred if less concise dating evidence is used. Unfortunately, many examples have wide date ranges that could not be included, which is often due to the way that milling tools are deposited. Added to this, the reuse and redeposition of querns, including lava, creates a time lag from the moment of first use and final deposition, possibly creating a delay of 50 years or more between these dates. Added to this, it is not always possible to determine the extent to which the chronology of lava deposition depicted here relates to residual material and some care needs to be taken in the interpretation of change in deposition over time. There is no clear way to define the extent to which residuality has affected the results, but a time lag is to be assumed in all cases.

The results show that lava was introduced initially mainly in the south-eastern and eastern regions, with the greatest density being around London and Colchester, as might be expected due to our knowledge of Roman activity in these areas during the conquest period. Urban centres in the south and, to a lesser extent, the north also show clusters of lava. Boudiccan fire deposits at Verulamium, Colchester and London and other southern areas affected by the Boudiccan rebellion, are also more likely to have produced lava from securely dated first century contexts. Lava at the military sites follows what we understand of military occupation and movements in the first century, with clusters appearing in Wales and at southern military sites. This and other evidence related to lava distributions confirm a link between lava introduction into Roman Britain and the military. The first century lava distributions cannot, however, be identified as being solely military as there is no way of clearly separating the social context of use in urban centres that also had military populations present or moving through. A strong military association does, nonetheless, appear to have existed and this may have initiated civilian and other uses for these tools. When and how such a transition may have occurred is also not clear, but rural use in the eastern region of the province does appear to have happened in the early phases of lava introduction, as seen in the first century distribution

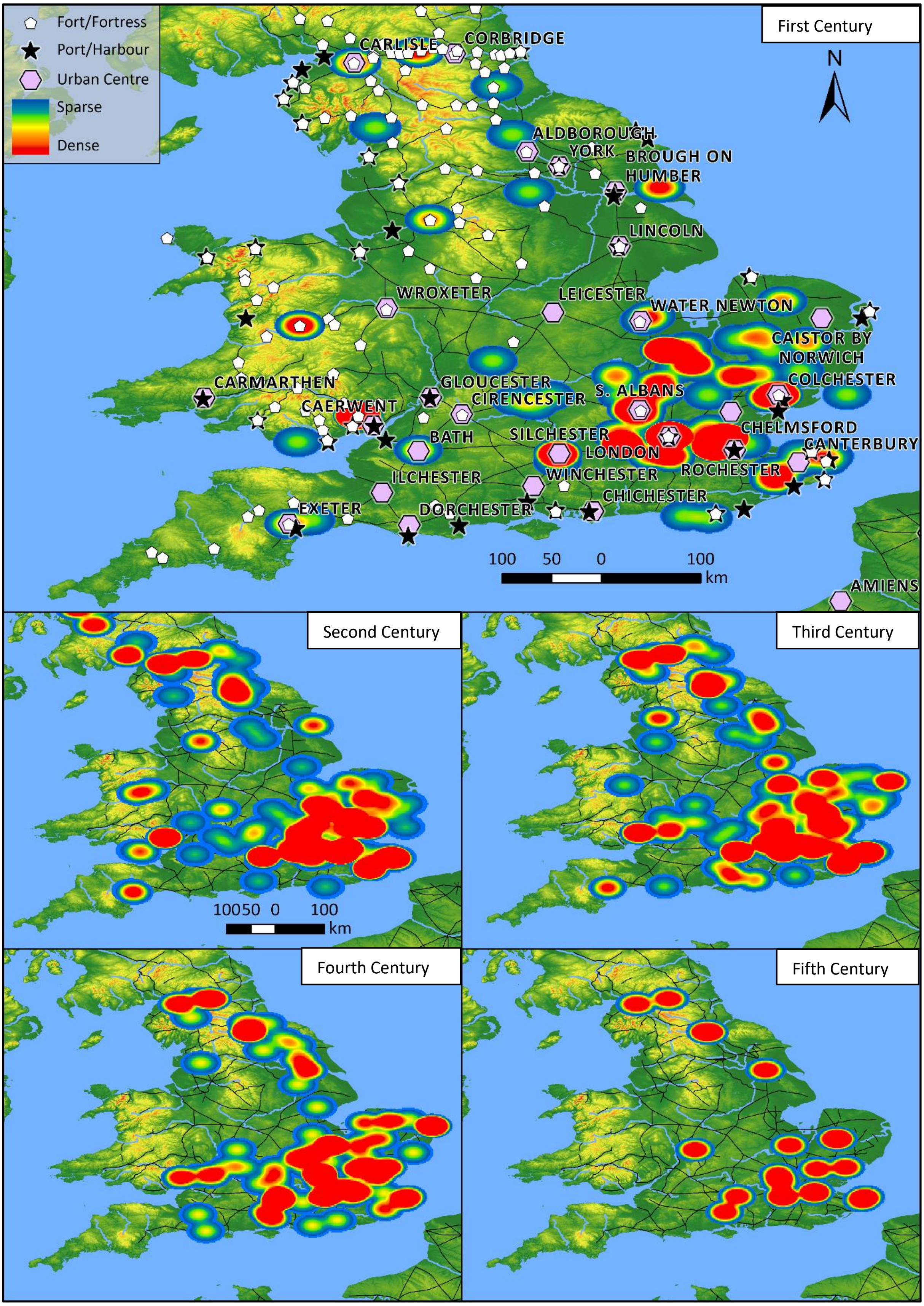


Figure 78- Chronological change in lava milling tool distributions from the first to fifth centuries in Roman Britain.

map. This may have been the result of the proximity of these sites to Colchester, where wider distribution of lava is likely to have occurred. This situation and the deficit of suitable sources of stone for querns in the east, may have been the driving factor behind this early uptake.Volumes of lava increase from the second and third centuries, when deposition was at its peak. The appearance of lava milling tools at Hadrian's Wall and around the Antonine Wall in the second century again mirror the known movements of the military and emphasise the important connection that lava had to this section of society. Expansion of use saw greater concentrations and density spreading west of London across the second century, with a slight contraction observable by the third century when volumes in Wales also appear to decrease. This contraction continues into the fourth century, resulting in no lava present in Wales during this period, with a rapid decline in the fifth, where the distribution is probably more related to redeposited material.

Primary Use

Measuring and comparing the primary use of a quern for a large dataset has only been possible using measurements of the stone thickness. As explained in the methodology (Chapter 3), this has been completed for upper and lower querns stones separately, with measurements taken at the edge for both stone parts to ensure consistency and the unused querns from the site at 1 Poultry have been excluded from the analysis. Charts have been produced for the whole British dataset, which will be used to compare the urban, rural, and military case study datasets in the following thematic chapters. However, here analysis has also been undertaken on all military, urban and rural sites collectively, as well as looking at regional and chronological differences in extent of use.

Stone Thickness for the Whole Dataset

Upper and lower stone thickness for the whole dataset are shown in figure 79 and 80 respectively, with the upper and lower 25th percentiles indicated with red lines. From this, it is noticeable that the range of thickness apparent on upper stones is much narrower than that of the lower stones. As more upper stones were identified than lower, this might suggest greater resolution in the data, though it is also possible that lower stones were used in a less consistent way than upper stones. Possible evidence for fixed position querns set into the floor or other surface at Verulamium, Vindolanda and Silchester (see Chapter 6 and 7) suggests that lower stones may have been used and, thus, worn differently according to their placement, which may have varied according to context of use. However, it should also be noted that upper stones that accommodate most of the mechanical parts for a rotary quern are more vulnerable to damage due to wear. At a specific point of wear, irreparable damage would occur whereby the quern ceased to function. Though mending might allow use to continue past this point, some consistency in thickness should be expected. Alternatively, lower stones would have been disposed of before full wear was reached due to the faster wear and damage of its paired upper stone or may have been paired again with an alternative upper stone. This would create a wider range of thicknesses depending on the options explored by the quern user.

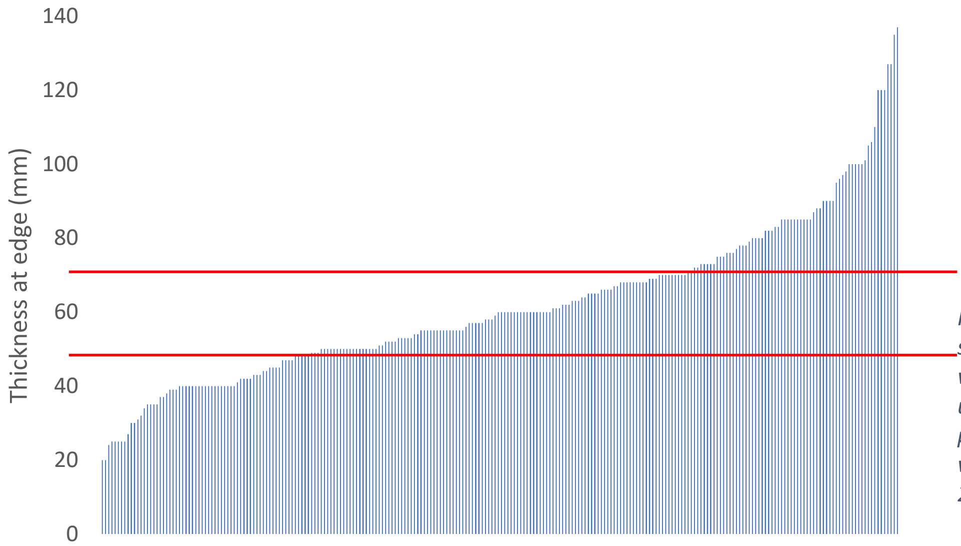


Figure 79- Upper stone thickness for whole dataset with upper and lower 25th percentiles shown with red lines (T= 248).

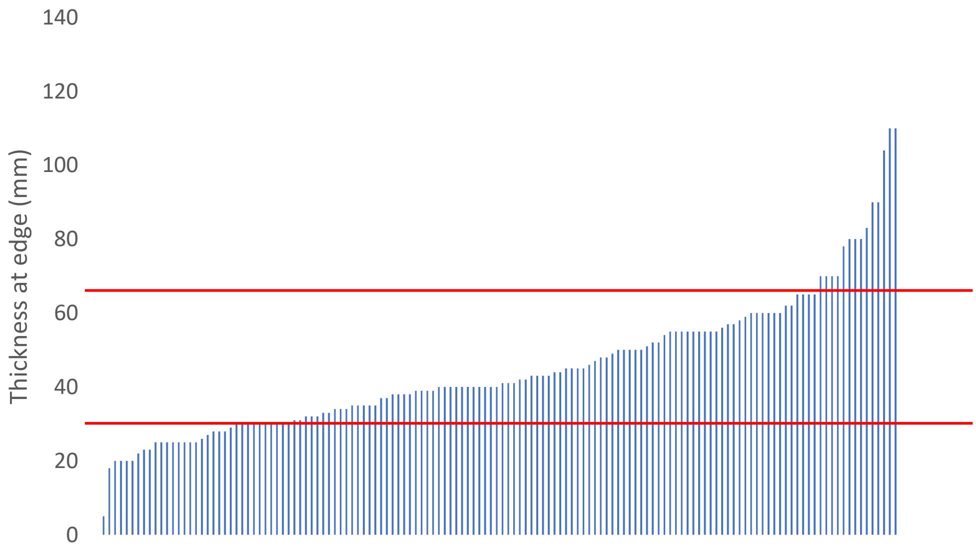


Figure 80- Lower stone thickness for whole dataset with upper and lower 25th percentiles shown with red lines (T= 138).

Stone Thickness by Region

Stone thickness relates to intensity of use, and regional difference in stone thickness and wear for lower stones are shown in figure 81. Insufficient data on lava quern thickness was available for the south-west, East and West Midlands regions. For the West and East Midlands, too few sites are represented to generate suitable comparison, while the south-west saw a low level of lava quern use (see discussion on distribution for this chapter). Interestingly, there does appear to be some regional variation in the data. In both the north-east, Wales and the south-east, a greater range of lava quern thickness can be observed, with this being more pronounced in the north-east. This can also be seen in table 6, which provides the 25th and 75th percentiles for thickness for each of the regional datasets, alongside the range between these two values. Although the dataset for Wales is relatively small and thus questionable, interpretations of this range for the north-east and south-east might consider the possibility that lava querns were used, and thus worn, in wider variety of ways than that of other regions. It may also relate to greater divisions in society in terms of the access that people had to imported goods in these areas and, thus, the intrinsic value attributed to these items. Some people may have repaired their lower quern stones or repaired them with new upper stones to allow for continued use to the point of exhaustion. Alternatively, others must have disposed of their querns well before this point had been reached, perhaps because they were able to replace them more easily. The wide range shows that behaviour in this regard was not consistent, and that choices varied considerably within these regions.

However, the upper and lower values for the 25th and 75th percentiles in the south-east and the north-east regions vary considerably. Lower stones were much thicker when they were deposited in the north-east when compared with the south-east. The north-west and Scotland were similarly thicker, while Wales may also be tentatively categorised within this group. As regions that were more heavily militarised, it is likely that the pattern of stone thickness relates to the prevalence of forts and the use of lava milling tools by the army. Military sites contributed to the bulk of the data for all these regions (see following section), and this has influenced the data significantly. In contrast, the south-east and the east regions where rural sites provided the bulk of the data, both the lower and upper percentiles for lower stone thickness is much smaller.

The data for upper stone thickness was more extensive overall, allowing for the inclusion of the east midlands and the south-west for comparison (figure 82). However, it should be noted that these regions, with the inclusions of Scotland, Wales and the south-west produced very few measurements for comparison. These may be considered alongside the regions that had more data available, though interpretations must be generated with caution. For upper stones, the greatest range of thicknesses is observed for Scotland, Wales, the south-west, the west midlands and,

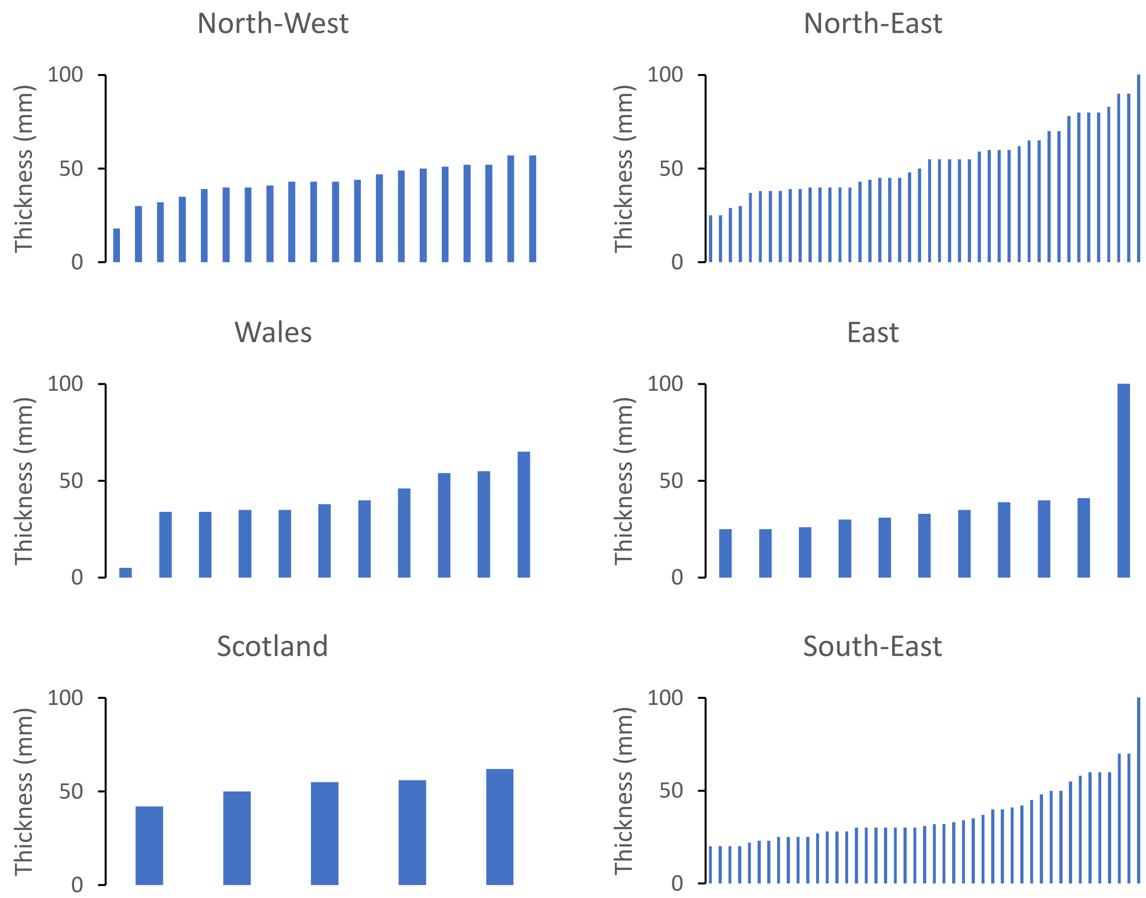


Figure 81- Charts showing the relative thickness of lower stones by region. The south-west, east and west midlands regions are excluded from the analysis due to insufficient available data. East T=10, north-east T= 44, north-west T= 20, Scotland T= 5, south-east T= 45, Wales T- 11.

Table 6- The 25th and 75th percentiles of lower stone thickness by region, with the range between the two values.

	East	***North-east***	***North-west***	***Scotland***	***South-east***	***Wales***
25%	26	40	39	46	26	34
75%	40	65	51	59	47	54
Range	14	25	12	13	21	20

tentatively, the north-east. It should be noted that most of this group comprises small datasets, except for the north-east, meaning that extreme values are more likely to skew the results and generate an inflated range. It is, however, interesting to note that the north-east region shows a wide range for upper stone thickness, as was also seen for lower stones, while the south-east region does not. It appears that upper stones were used and worn in a more consistent way in the south-

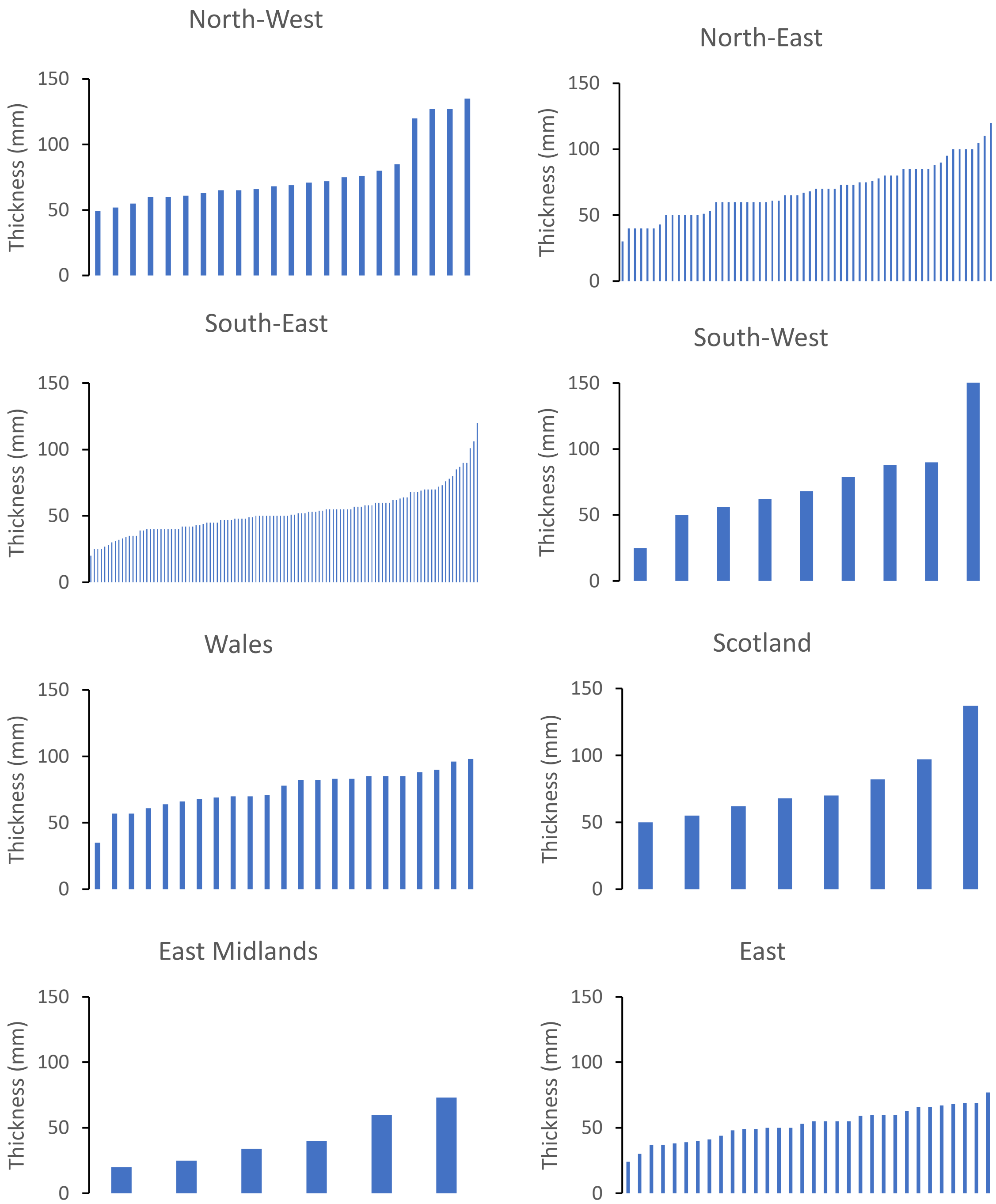


Figure 82- Charts showing regional difference in upper stone thickness. North-east T= 60, north-west T= 22, south-east T= 111, south-west T= 9, Wales T= 23, Scotland T= 8, East Midlands T= 6, East T= 33.

Table 7- The 25th and 75th percentiles for upper stone thickness by region, alongside the range for these values.

	East	***East Midlands***	***North-East***	***North-West***	***Scotland***	***South-East***	***South-West***	***Wales***
25%	42	24	55	61	57	42	53	66
75%	62	63	84	81	93	60	89	85
Range	20	39	29	20	36	18	36	19

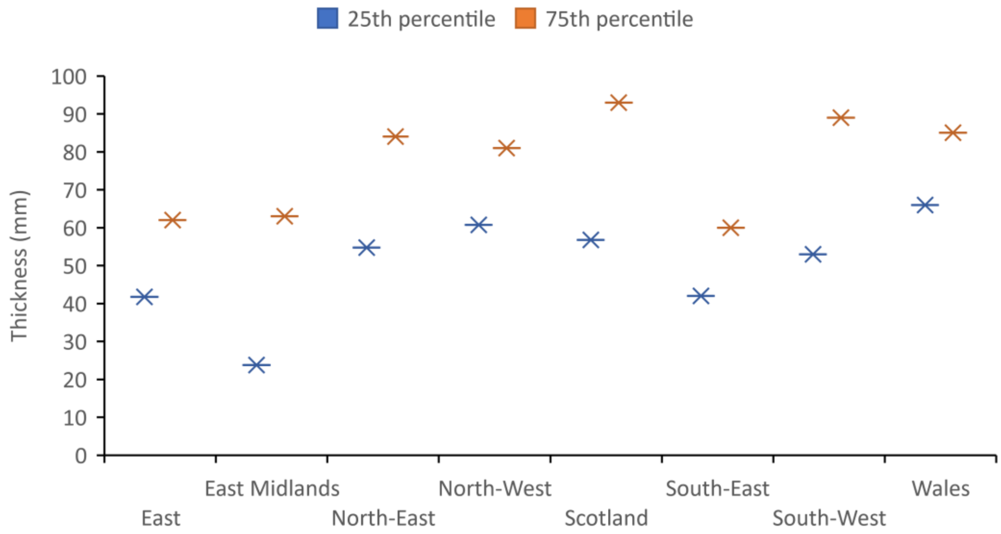


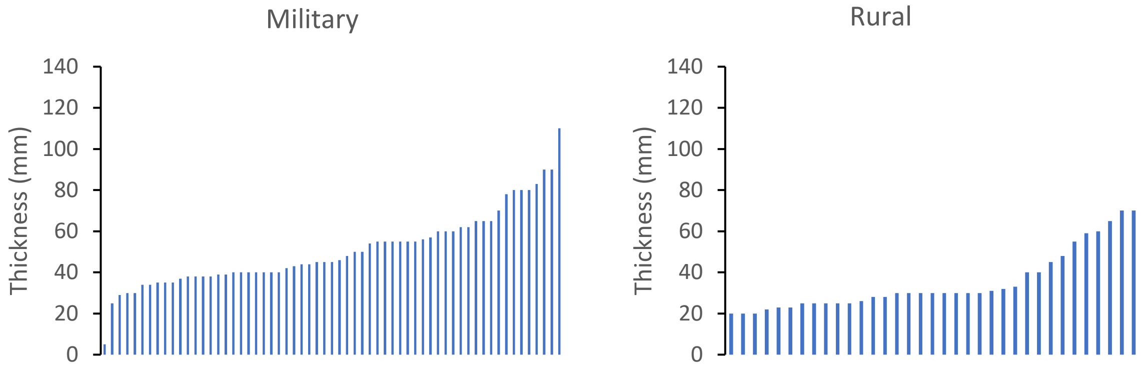
Figure 83- Chart showing the 25th and 75th percentiles by region for upper stone thickness.

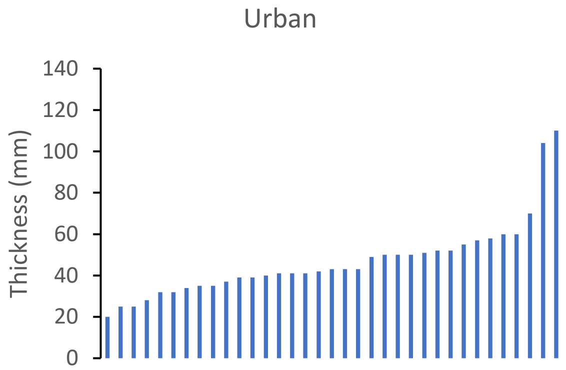
east compared to the north-east, while greater disparity existed for the use and wear of lower stones in both regions.

As with the lower stones, the south-east and east regions present very similar values for the 25th and 75th percentiles for thickness (figure 83 and table 7), with the possible addition of the east midlands in this group. This shows that similar behaviour relating to lava quern use and deposition may have existed across these regions. The thickness measurements also show that a greater degree of wear in these areas, suggesting that upper lava quern stones were extensively used prior to deposition. However, as with the lower stones, the dataset is dominated by quern stones recovered from rural sites in these regions, meaning that this may be a factor that is also related to the site type, as opposed to it simply being a regional variation. Nonetheless, the fact that all three of these regions are located to the east of Britain suggests that regionality did have a role to play. The north-east, north-west and Wales show similar figures, as was similarly observed for lower stones and is likely to also be related to the location of military sites in these areas.

Stone Thickness by Site Type

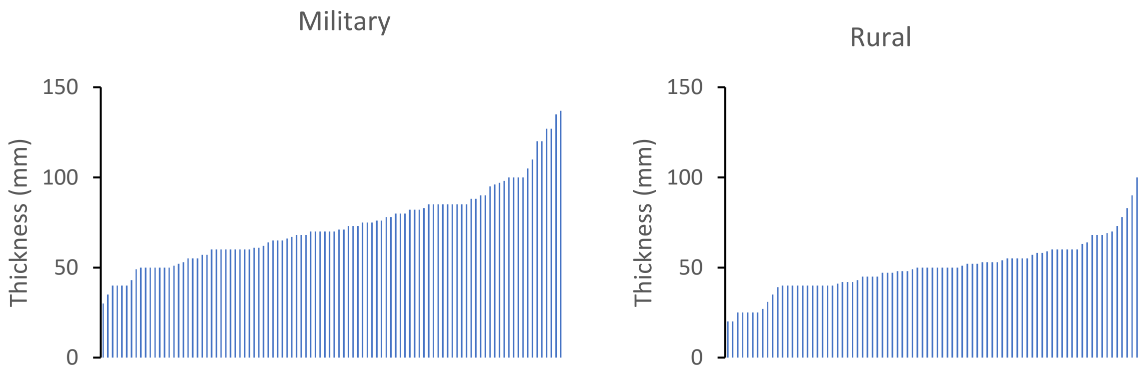
The results of the examination of stone thickness by region has suggested that thickness of stone type may also be related to the site type, and that this may have been a more significant factor contributing to the extent of wear prior to deposition. This has, therefore, also been explored and the results of the analysis can be seen in figure 84 for lower stones and figure 85 for upper stones. These confirm that there is a clear differentiation in levels of wear on lava querns recovered from

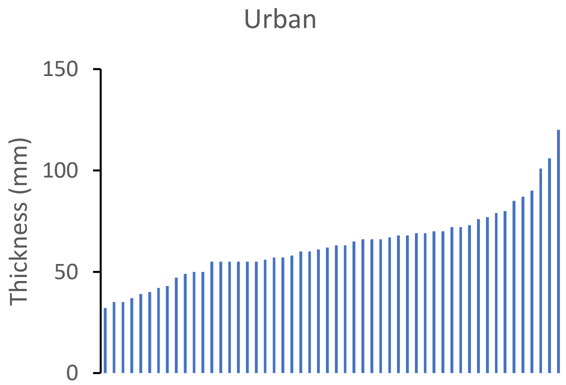




	Military	*Urban*	*Rural*
25%	39	35	25
75%	60	52	40
Range	21	17	15

Figure 84- Analysis of the thickness of lower stones by site type. Military T= 62, rural T= 35, Urban T= 35.





	Military	*Urban*	*Rural*
25%	60	55	40
75%	85	72	58
Range	25	17	18

Figure 85- Analysis of the thickness of upper stones by site type. Military T= 98, rural T= 83, urban T= 52.

military (including military/urban) and urban sites when compared with rural, and more slight deviation observable between military and urban. Both upper and lower stones present similar trends; at military sites, both the 25th and 75th percentile measurements for thickness are significantly larger than that for rural sites, and slightly higher than for urban sites.

This probably relates to the privileged access that the military community had to imported goods through military contacts. The range of thicknesses seen at military sites is also greater than for urban and rural, showing that there was less conformity in the extent of wear prior to deposition in military contexts. The reason for this remains unclear. Possible interpretations should consider whether ritual deposition may have had a role to play, as querns may have been selected for deposition that were still usable and, thus, thicker. These would contrast with querns that were discarded after their original use lives had come to an end. Military supply, which would probably have been more reliable and extensive is another factor, as good supply would promote disposal of milling tools at an earlier stage when they were heavily worn, with less anxiety about its replacement. There is also the possibility that the redeployment of troops to new locations may have resulted in the abandonment of heavy milling tools before full use had occurred. Military sites often saw gaps in occupation and on withdrawal from a fort, mass destruction and dumping of material appears to have occurred, which is likely to have included querns. Examples of such events include the large dump of nails at Inchtuthil (Cool, 2003, p. 1), and the Vindolanda tablets (Bowman & Thomas, 1975, pp. 465-466). However, this pattern may also relate to excavation methodologies and finds retention policies at sites that were subject to earlier and antiquarian investigations. Larger fragments are more likely to have been kept in these cases, and if later excavations followed where smaller pieces were then also retained, it might exaggerate the range between thicker and thinner stones.

Urban sites show values for quern stone thickness that lie between military and rural site values. The 25th and 75th percentile values show that querns were deposited when still relatively thick when compared to rural sites but saw a greater degree of wear to that of military sites. This fits with common perceptions of how the economy worked in Roman Britain; the military received priority access to anything required, urban populations benefitted from good access to infrastructure and exchange systems, while the people living and working in rural areas may have had less access to, or desire for, imported goods. The extent to which this was true for the rural sites is clearly visible in the data; the value of the 75th percentile for quern thickness is roughly equivalent to that of the 25th percentile at military sites. Some of the thickest querns deposited at rural sites were, therefore, almost the same thickness as the most worn examples at the military sites. Significant degrees of repair must have been necessary to allow for continued use in these cases. Despite the variation in thickness between urban and rural sites, the range of wear is very similar. This presents the possibility that there was a socially acceptable extent of wear for a quern prior to its deposition in both rural and urban contexts. Once a quern stone had reached a particular extent of wear, it would be rendered unusable and cease to function. However, this was different between site types, indicating that this was not a purely economic concern as an element of choice must have been involved.

Overall, the data analysis presented here does not tackle the intersectional nature of the variability involved. Some patterns have been identified for site type and region, but consideration has not been given for chronology or the more nuanced aspects of site type, such as the differentiation between rural villas, defended settlements, farmsteads, roadside settlements etc., because the respective datasets would become too small. Future work might use multivariate analysis to explore these themes, though more data would need to be collated first.

Reuse

Reuse is a feature of the object biography that was rarely identified with any confidence or recorded in site reports. Most of the examples presented in this thesis were either personally recorded, taken from Shaffrey's dataset or from instances of more detailed quern reports. It seems likely, therefore, that many more cases of reuse exist within the dataset than can be presented here and it is hoped that more effort will be invested in acknowledging possible reuse on querns in future work. It has been observed that the inhabitants of sites with poor access to local or imported stone suitable for ground stone tools often reused quern and building stone for other purposes (for example, see Allen, forthcoming, 2022). Reuse, therefore, can reveal a great deal about the economic and social circumstances of a particular site and changes in connectivity with other parts of the province. This section will only deal with the reuse that is perceptible on the stone itself, as reuse in the form of deposition will be explored in the following section.

Overall, 26 examples of reuse were recorded from 14 sites (table 8). Very few of these had identifiable traces that would indicate a specific type of reuse, and many interpretations simply mention wear traces that do not correspond to original use as a quern. Of the 14 sites with reuse observed on lava querns, six are in the south-east and these contributed to the bulk of the dataset. However, as three of these sites were recorded personally or by Shaffrey, there are clear issues in interpreting this pattern. No clear trend is apparent in terms of reuse according to site type. Although rural sites appear to be more prevalent in their reuse of lava, there are many more rural sites than other site types in the dataset and this must be compensated for. Generally, exploring the full dataset for reuse does not appear to be an effective approach for identifying trends in behaviour. However, on an individual site basis, this has been more successful, as will be seen in the following chapters. Overall, reuse tended to be associated with other processing activities, such as for whetting and sharpening of blades, but specific reuse is hard to pinpoint from wear traces alone. That there would have been a continued value associated with lava for reuse purposes should not, however, be overlooked, especially in regions where suitable stone for processing was absent or inaccessible. The extent to which lava querns were recovered as fragments in the south and south east of Britain may relate to the value of broken-up querns to supply this need, and the extent of fragmentation may not be solely explained by taphonomy or deposition practices.

Table 8- Sites, locations, and site types where reuse of lava querns has been observed and recorded.

Site Name	No Querns	Site Region	Site Type
Vindolanda	1	NE	Military
Colchester	1	E	Military/Urban
Great Dunmow	1	SE	Rural
Carlisle	1	NW	Military/Urban
Mucking	1	SE	Rural
Silchester	4	SE	Urban
Church Field	1	SE	Unknown
Wanborough	1	SE	Urban
A14 Cambridge	4	E	Unknown
Carvossa	2	SW	Rural
Billingley Drive	1	NE	Rural
Corbridge	2	NE	Military/Urban
Usk	1	Wales	Military
Verulamium	5	SE	Urban

Deposition

Unlike smaller objects, the find spots of querns and millstones cannot be directly correlated with use contexts as they are not subject to casual loss. Deposition was more likely to be intentional, either through disposal, ritual practice or reuse/redeposition. The wide variety of deposition and redeposition contexts can be seen in figure 86, which presents the most common Romano-British archaeological features from which lava querns and millstones were recovered. The relative volumes in which deposition occurred in these contexts is also shown. It should be noted that although 1241 lava milling tools were associated with a specific deposition context, as shown in the chart, many more were from unspecified contexts (1201), unstratified (83), or were not associated with a particular archaeological feature (177). These have not been included in the chart as their presence would dwarf the other data and obscure any possible patterns. However, it does emphasise how much data is potentially missing or impossible to interpret in terms of deposition practice.

From the chart, deposition in pits occurred most frequently, with floors/roads/levelling and ditch deposition also common. This should not be surprising considering how often pits and ditches occur on archaeological sites and given that material culture typically is found in cut features. The extent to which these may relate to ritual deposition, practical reuse or the dumping of rubbish is a complex matter that should be considered according to context and will be explored further in the thematic chapters and individual case studies. The frequency at which deposition into roads, floors and for levelling occurred might be the consequence of conflating three different feature types. Though these contexts may seem relatively similar in functional terms, meaning associated with deposition into a road surface may have been very different to that for levelling or for floors. There are some issues associated with interpretation on a site level for this category, and I was not always able to distinguish between the three possible feature types. Therefore, they have been grouped together during the data recording process, as have ovens, corn dryers and hearths as similar issues exist for these features. It should also be noted that the site at 1 Poultry, London, has also inflated numbers, as the large lava quern assemblage was predominantly incorporated into a cobbled floor surface, comprising 213 such examples (Hill & Rowsome, 2011).

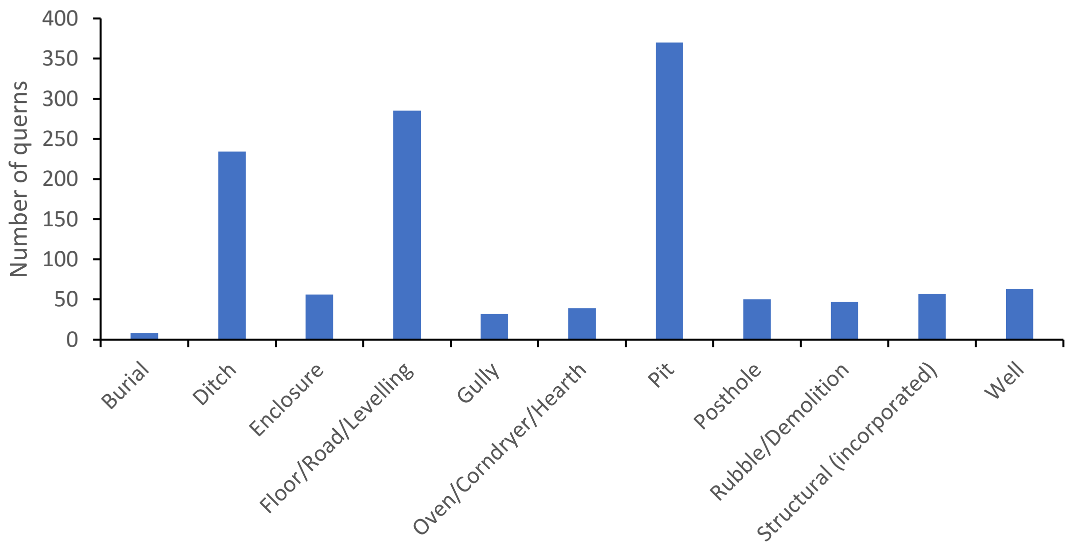


Figure 86- Chart showing the most common archaeological features where lava milling tools were deposited and the frequency that this occurred for each (T= 1241).

After the removal of the 1 Poultry querns and after further defining the type of deposition context, it is possible to see that there is little to distinguish between the occurrence of deposition in road surfaces, floors (internal to a building/structure), surfaces (external to a building/structure), and use for levelling (figure 87). However, these do appear to occur differently depending on the site type, though this is difficult to reconcile this with the variable extent to which certain site types and feature types occur. Therefore, to explore this further, correspondence analysis was carried out to explore whether specific site types saw more frequent deposition of lava within floor, road, surface, or levelling contexts. The results, shown in figure 88 indicate that urban sites were more likely to yield lava querns from levelling contexts, while military sites saw greater frequency of deposition in road surfaces. Rural sites had less of a strong correlation to specific deposit types, but clustered most closely with floors and surface contexts.

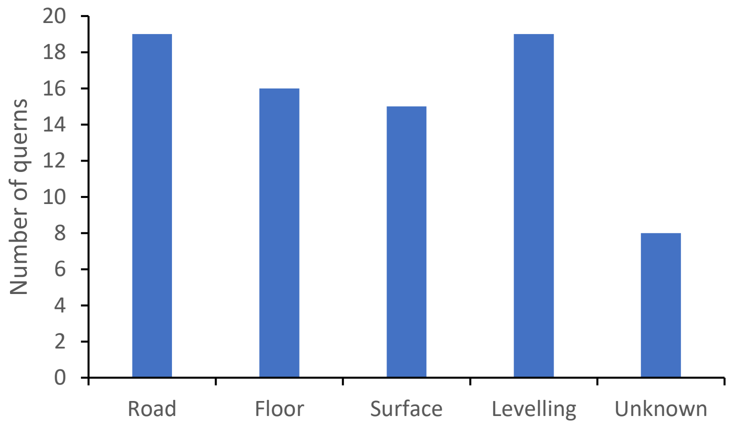


Figure 87- Chart showing the frequency that lava querns were recovered from road, floor, surface, or levelling contexts, and those from an unspecified surface (unknown) (t=77). The data excludes the querns recovered from 1 Poultry.

Again, it is worth considering whether this demonstrates different deposition practices across different site types. It should be noted that of the 17 recorded lava deposits in urban levelling contexts, ten were from Silchester. This might be more of a site-specific phenomenon or may be due to better preservation of the stratigraphy where levelling occurred, which is less likely to survive in urban environments that have seen multiple post-Roman phases of occupation. The fact that detailed stratigraphic information was available for Silchester is also a factor for consideration. Similarly, the greater occurrence of deposition in road surfaces at military sites will, to some extent, be related to the fact that Roman period infrastructure is more likely to become the focus of excavations at military sites.

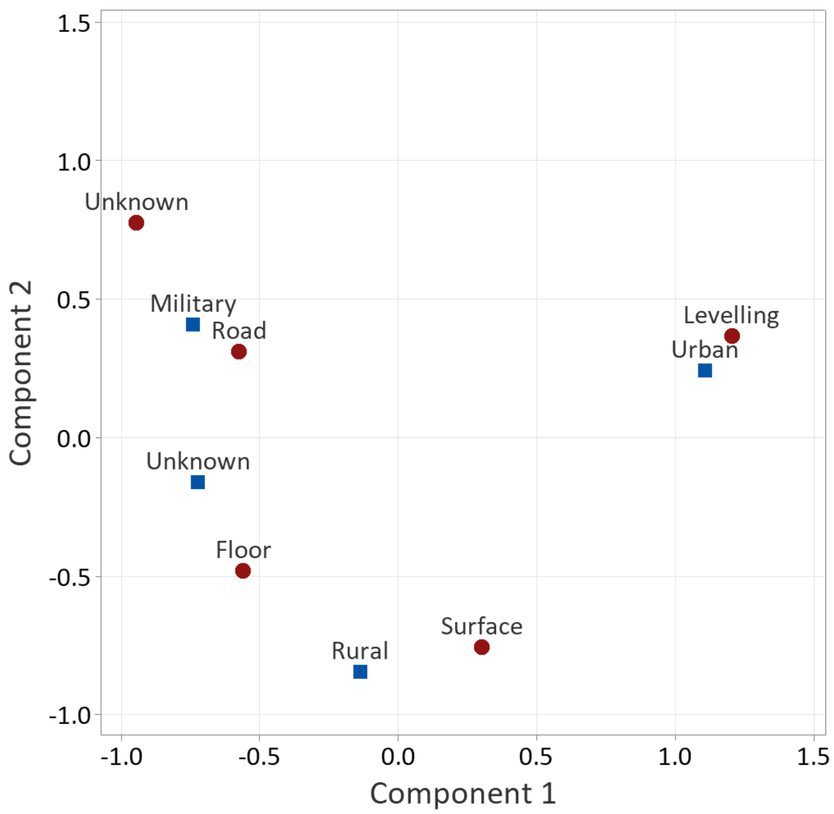


Figure 88- Simple correspondence analysis completed on the frequency of occurrence for deposition of lava in specific contexts at different site types. Total inertia for component 1 is 67% and for 2 is 31%.

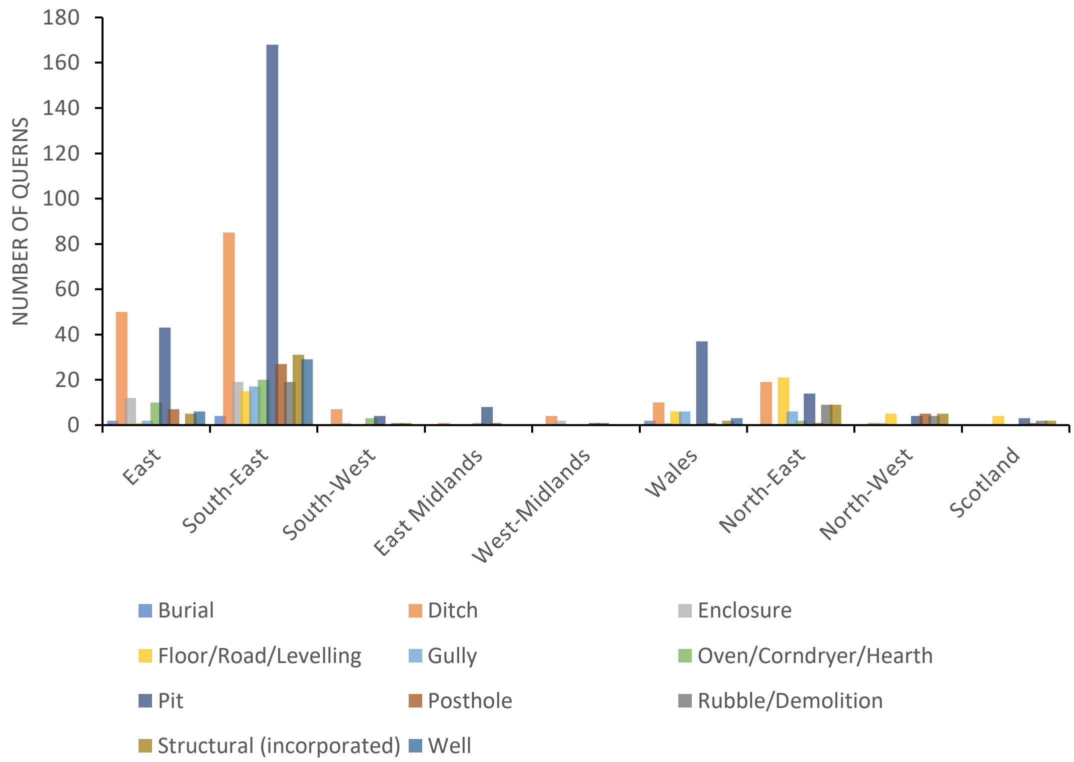


Figure 89- Chart showing the frequency at which lava milling tools are deposited in different archaeological features by region (T= 794).

The results show that deposition in floors, roads and for levelling, alongside demolition/rubble was more common in Scotland, the north-east and north-west. This is an interesting distinction, as it suggests that this form of deposition occurred more often in the north, and is, therefore, likely to be strongly associated with military sites, probably in relation with various fort abandonment and reconstruction phases. The south-east correlates most closely with deposition in pits, postholes, and wells, while the east is associated with enclosures, ditches, corn dryers/ovens/hearths, as was the south-west. The East Midland sites clustered most closely with burials, wells, and pits, as did Wales, though to a lesser extent. The West Midland sites do not appear to have any specific closely associated features. Again, these patterns can be somewhat explained by the higher incidence of certain features at particular site types and regions. For example, the east saw much more frequent use of lava milling tools at rural sites (see Chapter 5), and so higher occurrence of deposition in ditches and enclosures would be expected. However, the fact deposition for the northern and the eastern regions correlate does suggest that some pattern in practices could exist. The analysis does suggest that military users had a different relationship with the lava milling tools than populations in the south, and that this was more functional and less personal. Further data and analysis would clarify this in future.

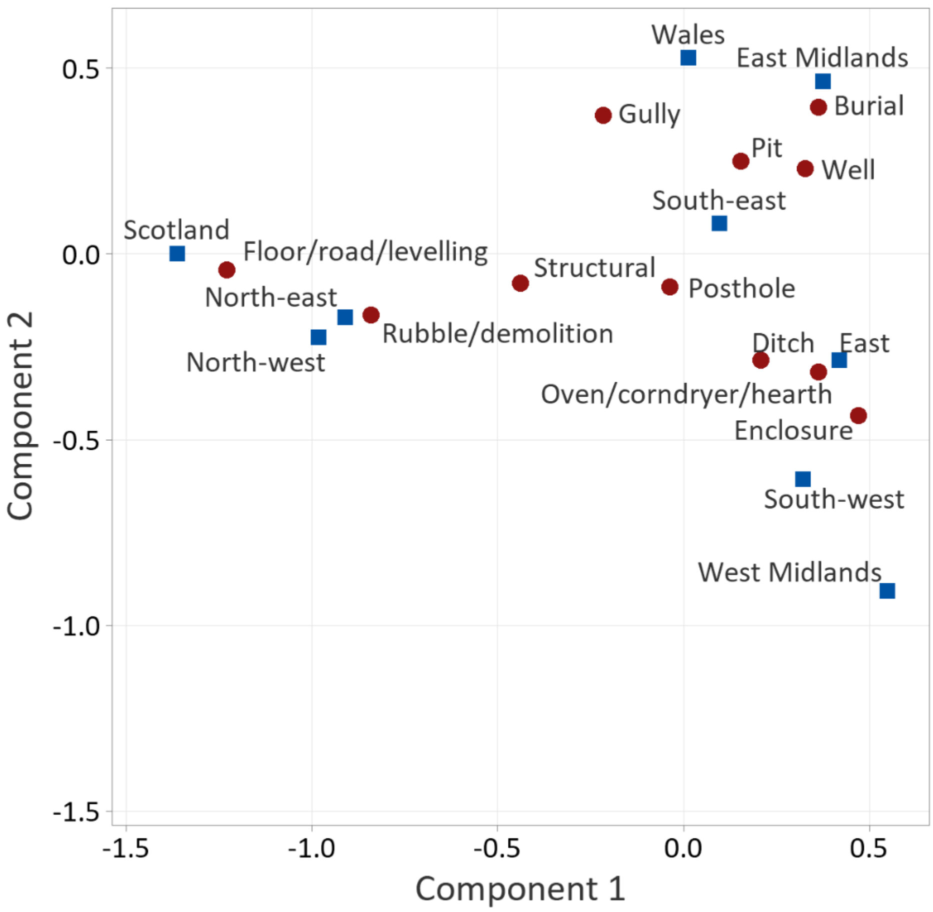


Figure 90- Graph showing results of correspondence analysis for deposition context according to region, excluding the querns from 1 Poultry. Inertia for component 1 is 56.99% and 20.05% for component 2.

Looking at deposition by site type (figure 91), pits are the most common feature for lava deposits across all site types. Deposition in ditches and enclosures occurred most frequently at rural sites, and floors/roads/levelling and ditches were most common at military sites, again, probably the result of there being more of these types of features at these respective sites. This was, again, examined using correspondence analysis to establish the extent to which site type was affecting the overall interpretations of deposition behaviour associated with lava (figure 92). These results confirm some of the observations made of the regional variation in deposition; rural sites are closely correlated with enclosures, ditches, and ovens/corn dryers/hearths; urban sites are associated with wells, pits, and wells; military sites are clustered with roads/floors/levelling, rubble and demolition. These closely correspond to what was observed for the regional variation, and it seems to be clear that site type has the biggest influence on the type of deposition experienced by lava objects, and often relates to the types of features that are most common in those contexts. However, this should not be used to explain all the patterns seen. For example, deposition of lava into possible 'ritual' pits in urban contexts is a behaviour that may have been a specific practice associated with lava querns (Fulford, et al., 2006), and the clustering of urban sites with pits on the graph does suggest that this is being highlighted in the data. However, the fact that pitting is a reasonably common urban practice of rubbish disposal (Fulford, pers. com) may also explain the strong association seen. This will be explored further in Chapter 6.

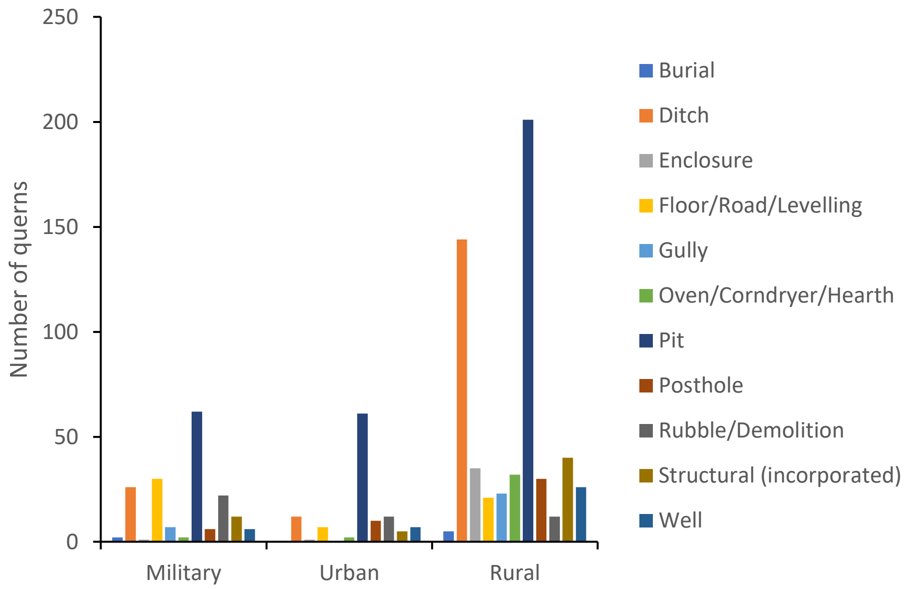


Figure 91- Chart showing the frequency of deposition of lava in specific archaeological features by site type.

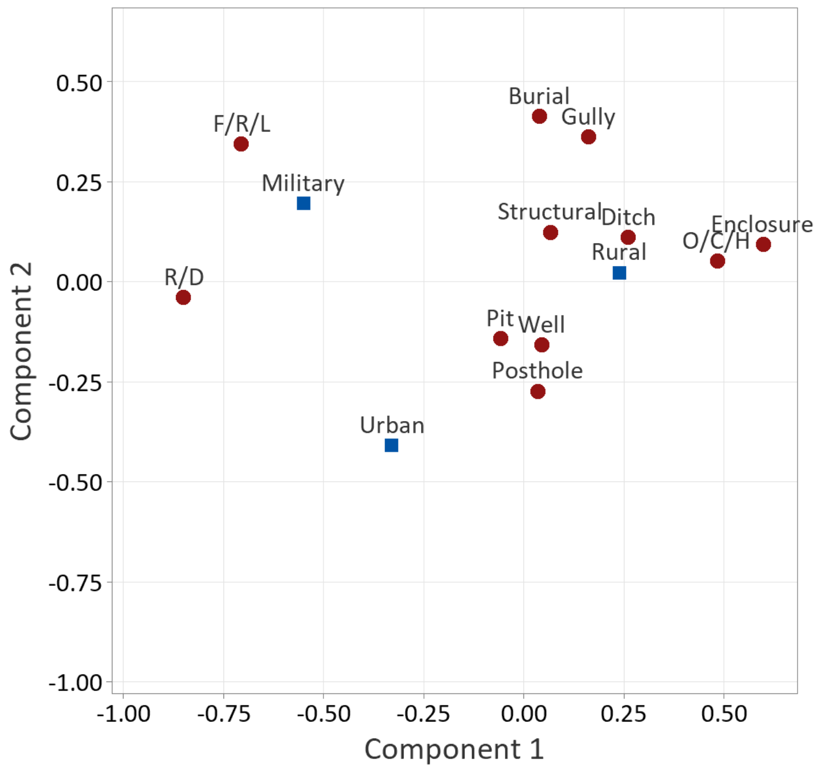


Figure 92- Results of correspondence analysis showing the relationship between deposition context type and site type. Inertia for component 1 is 78.73% and 21.27% for component 2.

Conclusion

Overall, the full dataset analysis has identified patterns and trends to the data, some of which will be examined in more detail within the individual case studies that follow. In relation to the manufacture stage of lava milling tool biography, a diameter measurement of 500mm has been identified as the division between lava querns and lava millstones. This differentiation needed to be established at an early stage in the data analysis to ensure consistency, but in-person data collection has confirmed that the functional features of lava milling tools agree with where this separation has been defined. This provides a useful benchmark for all future lava milling tool recording for Romano-British assemblages. When considered separately from the probable lava millstones, stone diameter measurements have demonstrated the high level of standardisation that exists for lava querns in the province, 50% of which fall into the size range of 400-420mm. This further supports the idea that these objects were centrally produced and may have been made to set specifications and standards.

This standardisation is also visible in the functional fittings of lava querns, which predominantly had elbow handle fittings, overdrift rynd fittings that were fixed in a consistent way and raised annular kerbs. Kerb width did not appear to display a consistent pattern but there did appear to be some correlation between possible ‘iron band’ handle fittings and indistinct, faint kerbs. This may relate to the changing role of the kerb from a functional to a decorative element for querns with iron band fittings, but further work would need to be undertaken to verify this theory. Iron band handle fittings were identified in two cases, with a further four possible examples. The lack of other types of handle fitting on these querns suggests that the iron band may have been intended at the point of manufacture, making this a previously unidentified typological variation from those listed by Röder (1953) (see Chapter 2).

The extent of use has been explored by measuring the thickness of upper and lower stones and comparing these by region and site type. It was found that there was probable inequality in the supply of lava milling tools that effected populations differently depending on whether they were living at a rural, urban or military site. Military sites may have had priviledged access to lava products, as these sites presented the thickest querns at the point of deposition. Urban lava querns were slightly thinner, while rural sites produced very thin and worn quern stones. Rural populations must have experienced greater difficulty with regards to replacing their milling tools, as these were worn to extreme levels in some cases.

Spatial distribution of lava milling tools has shown a clear east-west and north-south divide. Lava milling tools were more likely to be used at sites in the east and south-east of Britain. This is especially the case around London and Colchester where lava volumes are the most dense, and these are the ports that were probably accepting cargoes of lava querns for further distribution. In the east of the province, rural sites of any status were consuming lava products, probably due to the lack of suitable local stone sources for producing milling tools. Elsewhere in the south, lava consumption is centralised on urban and military sites, with some 'seepage' into the wider hinterlands. In the north and on Hadrian's Wall, only military sites were found to have lava, with very little being distributed amongst the rural populations. This may show the scale to which there was integration, connectivity and exchange between different communities in different regions of the province.

In terms of chronology, lava was introduced to Britain in the first century, where it was first used at military sites and urban sites that had early military foundations. Lava became much more widespread and peaked in distribution in the second and third centuries, after which a contraction is seen with a long trail of continued deposition into the fourth and fifth centuries. The continuation into the later Roman period is likely to relate to the scale of reuse and redeposition of lava milling tools, shown by high levels of depositon in floors, roads and surfaces and reuse as building material, especially at military sites. Other patterns relating to deposition context are harder to identify and will need to be examined for individual case studies.

Chapter 5. Foreign Stone in the Hands of Farmers: Lava Querns and Millstones in Rural Roman Britain

Introduction

Rural life was the lived reality for most of the population of Roman Britain, though early research focused much more on military and urban sites. In recent years, recognition of the significance of the rural past has transformed research objectives and perspectives within the discipline (Hingley, 1989; Rippon, et al., 2015; Taylor, 2007). One of the most important and influential projects to harness Roman rural research objectives, the 'Rural settlement of Roman Britain' Project (RSRB), involved large-scale collection of data relating to site characterisation, finds evidence, burials, and environmental evidence from c. 2500 Roman rural sites in England and Wales. The outcome of the project was an open access database containing data collated during a comprehensive literature sweep of excavation reports and county journals of any date, and 'grey literature' reports produced as part of developer funded excavations post 1990.

Data was compiled and analysed to produce three thematic interpretive volumes: The Rural Settlement of Roman Britain (Smith, et al., 2016), The Rural Economy of Roman Britain (Allen, et al., 2017) and Life and Death in the Countryside of Roman Britain (Smith, et al., 2018). By including unpublished developer funded excavation reports, the project was able to incorporate and interrogate data often excluded from research narratives, which tend to rely more heavily on published works. As rural settlement sites are more likely to be excavated within the commercial sphere of archaeological investigations, 'grey literature' reports provide a substantial data source that should form a vital component to any investigation into Roman rural life. Prior to this project, the potential for such data to enhance interpretations had not been fully realised, and the approach has generated a more informed and substantive exploration into a hitherto less well-known facet of the Roman past.

Although the project successfully produced a comprehensive overview of life in Roman rural Britain, there is a great deal more that could and should be done to better utilise the data generated. As with all projects of this scale there were limits to the level of interpretive detail that that could be extracted and presented from the large dataset and there are many instances where subtlety and nuance are dwarfed by the sheer complexity of dealing with such huge volumes of interrelated information. The RSRB project should not, therefore, be considered an endpoint to our investigations and should instead be thought of as an excellent resource to be exploited and employed within further studies.

This chapter aims to address research questions relating to lava querns and millstones by utilising the RSRB data to gain greater insight into the role of these objects within the wider context of rural life, while also considering the inter-relations between rural, urban and military sites. As strong indicators of agriculture, food production and processing activities, querns and millstones are significant objects that are likely to have held important roles in rural life. This is recognised in the RSRB project (Brindle, 2017, pp. 71-72; Allen & Lodwick, 2017, pp. 142-177; Brindle & Smith, 2017, pp. 198-200), though a separation between querns and millstones of lava from those made from more local sources was not made within the original study. This chapter will therefore exploit the RSRB dataset (relating to presence, absence, and volumes of querns at a range of different rural sites) but add the further dimension of a comparison between imported and local querns to better understand social and economic life in Roman Britain. The structure of this chapter will not follow the object biography approach, as potential individual case study rural sites could not be explored as result of Covid restrictions. However, a lack of access to suitable primary data for rural sites has created an opportunity to explore the data in other ways.

A full and detailed review of the RSRB Project has been included in the appendices (Appendix 1), which focuses on the analysis of the quern, millstone and other associated data that was generated as part of the project, its outcomes, and interpretations. In response to this investigation, this chapter commences with an assessment of how the research for lava querns and millstones can build upon that produced by the RSRB project to generate new interpretations. From this, an outline of the dataset used for the analysis will be provided and discussed in terms of how it was collated and possible biases present. The data analysis then commences, beginning with an exploration of milling tool diameter and the extent of wear observable on the stones. Following this, distribution analysis will be presented, including general distributions for lava and non-lava milling tools and more in-depth examination of East Anglia and the south-east. This will include locations of urban and military sites to provide context. Distribution by site type will then be detailed, followed by chronological distribution.

Reviewing and building on the RSRB data

The data analysis for food processing tools and how it has been correlated with other finds and site evidence forms an interesting narrative relating to each of the regions described by the project. However, there are some issues, many of which are acknowledged in the discussion and interpretation of the settlement data, though there are others that directly relate to querns and millstones that may have been overlooked as part of the RSRB original investigation. Differential excavation strategies and sampling are key problems when comparing mass data of this kind, and this is well recognised. The varying extent of excavation between different sites will produce very different levels of detail due to sample size, and it is important to recognise that the conflict between absence of evidence and evidence of absence is a key factor that should be applied to any interpretation. There has been some attempt to consolidate the data with reference to scale of excavation by calculating finds per hectare excavated, as seen in the analysis completed for the central belt region. However, this is not something that is done consistently for the other regions in the dataset, making the results less comparable between the regions. Furthermore, as archaeological excavation operates in three dimensions, it is questionable whether a two-dimensional unit of measurement realistically captures the extent of excavation between sites; not all features may have been fully excavated, not all areas fully investigated etc. Nonetheless, the issue of scale of excavation is largely counterbalanced by the sheer size of the dataset. Inconsistencies are more likely to be 'smoothed out' to present recurring patterns and highlight abnormalities.

Similarly, the chosen area of excavation is likely to have an impact on the types of find and the kinds of evidence that are recovered at different categories of sites. As previously mentioned, this is especially the case at villa sites where querns and millstones could be missed due to less attention given to auxiliary buildings or dumps where these specific objects may have been used or disposed of. As another example, fieldwalking and chance finds have often uncovered querns at field boundaries, places that are less likely to be incorporated into archaeological investigations. Such peripheral locations could relate to deposition or disposal practices involving specific types of objects in liminal places, affecting how we view the presence or absence of some artefact categories. This is an important issue that feeds into the way that the data has been presented- i.e., regionally. A large part of the dataset has been generated using grey literature from developer funded excavations, produced by commercial archaeological units that tend to be regionally based. This produces some consistency in the excavation sand publication strategies within specific catchment areas, but variation between them. Therefore, comparing the data inter-regionally does present some clear problems.

Similarly, how we interpret the data by considering regional variation needs to be more conscious of geographical differences in disposal and deposition practices (Smith, et al., 2018, pp. 185-186). Specific object types or groups may have been disposed of in ways that were culturally or socially determined, and these may not be as easily interpreted as more obvious structured or ritual deposits. As cultural variation can be based on geography, it is likely that there may have been regional, and sub-regional, differences in deposition practice. This will have an influence on any dataset that examines the distribution of objects as a way of exploring inter-regional variation in rural food production and processing. If presence or absence is used as a measure of quern use, there is a failure to acknowledge the different disposal practices that may have existed in association with querns and millstones. Therefore, if in one region the practice was to dispose of querns at relatively unexcavated areas, such as at field boundaries, and another region disposed of their querns in building foundations, the latter region would show a prevalence of querns. If this were used to interpret greater activity related to food processing, it would not be a true representation of past events.

However, as food consumption and production are a vital component of Romano-British socio-economic life, the correlation between the presence of other objects alongside querns, such as agricultural tools, is well worth further investigation. In doing so, there a danger of becoming too literal in interpretation. The presence of certain tools does not necessarily mean that they were always used for specific tasks, as the use of objects can vary due to context, serve a range of purposes, and be imbued with diverse meanings at different times (Webster, 2001, p. 218). Not all uses would necessarily be interpreted as 'functional' according to modern concepts of utility; for example, tools deposited as votive offerings. In the past, however, ritualised use and practical use are unlikely to have been distinguished in such ways and would always have been performing some form of purpose (Brück, 2006, p. 307).

This makes consideration of depositional context and the treatment of artefacts highly significant when interpreting the presence or absence of tools on specific sites, a factor that is lacking in the graphs that present the Rural Settlement of Roman Britain data. Nonetheless, it must be acknowledged that, especially with regards to tools, that there are affordances that create a strong correlation between design and function (Swift, 2014, p. 204). Tools, such as querns and millstones, are designed to perform specific tasks and these designs suggest how they operate to the person interacting with the object; sometimes forcing certain modes of use. Use-wear analysis on artefacts can be used to further support interpretations that certain movements or actions were performed during the use-life of an object. It is acknowledged that although such analysis would be highly beneficial to the rural data, that this is not a realistic accomplishment with regards to this dataset. Without in-person analysis of querns and millstones, use-wear examination will not be possible as this is not regularly recorded in excavation reports. However, the concept of affordances can and will be applied to the data by investigating variation in mechanical features of querns and millstones. This will imply certain movements and operation methods that could reveal differing design related to differing function.

Preservation is also an issue that must be discussed in relation to querns and millstones. Although it is often assumed that objects of stone always persist in the archaeological record, this is unfortunately not true for those made of lava. Lava is sensitive to frost damage and does break down over time, making the remains almost unrecognisable as artefacts in some cases. Lava querns reused in road surfaces, floors or exposed walls may not leave much to be recovered, Soil conditions, such as acidity, also have a role to play and as a factor that is very much regionally determined, it can have a huge impact on where these objects are seen to be present and where they are thought to be absent. In those areas where lava is more likely to be broken down through post-depositional processes, fragments are not always recognised as potential evidence for querns.

Quantification itself raises some very important considerations, many of which are not addressed in the data interpretations. On detailed examination of the quern data compiled as part of the RSRB project, there were some inconsistencies in how querns and mills were counted at each site, though it must be emphasised that this was not always controllable. The issue lies mainly in the presentation of results across the various excavation reports used as the source of raw data. Various strategies have been utilised in these reports, which include the following: counting quern fragments individually, counting by feature, counting by context, using the weight of fragments, only cataloguing complete or near-complete examples. All these approaches provide ways of achieving the same objective, though they have the potential to generate very different figures. However, it is not always possible to quantify querns using a blanket methodology due to a lack of detail in the necessary raw data. For example, if weight were to be used to determine minimum numbers of querns present, only a few sites have made this information available and so it cannot feasibly be used in a consistent way. Most reports appear to use quern fragment counts as a method of quantification, unless there are clear refitting parts. This is mostly replicated in the RSRB data, though the precise strategy in use has not been detailed. Therefore, it was necessary to return to the original publications to reassess how the milling tools had been counted and to, on occasion, adjust the volumes provided to follow the methodology set out in Chapter 2. There are clear problems with this approach, as has been well-recognised and addressed in pottery studies that also tackle high volumes of fragmentary artefacts (Millett, 1979; Orton, 1989). Although this is discussed in more detail in Chapter 8 it must be acknowledged here that without a uniform strategy for recording querns and millstones by the excavators, there cannot be a consistent way to gather and apply quantitative data relating to them. Though the issue is present in the dataset and has not been dealt with fully, it is necessary to find ways of using the information available until a more consistent recording strategy can be developed and implemented across all archaeological investigative work.

The analysis that has been completed on the main artefact groups does reveal some interesting insight into the use of querns and millstones in Roman rural Britain. However, there is still a great amount of detail that can be extracted from these data and applied to this research. One of the main criticisms of the analysis is the lack of chronological information, which must be considered as a significant part of any archaeological inquiry. Regional and sub-regional differences must be examined chronologically. Although this is discussed to some extent within the project monograph, the graphs and tables are largely structured around presence or absence of the main finds groups. If a site presents one quern and this is dated to the early Roman period, followed by no querns for the rest of the Roman occupation, it reveals some very important information about that site. However, this would simply be recognised as a presence and the site would be counted alongside sites with multiple querns dated to various phases. This clearly misses some of the nuance that would be possible with a more detailed chronological examination of the finds data.

Similarly, there is a deficit of quantification in many of the regional analyses, and this is only sporadically tackled. Presence and absence of querns is one way of examining the data, but it does not give an idea of scale as part of inter-site and inter-regional comparison. It is difficult to visualise the data and to gain real-world understanding of the role that objects played in the past through presence and absence alone. There would be significant differences between a site with several hundred querns present and a site with one fragment, and there are benefits to examining this variation. Though this has been addressed in the form of tables of quantification data for some regions, these have been produced using different methodologies, and so, are not comparable with each other. These have been produced in a way that aims to make inter-site comparison within regions possible, by using percentages and ratios to adjust for differences in excavation scale and size of settlement. However, it would be beneficial to also allow for inter-regional comparisons. It should also be questioned as to whether data tables allow for the best visualisation of quantification data, as distribution maps might provide a better way for this to be interpreted and contextualised.

The final and most fundamental way in which my research can add to that of the RSRB project involves the separation between lava querns and those made from indigenous stone sources. The Roman Rural Settlement programme focuses on the presence or absence of millstones and querns, with quantification of these objects where possible. As the aims of the project were to gain a much clearer overview of Roman rural Britain and to integrate different data types, the data has been collected to serve this purpose and due to the scale and complexity of the undertaking, there is no differentiation between types of querns, and the materials from which they were manufactured. As previously mentioned, there is a significant difference between an object that has been imported and one that has been made from a local supply and classification of quern and millstone type, even at the most rudimentary level, is therefore vital to understanding the role they played in ancient societies.

The Dataset

There are a total of 920 rural sites in the Rural Settlement of Roman Britain database that yielded information on querns, out of *c*. 2500 sites recorded by that project. These were identified by a database search followed by thorough examination of the original site reports and publications, as geological determinations for querns are not provided as part of the rural settlement data. This also provided the opportunity to gather more detailed information about individual examples of lava querns, context of deposition, chronology and physical features relating to typology. It also allowed for the differentiation of sites that had lava querns or millstones present (n=363) with a total of 1467 objects recorded from those sites, and those with querns or millstones present but none of lava (n=557), with a total of 3210 objects[2] (figure 93). This dataset will be used in combination with the site and settlement data produced as part of the RSRB project to develop a greater understanding of the role of lava querns in Romano British rural socio-economic life. The data analysis will be structured to first explore the details pertaining to lava querns and millstones as objects: sizes, types, frequency, context of disposal etc. Following this, wider patterns of distribution and use will be explored.

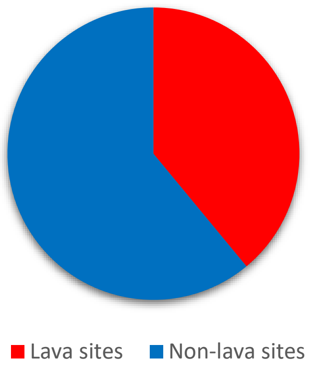


Figure 93- Percentage of sites in the dataset with lava milling tools present compared to those with milling tools, but none of lava (T=920).

[2] It should be noted that although 1286 sites from the RSRB database had querns present, it was not possible to include every site; excavation reports did not always provide geological determinations, and some reports could not be accessed due to Covid restrictions.

It should be noted that although the site designations used as part of the RSRB project have been utilised as much as possible, it has not been practical to mirror these precisely in every stage of the data analysis. There are various reasons for this, including the complexity involved in presented data that can recognise patterns across major and minor settlement types, alongside that of rural settlement form. Added to this, the problematic nature of assigning settlement types was considered. For example, if a settlement were to be enclosed by a 'defensive' ditch system, was associated with a major road, and had a Romano-Celtic temple, which of these would be considered as the most defining factor in its classification? Although the RSRB database can deal with the intersectional nature of these definitions to some extent, projecting it into this analysis created several problems when trying to visualise the data effectively. Therefore, for some areas of this study, the number of site designations was reduced significantly to accommodate the needs of this specific project. Sites were classified as either a small town/settlement, a vicus, a villa, or other. It was felt that this provided the means to explore different social groups within a rural context; civilian, elite, and military. With respect to the socio-economic approach applied as part of this research, it was determined that this differentiation was more important in terms of understanding lava quern distribution than whether a settlement could be described as 'complex' or 'enclosed'. The 'other' group describes sites that were not associated with a settlement at all, such as a road, field system, or single building of unknown purpose, while the small town/settlement group incorporates a wider variety of minor and major settlement types, including farms, farmsteads, defended towns, roadside settlements, and nucleated settlements.

For the distribution analysis in this chapter, the minor and major site types were utilised to a greater extent in a more nuanced examination of lava distribution. This analysis differentiated between roadside settlements, religious/ritual sites, defended small towns, funerary sites, villae, vici, small towns/settlements, farmsteads and 'other'. These were chosen as groupings, again, in attempt to present how lava quern distribution may have been influenced by social differences and levels of connectivity with other parts of the province. For future researchers, the full breakdown of minor and major site designations as provided by the RSRB project is included for each site recorded within the full quern database.

Millstones vs Quern stones

For the purposes of this research, lava millstones have been defined as being over 500mm, though features typical of millstone operation should also be sought on individual stones as larger querns may have existed (Chapter 4). For other stone types, there is less clarity in terms of where the division between querns and millstones exists (Chapter 1). The RSRB project used 600mm to establish this threshold. However, it was found within the site reports that millstones were often identified using other means; occasionally resulting in a millstone identification when the diameter was less than 600mm, and sometimes when diameter measurements could not be taken. For example, signs of fixtures or fittings to suggest mechanical rotation can also be used to categorise a stone (see Chapter 2). Therefore, the dataset presented here contains 'millstones' that may not fall into this category based on size alone. Designations have been determined based on individual object features, sizes, and descriptions.

From the 363 sites with lava present, 1467 querns or millstones were recorded; 17 identified as millstones, 502 as quern stones, 949 unidentified (figure 94). It is worth noting that the fragmentary nature of lava creates problems when attempting to identify diameter, as seen from the large number of unidentified examples. As diameter is a fundamental measurement that determines the separation between a quern stone and a millstone, those identified constitute a sample of what may have existed in the Roman period. From the chart it is possible to see the scale of the issue relating to identification. Once fragmented, millstones are much harder to identify and it is difficult to know whether the proportion of lava millstones present in the dataset reflects preservation, or if lava millstones truly were as rare as the data suggest. From the non-lava data, 3048 querns and 162 millstones are represented. Other stone types, such as sandstone and conglomerate (figure 95), are much less affected by preservation and identification is less of an issue, which is reflected clearly in the data. This may have resulted in better identification of millstones for those of non-lava types, though the numbers of millstones are still heavily outweighed by the volumes of querns. In terms of proportions, as a ratio of lava millstones to lava querns there are approximately 1:33, while non-lava examples show a ratio of 1:20.

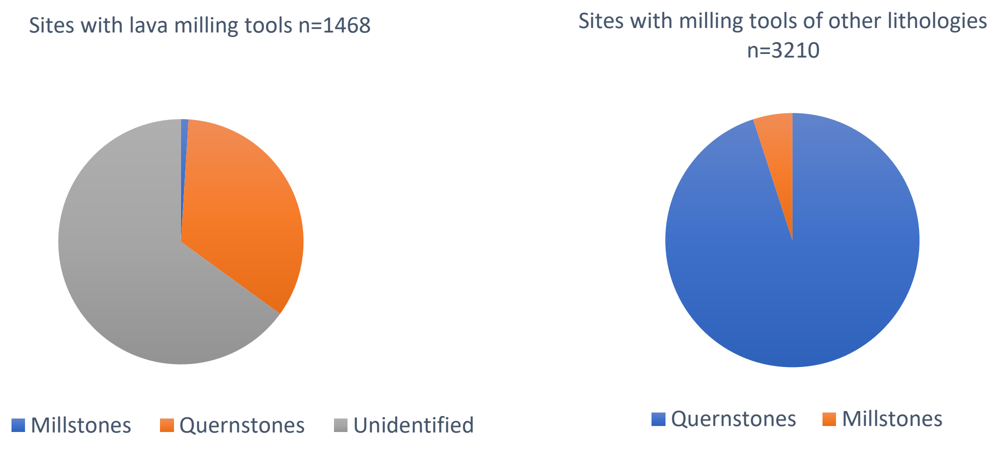


Figure 94- Percentage proportions of millstones to quern stones for sites with lava and non-lava milling tools.

Figure 95- Conglomerate Puddingstone quern from Chichester district that shows excellent preservation (photo by author, ©Novium Museum).

The issue regarding sizes of millstones should be investigated further, however. The physical limitations and abilities of the human body have been used to determine the threshold of what constitutes a quern and a millstone; anything too large cannot be operated by hand as a person would not be able to create the movements necessary. Although this provides us with a suitable measure with which interpretations can be guided, it is not drawn from archaeological data. As has been shown for lava milling tools, it may be possible to better distinguish querns from mills by systematically comparing the diameters of milling tools of specific types to see where measurements diverge. There is no requirement to separate upper and lower stone measurements, as diameters for paired stones are known to have been almost identical.

The high level of standardisation present in lava querns highlights those objects that do not fall within the 'normal' specifications, making it possible to determine a difference in diameter between standardised querns and less common specialist millstones (see Chapter 4). From figure 96 this standardisation of size is clearly visible for rural sites also, with the size range of 401-450mm being the most common amongst the 177 specimens complete enough for measurements to be taken. This standard size of a lava quern does not appear to exceed 551-600mm, which is where the classification of millstone can begin to be applied. Looking in more detail at this data using only smaller size categories up to 580mm and discounting the 'obvious' millstones (figure 97), it is possible to refine this further. From this, it appears that most lava querns are between 381-460mm in diameter, with some larger sized querns/smaller sized millstones occurring in 461-500mm range. The clear separation from a standardised diameter occurs after 500mm, where sizes are both inconsistent and infrequent. As millstones must be specially manufactured to fit the mechanisms already in place in mill structures, millstones are less likely to be subject to the same degree of standardisation as their hand operated counterparts. The lack of clear conformity between diameters after 500mm appears to match what could be expected of millstones. These results agree with what has been identified within the wider dataset, showing that the source of lava milling tools for the rural parts of the province were probably the same as that of the whole of Britain.

In completing this analysis, it is also important to recognise the degree of error that could be present in the data. Diameters could only be precisely measured for stones that were at least 50% complete, and greatest accuracy could be achieved only for the largest fragments. A large proportion of the data for diameters was estimated using the curvature of the outside edge, or by assuming a centre point and extrapolating the possible size. Therefore, a degree of inaccuracy must be assumed. Figure 98 displays the diameters of each individual quern or millstone in the dataset as a histogram, identifying the measured and estimated examples. Although there is a great deal of agreement with regards to the standardised sizes of querns between the measured and estimated stones, it is quite clear that measured diameters do not measure less than 380mm. There is a strong indication that the smaller estimated querns in the dataset may have been underestimated, as these do not fit within the normal measured range. This range lies between 380mm to approximately 500mm, and there is close agreement across the entire dataset. With both estimated and measured stones, there is a clear deviation after 500mm, and this appears to correlate with what has already been surmised about the separation between quern stones and millstones.

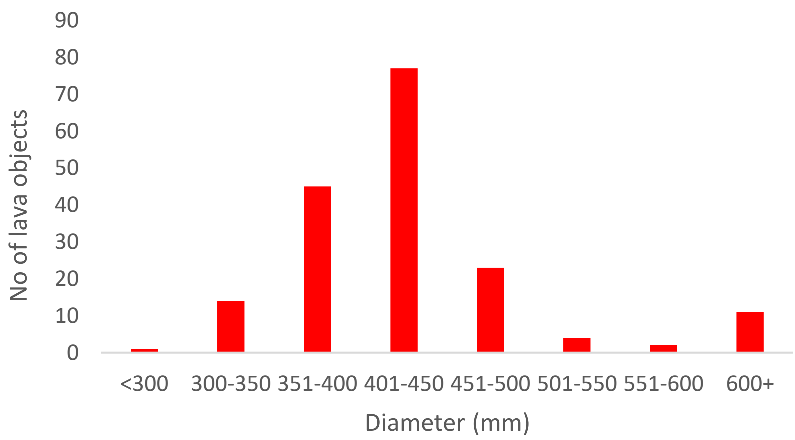


Figure 96- Frequency of different diameter groups for lava quern stones/millstones (T=177).

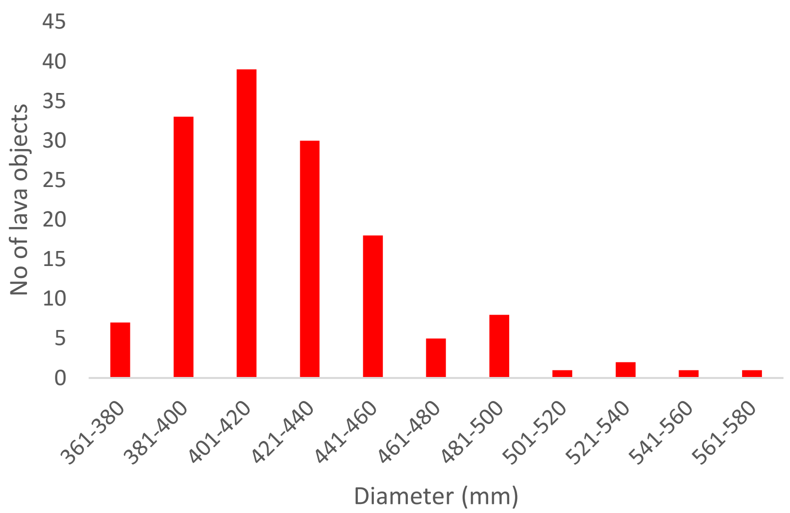


Figure 97- Frequency of different diameter groups for lava quern/millstones up to 580mm (T=165).

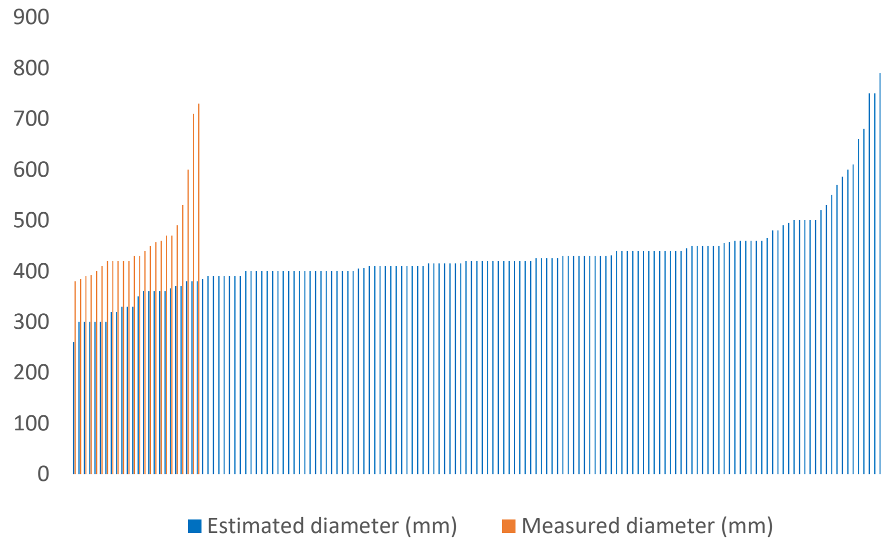


Figure 98- All measured and estimated diameters of lava querns and millstones (T=176).

Rural quern stone thickness

The thickness of a quern stone is indicative of the extent of its use prior to disposal or deposition. As discussed in Chapter 4, this could demonstrate perceived value of the object and relate to the economy of supply with regards to the replacement of old and worn querns. The thickness at the edge of quern stones was recorded in the dataset for a total of 62 lower stones and 114 upper stones. These values were separated according to upper and lower stone, as these will wear differently. For the upper stones, the thickness was plotted onto a histogram for each individual stone (figure 99) to show the range and frequency of thickness within the dataset. They ranged from

20mm in the smallest instance, to 100mm in the largest. As unused upper lava quern stones are known to have had a thickness in the range of 100-120mm, some of these clearly represent little used or unused examples. The largest proportion, 60% (n=71), fall in the range of 39-60mm thick and demonstrate the thickness at which upper stones were more likely to be disposed of. As the upper stones were more vulnerable to wear around the central hole that housed component parts for enabling the rotary movement, these were more likely show a consistent pattern of disposal due to wear. The data appear to support this, though the thicker querns may not have been completely worn and are worth investigating further to see if there could be other reasons for their deposition.

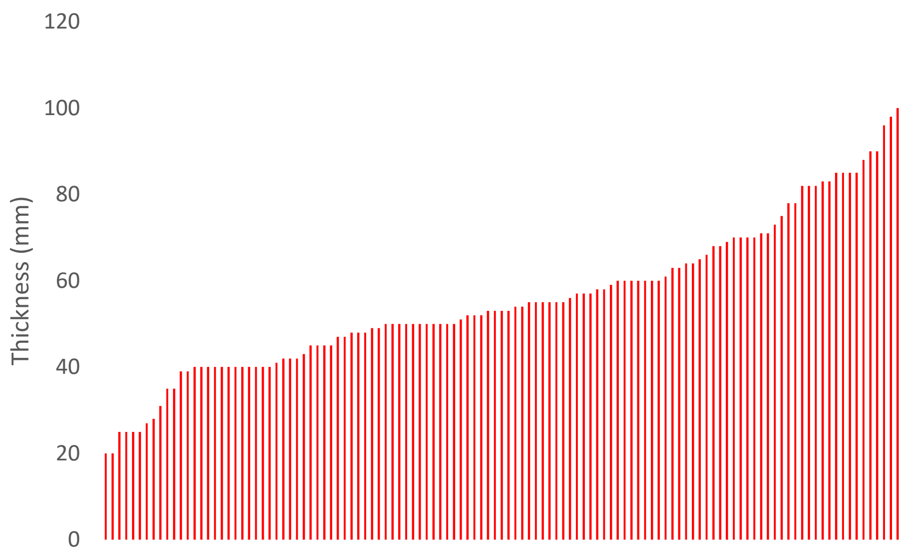


Figure 99- Max Thickness at Edge for Upper stones (mm) (T= 114).

Quern stones with a thickness of over 60mm represent 36% of the total number of upper stones (n=42). Of these thicker quern stones, 50% (n=21) were recovered from vicus sites, 38% (n=16) from small town/settlement sites and 12% (n=5) from villa sites. For clarification, the RSRB project refers to vicus sites as settlements close to military forts, and these would have been both inhabited and used by civilians, military personnel and people connected to military life. Within each site type, thicker querns comprised 23% of the total number of querns recovered from small town/settlement sites, 32% of the total at villa sites and 75% of all querns from vicus sites (table 9). This shows that the querns recovered from vicus sites were more likely to be thicker than 60mm than those recovered from villa or small town/settlement sites. This can also be seen in figure 100, which plots the thickness of each individual quern in the dataset as identified by the site type. Although the range for the thickness measurements are relatively similar for each site type, there is a greater density of those over 60mm for the vicus sites. The close connections that must have existed between the military community and those inhabiting the vicus sites provides one possible explanation for the results seen, and this correlates closely with the data for quern thickness at military sites presented in Chapter 4.

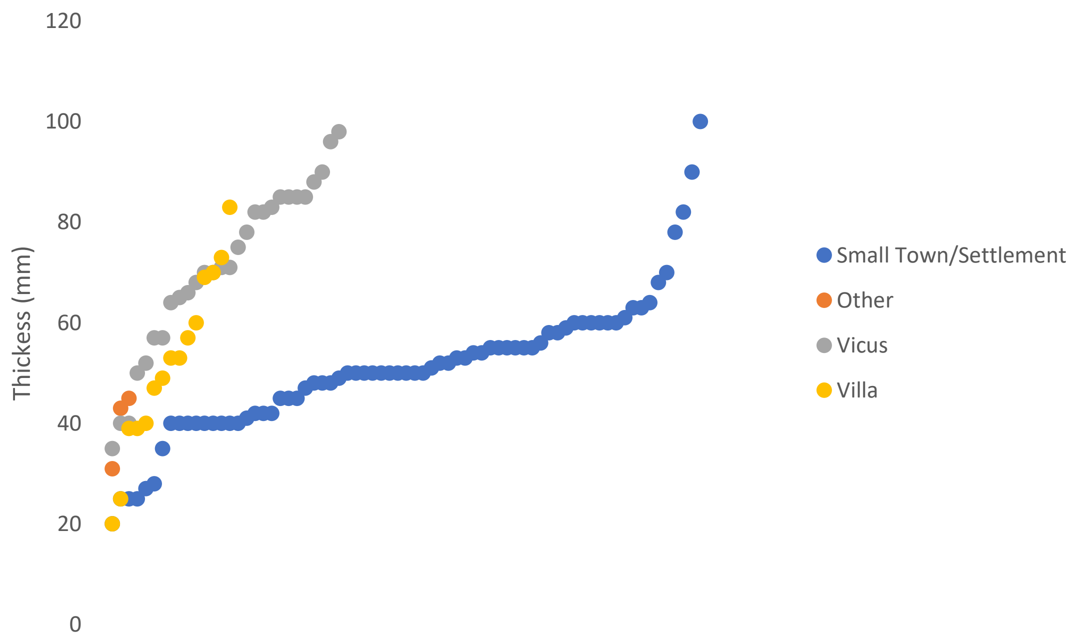


Figure 100- Individual thickness for each upper quern stone in the dataset, identified according to the site type from which it was recovered (T=114).

Table 9- Comparison of quern thickness by site type

Site type	Total querns recovered.	No of querns over 60mm thick.	% of thicker querns from each site type.	% of thicker querns within each site type
Small town/settlement	71	16	38 %	23 %
Villa	15	5	12 %	33 %
Military Vicus	28	21	50 %	75 %
Total	114	42	100 %	-

A similar process was undertaken for the lower quern stones (n=62) (figure 101), which showed a 'normal' disposal thickness at around 20-50mm. 79% of lower querns (n= 49) fell within this range, with 20% (n=13) in the upper range over 50mm. However, unlike with the upper stones, the lower stones do not demonstrate such an obvious difference between those within the 'normal' range of thickness, and those in the upper range. The variation is less pronounced and a shallower gradient on the graph. This is marginally steeper after a thickness of approximately 55mm, with a much lower frequency of querns with these thicknesses.

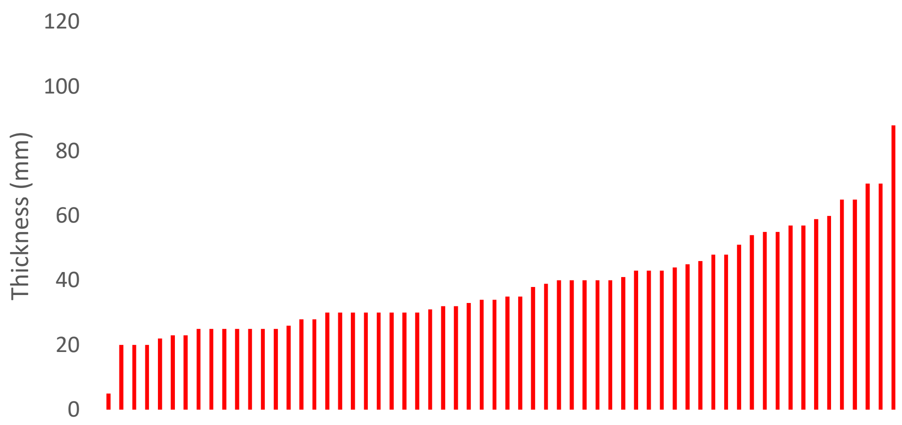


Figure 101- Max thickness of lower quern stones at edge (mm) (T=62).

Although the trend is less clear for the lower stones, it was still worthwhile to examine the thicknesses in relation to the site types from which they were recovered. These were also added to a scatter plot to demonstrate the individual thickness measurements for each lower quern in the dataset, identified according to the site type from which it was recovered (figure 102). Again, although the ranges of thickness for small town/settlement sites is like that of the vicus sites, the vicus sites have a slightly higher threshold of thickness when they were deposited. The thinnest querns at vicus sites were approximately 35mm thick before they were thrown away, whereas 61% (n=27) of all querns recovered from small town settlement sites (n=44) were less than 35mm when they were disposed of, a clear difference.

These results present some interesting possibilities with regards to the perceived value of a lava quern between different social groups, and the extent to which a quern could be used before it was deemed acceptable to dispose of/deposit. It seems likely that the pattern seen relates to the supply of replacement querns and differing accessibility to exchange networks. Other considerations might include the ease or difficulty posed in replacing a quern, and the question of expense/relative wealth of the consumer. It is important, therefore, to understand how different site types experienced connectivity, and how this may have had consequences on the value attributed to different types of material culture. Though it is well-known that vicus, villa, and roadside settlement sites had good access to a range of goods, as shown by the volume and types of material culture present, how this relates to the perceived value of an object is less well-researched. As objects with a quantifiable way of measuring use-wear, querns may allow us to explore this concept. Though the results shown here are merely suggesting a possible correlation between access to exchange networks and object value, more data would provide much greater resolution and would enable other trends, such as that of regionality, to be explored.

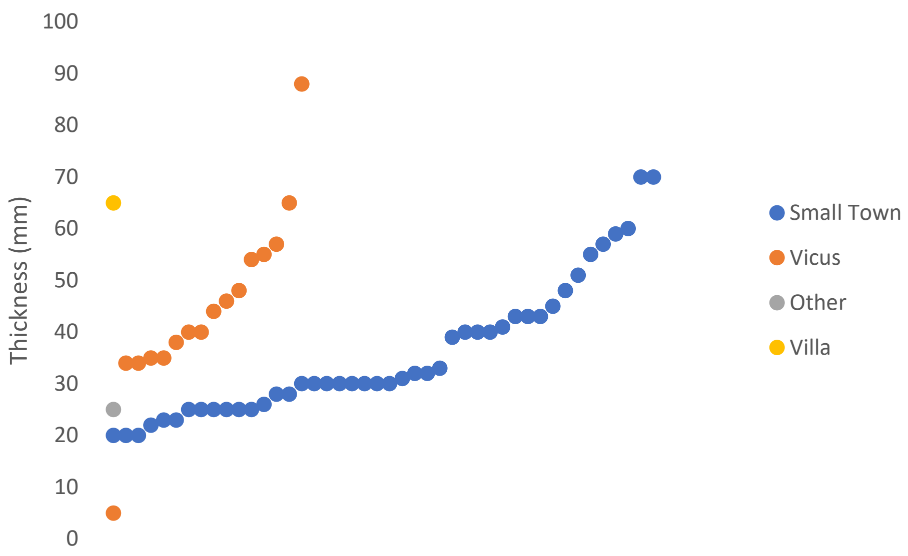


Figure 102- Individual thickness for each upper quern stone in the dataset, identified according to the site type from which it was recovered (T= 62).

Distribution Analysis

A record was made of both the locations of lava querns/millstone sites and sites where querns/millstones of other lithologies were found, but none of lava. It should be noted here that the sites with lava present usually also had querns of indigenous stone types within the same site. These are not presented on this distribution, though a more detailed analysis of this variable will be undertaken as part of the examination of the province-wide dataset (Chapter 4). To explore the economic aspect of quern/millstone transport, trade and exchange, the location (assumed or confirmed) of Roman period roads were also plotted (road data derived from Talbert & Bagnall (2000), as used by Ancient World Mapping Centre (2012)), alongside the location of the ports or harbours that are thought to have been in use during this period (data compiled by Cleere (1998)). It must be noted that the chronology of the roads and ports/harbours is not identified on this map, and they will not all have been present or in use throughout all phases of Roman occupation. However, due to the scale of the data being examined and to enable better visualisation, it is necessary to simplify some aspects on the maps and to instead deal with nuance, including chronology, within the discussion and interpretation.

Similarly, location data for the presence of military forts/fortresses was added to the map using a variety of source data, though this is only visible for the close- view maps. These are all confirmed military sites, though not all have been excavated and none are identified here with regards to chronology or phases of use. Those military sites identified solely as 'Saxon shore forts' have not been included, as these are less relevant to current investigations concerning early to mid-Roman period lava quern trade and exchange. The reason for the addition of military sites is due to the long-standing hypothesis that lava querns and millstones were initially introduced to Britain with the arrival of the Roman military (Gluhak & Hofmeister, 2011, p. 1604; Green , 2017, pp. 171-173). These objects are thought to have been imported as part of military contracts and used primarily within military contexts (Peacock, 1980, p. 50). Therefore, any relationship between military and rural sites, in terms of distance and interconnectivity, is an important factor to consider when examining rural distribution. The main urban centres have also been added using data taken from the Oxford Roman Economy Project (2021), and the backdrop mapping used in all distribution mapping is the copyright of the Ancient World Mapping Centre (2021).

General distribution- Examining presence/absence of lava milling tools

The initial means of analysis was to use 'point' data with indications of volume for the number of lava and non-lava milling tools from all rural sites. The main reason for this was to provide a way of displaying both presence and absence data on one map, something that cannot be done easily using a heatmap. This, therefore, allows for an assessment to be made with regards to 'missing data' and regions of Britain where we are unable to make interpretations relating to quern or mill use. Querns and millstones were vital tools for daily food processing activities wherever grain was consumed, and should be present, in some form, in most regions where domestic occupation is evident. Centralised methods of grain processing may have negated the need for querns to be present at multiple sites in a region, but this does not account for some of the large gaps in data seen within this dataset. The gaps in distribution mark a much wider trend in regional deficits of archaeological data and highlight some of the issues faced when attempting to identify provincial-wide patterns in distribution and consumption. Missing data in central East Sussex, the north-west, central-west and Wales is not a problem that is confined only to this project (Fulford & Brindle, 2016, p. 9) and more work must be done to understand the role these regions played in rural Roman Britain and to better contextualise the data that we currently have.

From figure 103, it is clear that there is an east-west and a north-south divide in the data, which follows expected trends according to the distributions of other finds types, for example coins (see Allen, et al. (2018) to map other finds groups from the RSRB data). Other expected patterns specific to lava querns and millstones are also visible (see Chapter 4, distribution section). It has long been speculated that one of the places that lava milling tools entered the province was at Colchester, and that this occurred in the early post-conquest period as demonstrated by pre-Boudican examples in the city (Buckley & Major, 1983, pp. 73-75). This has been interpreted as the result of Colchester's early associations with the military. Meanwhile, previously explored widespread distribution of lava querns at nearby settlement sites have been taken as indicative of 'civil/commercial' trade involving these objects (*ibid*). Although the distribution shown here does not absolutely confirm these findings, it does also present a high concentration of lava around Colchester and other parts of East Anglia and supports this theory. Similarly, several researchers have suggested that London was one of the primary locations that received lava querns and millstones via the Rhine using North Sea trading routes (Morris, 2010, p. 79). Therefore, it is not surprising that there is a dense cluster of lava present at settlement sites around the Thames estuary and the Greater London area. The urban material will be discussed in Chapter 6, but it is interesting to note here that rural finds are clustered around the Thames estuary region perhaps suggesting the impact of water transport rather than London acting as a centralised distribution area for these objects. However, the high level of modern development in this area could be over-emphasising the concentration of lava distribution.

In areas with high numbers of lava querns (especially the south-east), there are relatively few sites that have querns but no lava present. At first glance, it would be possible to surmise that trade and exchange mechanisms involving lava milling tools had consequences for the distribution of non-lava and/or vice versa. It is likely that there are complex inter-relationships at play between the use of different stone types and the choice between imported and locally sourced querns. These are unlikely to have been uniform across space and time. Aspects of this distribution that need to be explored in more detail include chronology, local geology, preservation of artefacts and issues related to excavation and recording. Nonetheless, the data provide an opportunity to understand how and why this may have occurred. In the South-East, sites located away from Roman roads appear to have no access to lava querns but have produced small numbers of querns of other lithologies. Examples include Nonington in Kent, where two sandstone quern fragments were recovered, and north-east Horley in Surrey, where four greensand querns were found. Both these sites are dated from the Late Iron Age to early Roman periods, indicating that the chronology is the variable affecting the absence of lava at these sites, and that the road systems may have not been as relevant in these specific cases. The clear absence of lava along the south coast is another trend that is worth considering further and will be addressed in later discussions.

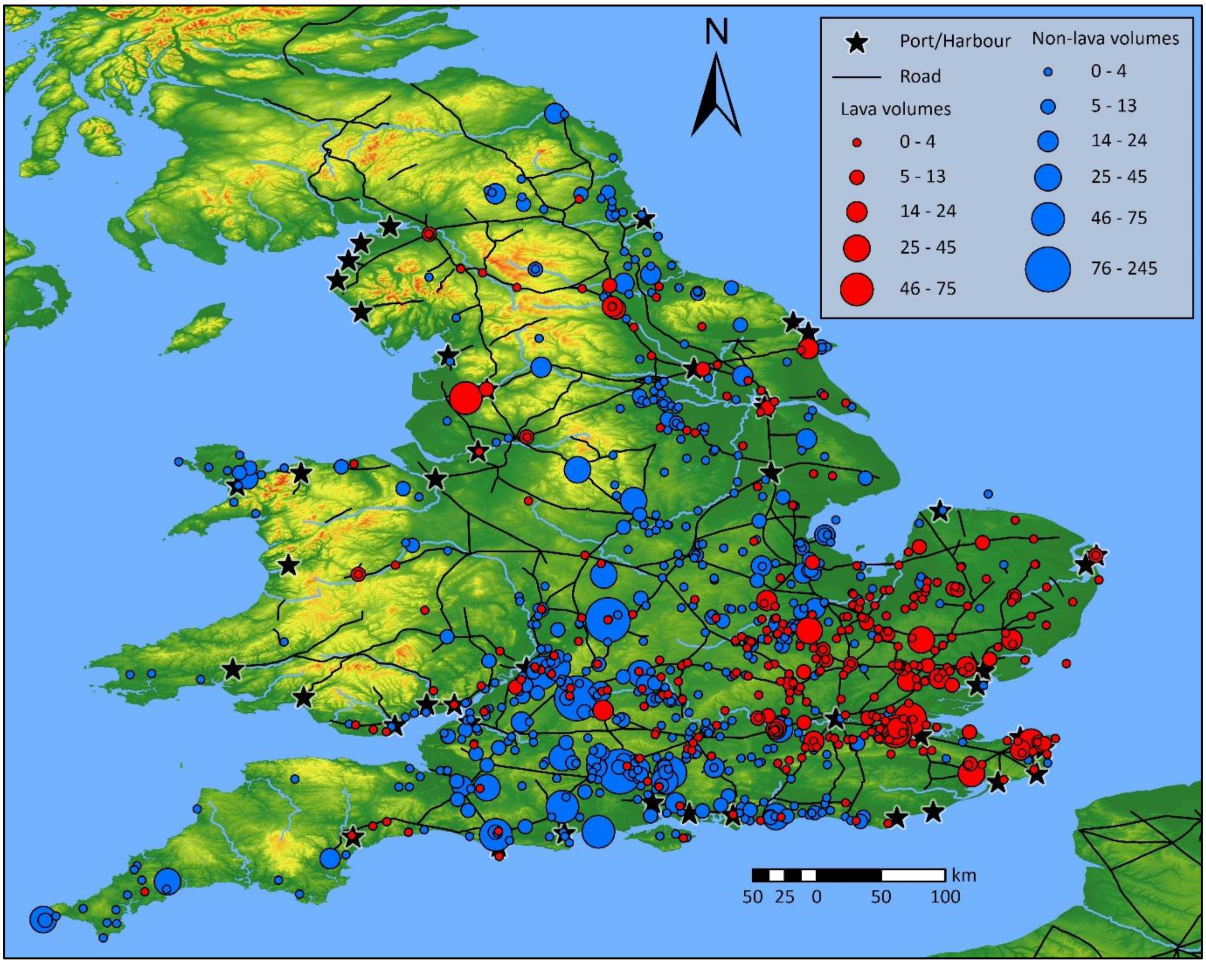


Figure 103- Rural distribution map to show the presence of lava milling tools in Roman Britain and their relative volumes, alongside locations of sites with milling tool, but none of lava.

Lava querns can be seen to occur in a wide band from the dense distributions around London and Colchester, moving westwards towards Wales and the Bristol Channel where there is a presence of lava at multiple sites. The route of the Thames appears to have some correlation with this data though there are sites to the north and south of the river that follow the Roman road network west out of London where the presence of lava is also clear. The distribution makes it difficult to distinguish between the role of road vs river transport along this route, as either or both may have been involved. Unlike the eastern region of Britain and the south-eastern area around London and the Thames estuary where lava sites are dominant, the presence of lava is more frequently interspersed with non-lava sites further towards the west. If we assume that London and Colchester were main distribution centres for lava milling tools, it would be expected that volumes and concentrations would decrease away from these centres. Another way of examining and visualising this is through a heatmap to display the quantities of lava milling tools by location at the recorded sites within the database (figure 104).

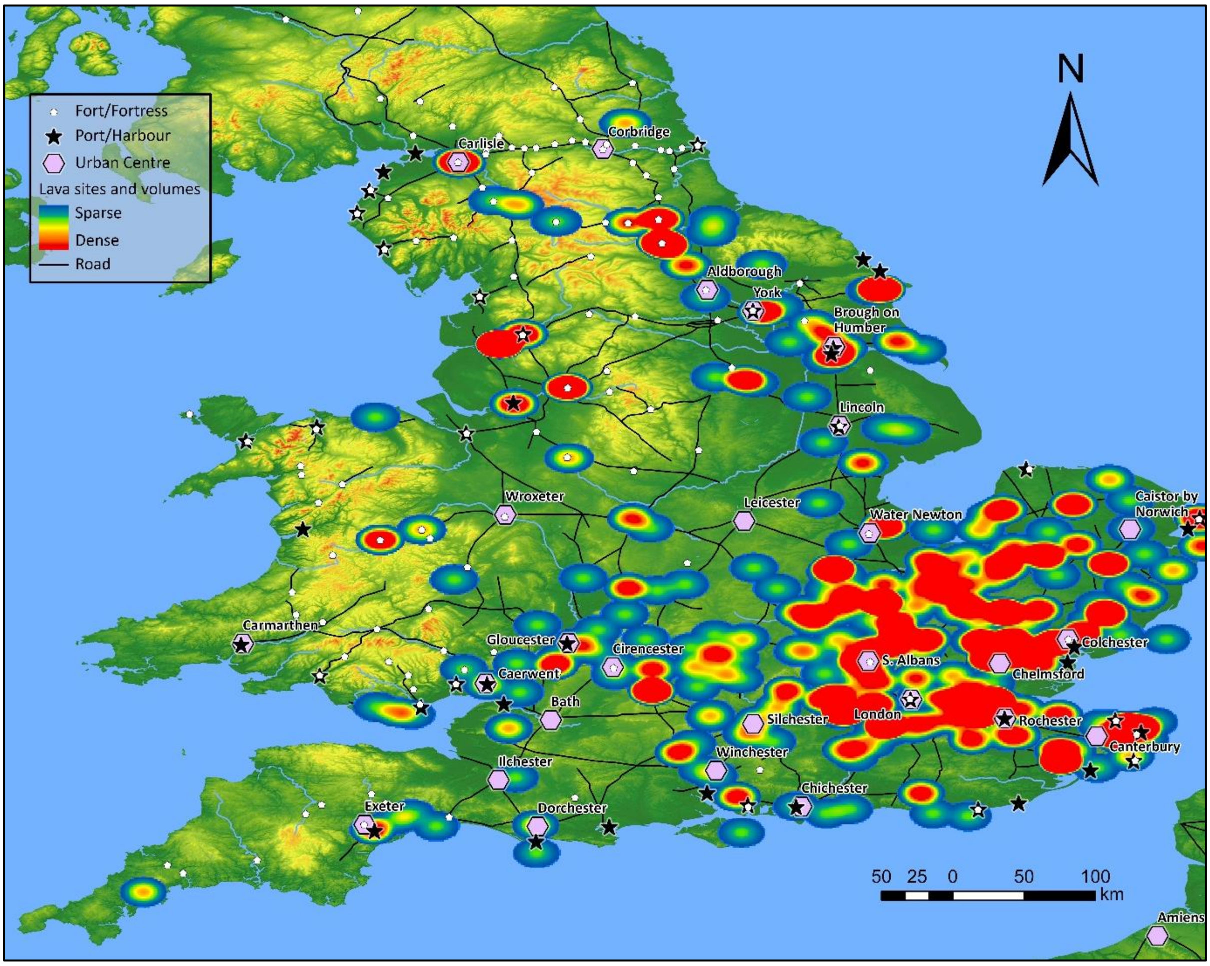


Figure 104- Heat map showing quantities of lava querns at rural sites.

As seen in the previous distribution, the heat map shows a visible difference in distribution between the north of Britain and the south, as well as between east and west; the south has greater volumes than the north, while there is also a marked greater volume in the east compared to the west. There are clear focal areas of distribution, which cluster around the urban centres of Colchester, London, and the Thames Estuary region. Interestingly there is also a heavy concentration around St Albans and Chelmsford, which needs to be investigated more fully. These areas may be within the catchment areas of London and Colchester respectively and so, it is worthwhile exploring this further with the addition of the urban and military site data (see Chapter 6). At present, it appears that urban centres in the south-east and east of Britain were foci for rural site lava distribution, while in the north, the clusters are mostly centred on military sites. The southern distributions centred on urban areas is of interest, as it has been concluded by Shaffrey (2021) that at Silchester, querns of other stone types were not distributed to the hinterland via the urban area. Similarly, rural distributions of pottery in the hinterlands of Silchester and Wroxeter have supported the idea that the urban areas were not market centres of distribution (Evans, 2007; Fulford, pers. com). However, as the Wroxeter hinterland did not yield much in the way of imported pottery at all, it is unclear whether this signifies a cultural and social separation between the consumption of imported goods in the urban vs the rural populations in these regions. Nonetheless, the distribution of lava in urban hinterlands of eastern parts of Britain suggests that lava querns saw very different distribution methods and mechanisms than those of indigenous quern types. However, it would appear that these mechanisms were not unilaterally replicated across all regions of the province, especially in the west. The distribution seen may also be related

to the fact that many of the urban areas in the south are also ports. However, it is possible to see that landlocked Silchester (*Calleva Atrebatum*) also displays a similar pattern of lava quern distribution, as does St Albans (*Verulamium*). Volumes of lava decrease further west and north, and away from these centres. It seems clear that the ports at Colchester, Rochester and London had important roles to play in terms of civilian lava consumption, while other ports on the southern and western coast see much lower volumes of lava spreading out to rural sites. The ports at York and Brough-on-Humber show relatively high concentrations of lava reaching surrounding rural settlements.

Urban centres further west also show some clustered lava distributions, such as that seen at Silchester and Gloucester, though these are significantly less concentrated than around the more easterly urban areas. It is interesting to note that in the south of England, many of the rural concentrations of lava tend to be focused round urban centres, while in the north, excluding Hadrian's Wall, this occurs more often in association with military sites. This may simply be due to a militarised north and an urbanised south, though it will be worth exploring further to assess whether different parts of the country were supplied with lava through different mechanisms of exchange. The addition of the urban and military data will help to distinguish this more clearly. In the area of Hadrian's Wall, there are virtually no lava milling tools at rural sites within the dataset, other than those around the urban area of Carlisle.

The distribution of sites with only non-lava milling tools (figure 105) shows us that that finds have been recorded from the rural hinterland areas, especially on the eastern part of the frontier, but that lava specifically was absent. The lack of lava in these areas suggest that very different distributive mechanisms were in place, and that these appear to have excluded the civilian populations. However, there are relatively few sites from the hinterland regions, and as a largely understudied area, it is difficult to know if this is a true representation of past activities (Breeze, 2018, pp. 2-4). A shared geology for neighbouring rural and military sites at Hadrian's Wall would result in very similar soil conditions, and preservation bias during comparison is not an immediate

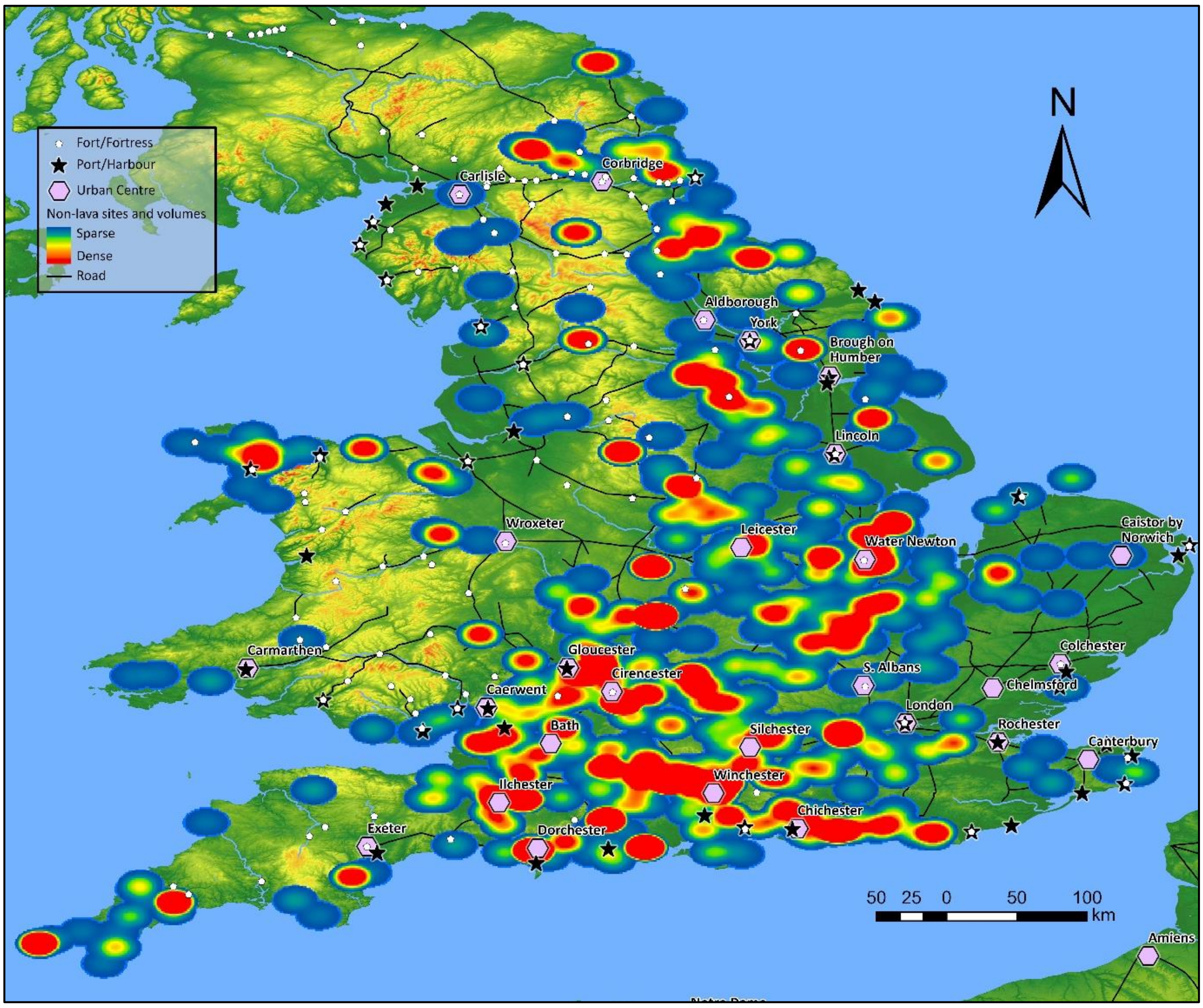


Figure 105- Heatmap distribution of non-lava querns and millstone volumes at sites with milling tools present, but none of lava.

concern on an inter-site level. Though the data are sparse for rural settlements, it should still provide a comparative picture of what was present or absent, though data resolution is an issue, especially towards the western hinterland regions of Hadrian's Wall.

The heatmap showing the locations and concentrations of non-lava milling tools at sites where lava was not present shows very different locations of clustering compared with lava presence, being most concentrated in a wide band stretching from the central southern coast northwards, through the midlands, heading eastwards past Lincoln and following the trajectory of the north-eastern coast before petering out slightly north of Hadrian's Wall. Unlike the lava milling tool heatmap, any centralised distribution areas are much harder to identify, and distribution occurs as a spread, with a much larger range of smaller clusters across a wider area. This is to be expected due to numerous quern quarries and production areas within the province. The known or assumed locations for some of these quarries is shown in figure 106. This allows us to view how, for example, the concentration of non-lava querns around the Chichester district probably relates to the local production of Lodsworth Greensand querns (Peacock, 1987), while the clusters seen around the Bristol Channel region may relate to Old Red Sandstone, thought to have been quarried from several locations within this region as observed by detailed examination of distribution and other evidence (Shaffrey, 2006).

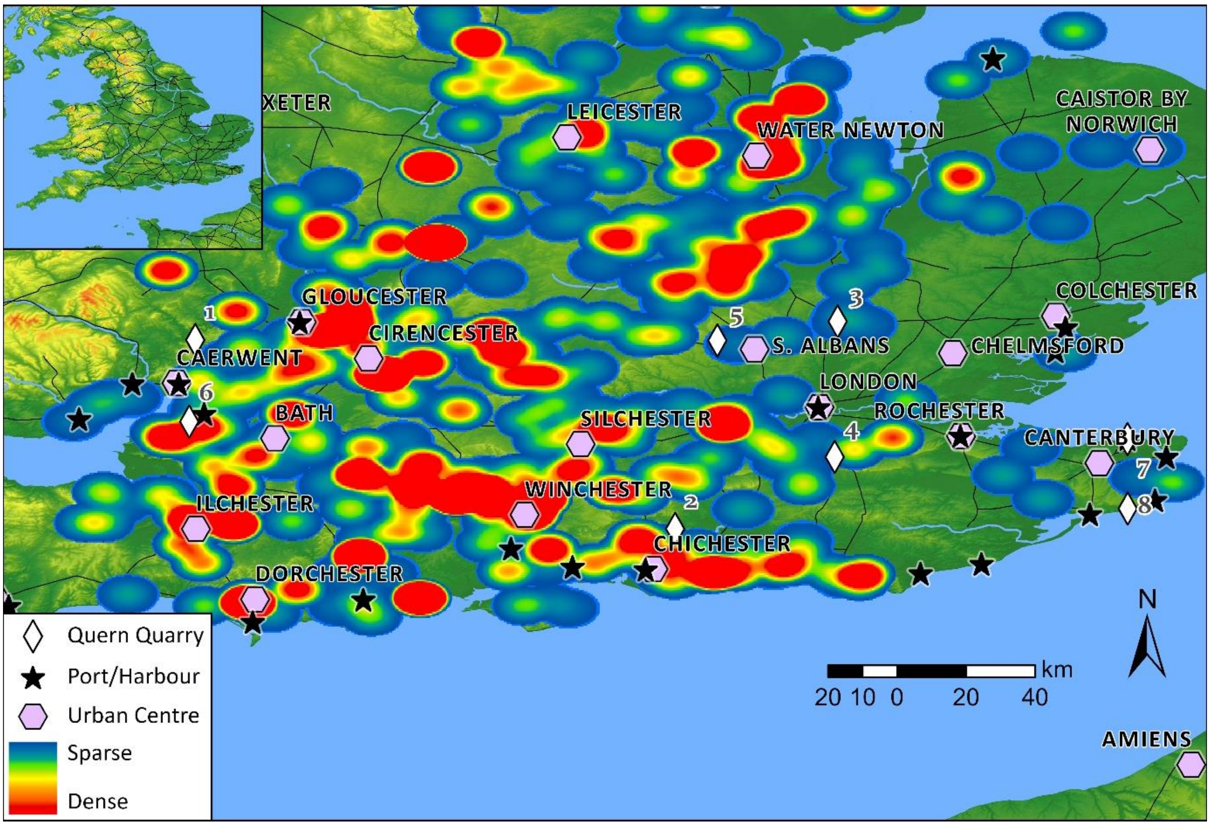


Figure 106- Heat map distribution and volumes of non-lava querns at sites with no lava present and the location of known or assumed quern quarry sites of indigenous stone types. 1-Pen Pits- Lower Greensand, 2-Pits Copse- Lodsworth Lower Greensand, 3-Colliers End- Hertfordshire Puddingstone, 4-Worm's Heath- Puddingstone, 5-Great Gadesden- Hertfordshire Puddingstone, 6-Penallt Quarry- ORS, 7-West of Reculver- Calcareous Sandstone, 8-East Wear Bay and Copt Point, Folkstone- Lower Greensand (Peacock, 2013, pp. 136-137).

Although not directly related to this current research on lava querns, knowledge of other quern production areas is fundamental to our understandings of how any trade involving lava operated within the wider Romano-British economy. It should be expected that interrelationships existed with regards to the use of lava or non-lava milling tools from different sources, and that any trade or exchange of these goods would have been affected by proximity to stone source/distribution location, costs of import/transport, availability, and desirability. It would be desirable, therefore, to consider these carefully and to include them within a wider discussion of the stone trade in Britain. Such detailed analysis is not, however, possible on such a large scale to include all possible quern quarry and production locations. This will, therefore, be tackled using a small-scale case study involving the Lodsworth Greensand quarry and its effects on lava distribution within the Chichester district, including Fishbourne Palace (Appendix 3).

Close-up analysis of distributions in East Anglia and the South-East

The main area of interest, in terms of lava querns on rural settlements, is in the east and south-east of England where there are large clusters of lava milling tools at a high number of sites. As previously discussed, it is unsurprising that these appear to be focused round Colchester, Kent, and London, as these have been long recognised as possible ports where lava was imported into the province, and possible locations for redistribution. However, using a closer view of the east and south-east region (figure 107), it is possible to see that in the direct vicinity of London there are fewer lava milling tools present. This may be the result of site misclassification in the wider London area, or the possibility that the area was not as intensively occupied or farmed during the Roman era. In direct comparison, there are some large clusters of lava in the immediate areas surrounding Colchester.

The main concentration of lava in the Thames region is further east, approximately 10km to the west of the 'civilian port' of Rochester (Fryer, 1978, pp. 150-153; Rippon, 2008, p. 89; Cleere, 1978), and this cluster is visible on either side of the Thames. This gives an indication that civilian trade and exchange of lava objects in certain regions may have occurred via different ports to that of military and urban supply. However, intensive modern construction in the Thames Estuary region as part of the Thames Gateway Project and HS1, alongside high levels of gravel extraction may have skewed the visibility of finds at large-scale excavations. Examples include Mucking and Springhead, which is where these clusters are focused. Nonetheless, the large volumes of lava querns and millstones at these locations, both rural and civilian in their context, may warrant further investigation. That the Thames was used as a means by which lava milling tools were conveyed into Britain seems to be indisputable. What is less clear are the mechanisms by which these found their way to rural settlements and whether the density of finds can be treated as indicative of a 'commercial' trade in these objects.

It is also interesting to note the small cluster of lava that is seen around Richborough and Reculver, both of which were ports and early military sites (Millett & Wilmott, 2003, pp. 184-185; Historic England, 1999). This distribution fits well with traditional interpretations relating to early military use of lava for milling (Gluhak & Hofmeister, 2011, p. 1064) and serves to demonstrate how commodities brought to Britain for military use could 'spill' out to nearby settlements that were geographically or strategically connected to military supply, and especially to ports. Again, however, the area has recently seen some intensive construction and development that could be providing a

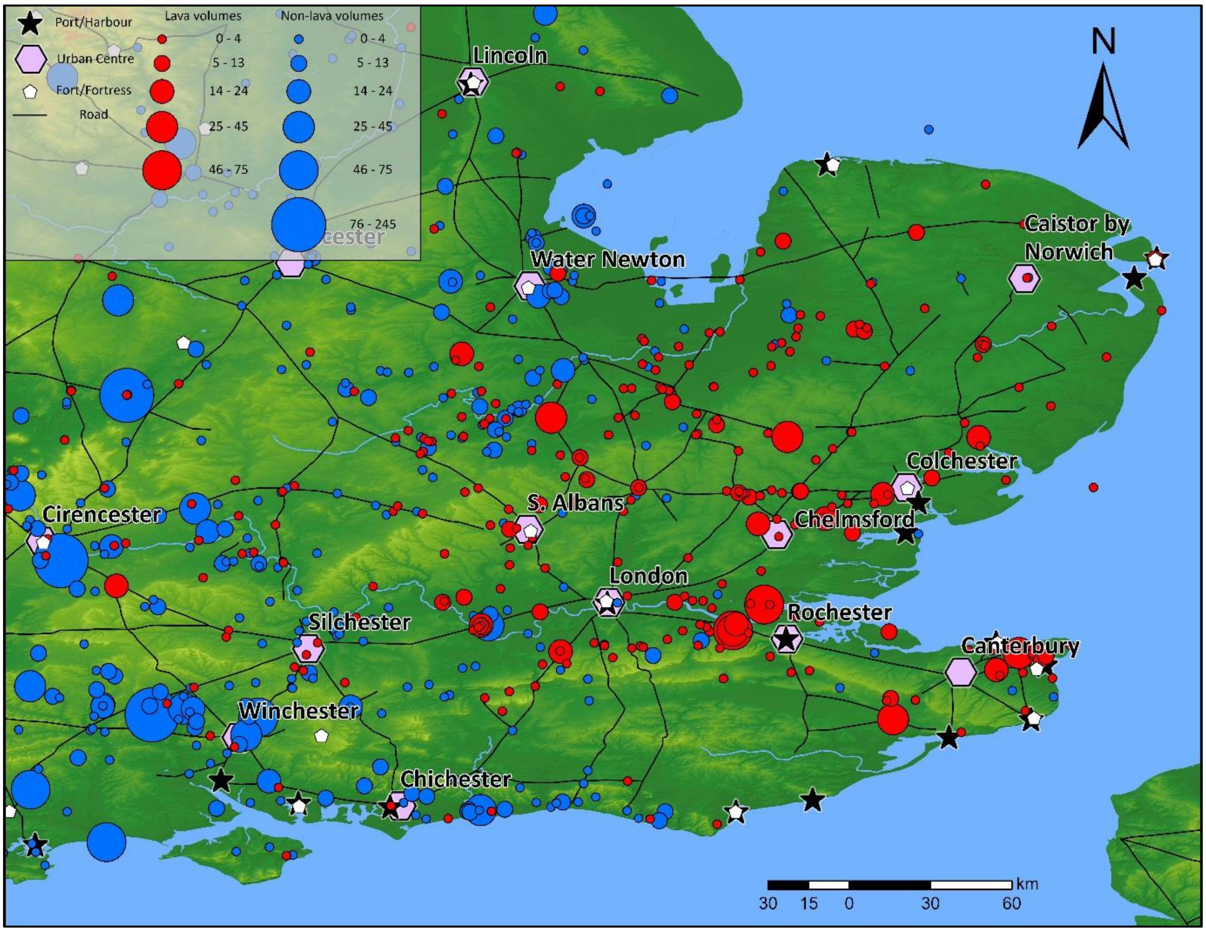


Figure 107- Distribution map to show the rural presence of lava milling tools in the eastern and south-eastern region of Britain, and rural sites with milling tools, but none made of lava.

false impression of concentrations in comparison with other regions. Colchester, London, and St Albans also were urban centres, though each had very different characteristics. Colchester was a presumed port with a very early military presence. The port was likely to have been in the area now known as The Hythe, in which case seagoing vessels will have needed to offload cargo to lighter craft downstream of the town (Crummy, 1997, p. 72). London was also a port, with a speculated early military character, while St Albans was civilian. This makes it difficult to determine which aspects of these sites that produced the driving force behind their role in rural distribution, or whether it was simply one factor of many. The fact that Colchester and London were some of the earliest occupied sites in Roman Britain may have some bearing on the early introduction of lava to the surrounding rural areas. If lava became less popular and imported in lesser volumes in later periods, this would have a clear impact on the number of lava milling tools that turn up on rural sites elsewhere in the province.

Another feature of this south-eastern distribution is the important role that roads and rivers must have played in the movement of lava milling tools. It is apparent that both modes of transportation were utilised and, despite the bulky nature of the goods, transport via road appears to have been just as vital as movement over water. This is not a new concept with regards to the movement of querns, as similar patterns of distribution via the road network were observed by Shaffrey (2006) for querns of Old Red Sandstone. The distribution does appear to suggest that the probability of having a lava quern in the south-eastern region of Britain is strongly associated with proximity to major Roman period transport infrastructure. What is most significant is that many of these routes via road or river connect clearly with the locations of the main lava clusters, in many cases, along a direct path. For example, the route from Colchester to St Albans presents multiple sites where lava is present. This appears to confirm that there were centralised distribution areas, such as Colchester, where lava milling tools were brought into the province and that it was from these locations that redistribution occurred via road and/or river to rural sites. This differs from the distribution of querns of other stone types, which were not dependent on urban sites in the same way that imported lava was (Shaffrey, 2021).

Distribution by site type

The map in figure 108 shows the distribution of lava milling tools with identification of the type of rural site from which they came, using the RSRB project site categories. From this, it is possible to see that in the east and south-eastern areas of Britain, there is less discrimination in terms of the types of sites where lava was found. Virtually every site type is represented, and none appears to be more dominant than another. Further west and away from the Colchester and London catchment areas, where the site clusters become less dense, there are more roadside settlement sites, defended settlements and villas with lava present, and the small town/settlement and farmstead sites become much less likely to have one of these objects present. This is the pattern seen as far west as Gloucester, where farmsteads are the least likely site type to have a lava milling tool. In the south-west, data are very sparse and there is only enough to say that two farmsteads close to a vicus site had lava present. Wales and the north-west of Britain show similar distributions. Lava is predominantly found at roadside settlement sites and vici. This is also true for the area around Hadrian's Wall, though defended small towns have also shown a lava presence. In the north-east and sites north of Lincoln, there is a scattering of different site types where lava was found. There are several farmsteads and three small town/settlement sites, though these mostly are near to either a vicus, villa, or roadside settlement site.

For comparison, Figure 109 shows the distribution for non-lava sites, again by site type. It is interesting to note that the sites in northern East Anglia without lava present are predominantly

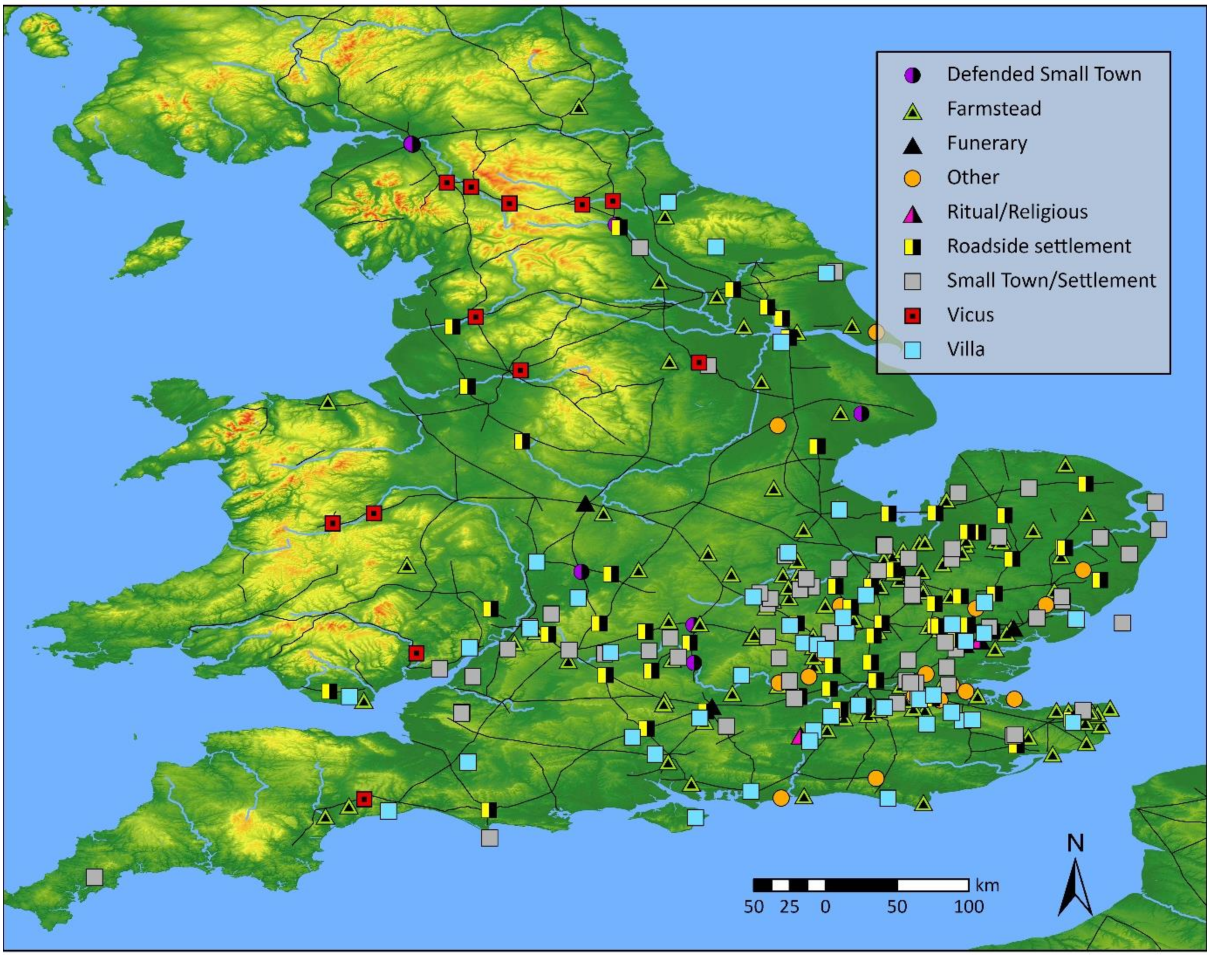


Figure 108- Distribution of lava milling tools by rural site type.

roadside settlements. Examples include Woodcock Hall and Crownthorpe, both in Norfolk. This is unexpected, as this site type tends to more likely to have more finds in general and are more likely to have objects that have been imported or manufactured elsewhere (Smith , 2016a, pp. 235-236). This will be worth some further investigation to determine why this may have occurred. Other than this, there are very few villae or roadside settlements within the London and Colchester catchment areas that have milling tools, but none of lava. West of London, it is mainly small town/settlement and farmstead sites that do not have lava querns or millstones, though south and west of Winchester, there is less discrimination based on site type, and more villa and roadside settlements become included. In the south-west, it is mostly farmstead and small settlement sites that use non-lava querns only, though this should be expected due to a decrease in the range of settlement types in this region more generally. Again, Wales and the north-west of Britain show similar patterns of distribution; several farmsteads, small town/settlement sites and some vici do not have lava. In Wales, these are mostly focused in the coastal areas or on the main river routes, though this may be due to the availability of data and site information. In the north-east of Britain, farmsteads and small town/settlement sites without lava are the most prolific, showing that alternative means of grinding and milling were used instead of lava. Lava was clearly not a popular choice in this area, either due to restricted access or choice.

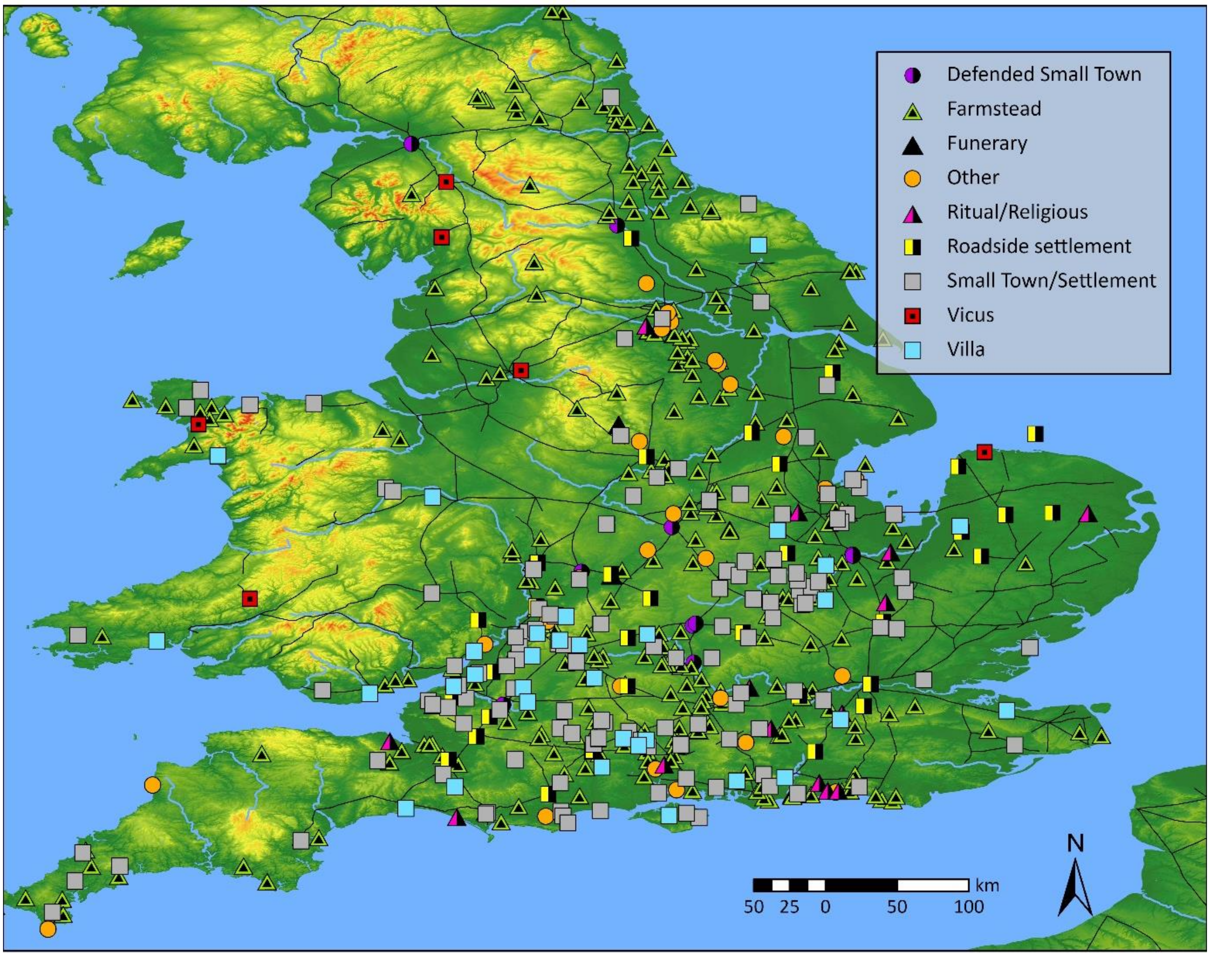


Figure 109- Distribution map showing rural sites with milling tools present, but none of lava by rural site type.

A close-up view of the east and south-east region is shown in figure 110, to provide clearer detail of the area with the highest density of sites. There are many small town/settlements, farmsteads, and roadside settlements, especially in the northern part of East Anglia, with lava present. There is a clear widespread distribution of lava, probably from Colchester where high volumes must have been imported for commercial exchange, and this reached the rural areas of eastern Britain to the extent that all types of rural settlement had access to the product. This is also true for the area around London, though there are more roadside settlements and villas that show a lava presence than smaller settlement types. This may just be due to the different settlements that existed within this region. The small cluster of sites around Richborough and Reculver with lava present are, also, of a

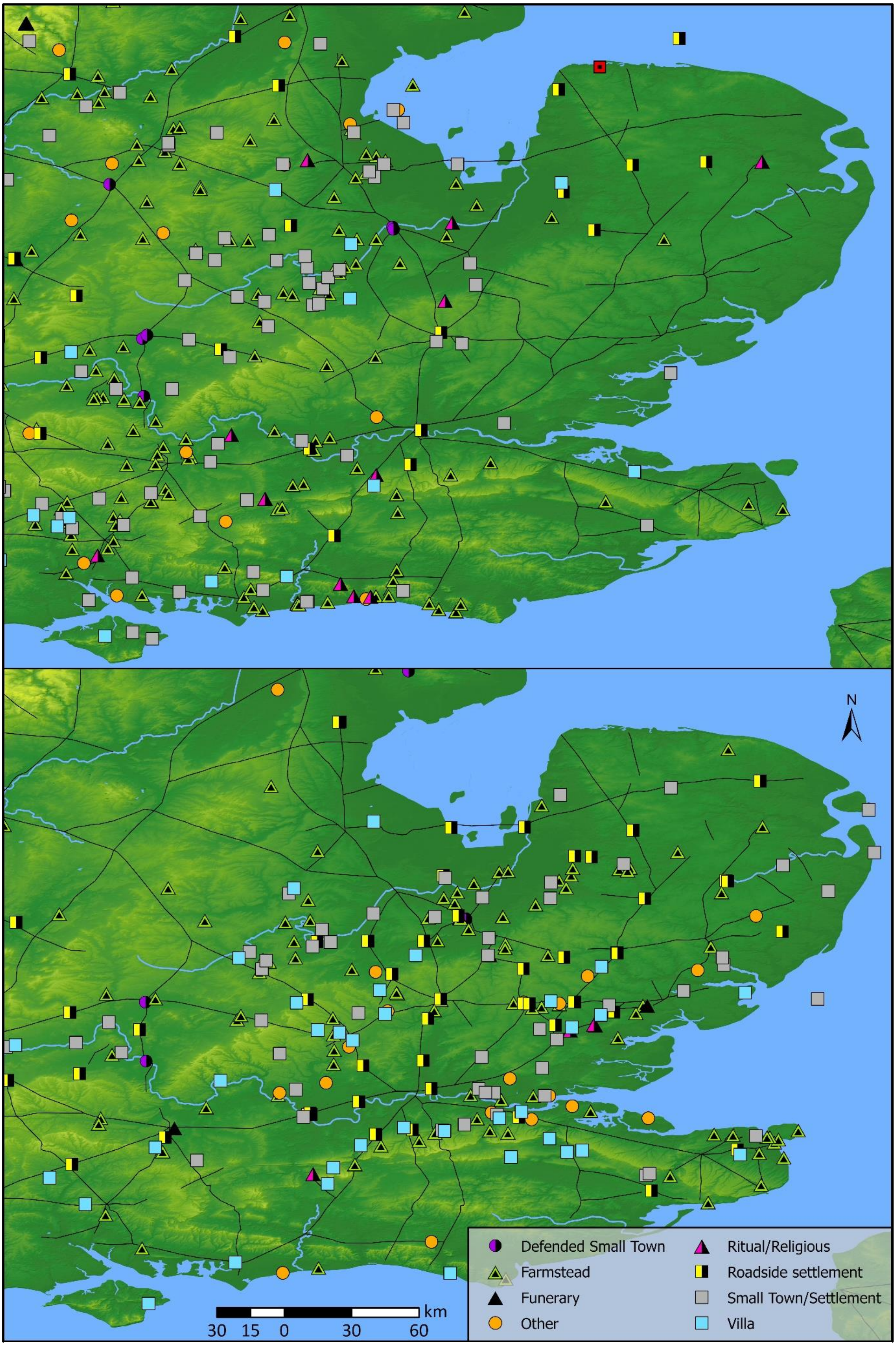


Figure 110- Distribution by rural site type of non-lava (top) milling tools and lava (bottom).

range of site types. This is like the pattern seen in East Anglia and could be indicative of large numbers of lava objects being available at this location for wider commercial exchange with other nearby rural settlements. The overall larger numbers recorded from Kent are, however, also a reflection of the large-scale road development and construction in the region in recent years, which has resulted in better documented assemblages from rural sites.

Further west from London and Colchester, though fewer sites in general have lava milling tools present, the mix of site type also changes. As shown in figure 110, the site types with lava present west of Silchester comprise the following: 10 farmsteads, 6 villas, 3 defended small towns, 7 roadside settlements, 5 small town/settlements and 1 ritual/religious site. Proportionately, it would be expected that there would be a much higher number of farmsteads and small/town settlement sites in existence and so this shows that there is a greater emphasis on villa and roadside settlements and that there is a higher chance of finding a lava quern or millstone at these sites than on a smaller rural settlement site type. In comparison to the data for this same area that shows sites with milling tools present but with none of lava, we can see that farmsteads and small town/settlement sites were more heavily reliant on other stone sources for their milling needs. However, a few kilometres west of Winchester, the situation changes again, and villas also become more likely to have a non-lava milling implement than to have been using lava.

In this region, it is also possible to see that non-lava milling tools are more likely to found than lava at sites that are characterised as primarily ritual/religious in nature (figure 111). This seems to occur in a relatively localised area to include Chanctonbury Ring, Lancing Down, Slonk Hill, Reigate Road, Wanborough Temple, Silkstead Sandpit, Weycock Hill. A smaller cluster of cases also exists between Water Newton and St Albans, with the possible shrine at Aldwick and the ritual/religious sites of Haddenham Shrine and Colleyweston. Lava occurs at four religious/ritual sites, the Romano-Celtic temple at Farley Heath, Great Chesterford Temple, the shrine and pottery production site at Ivy Chimneys and at Boreham Principia, the latter of which is only possibly a shrine and is more popularly recognised as a *principia*. It appears that lava is very rarely present at ritual and religious sites, with indigenous stone querns being much more commonly associated with these contexts, though mainly in a very restricted area south of Silchester, with a smaller group north of St Albans. This could simply be the product of proximity to sources of these indigenous stone types. For example, the cluster of non-lava querns close to Chichester could be the result of its location near to the Lodsworth quarries that were used for querns and mills in the local areas (Peacock, 1987). However, it would also be possible to argue that there was a deeper social and cultural association with these objects at these locations due to their production or distribution in these areas. For lava, these connections may not have existed due to it being an imported product.

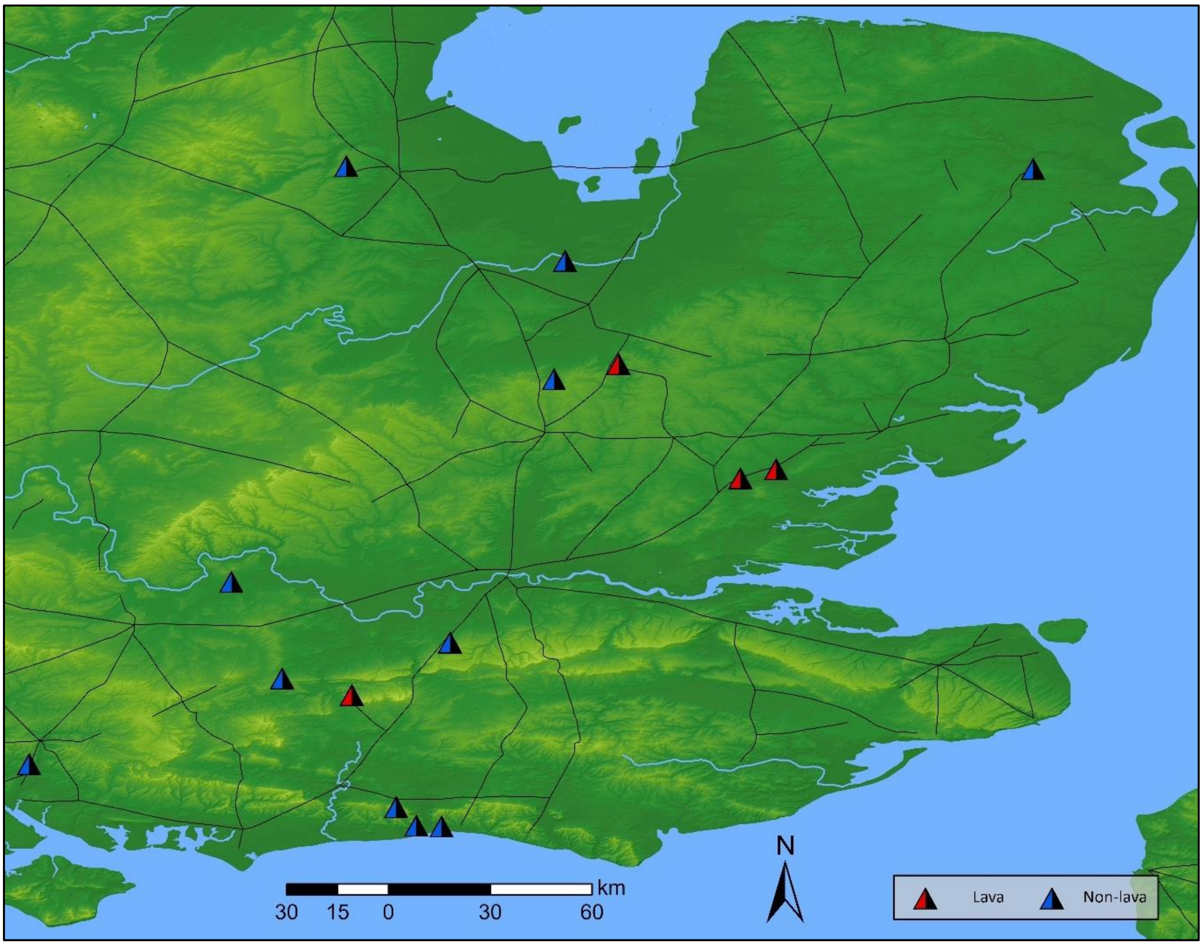


Figure 111- Location of rural religious/ritual sites with lava and non-lava milling tools in the east and south-east of Britain.

Chronological Distribution

Due to the often-residual nature of lava finds, with querns often reused or recycled, chronological definition is very difficult to establish. However, as there is a large volume of data within the rural database, this investigation hopes to provide a broad overview of chronological distribution. Lava querns or millstones that are likely to be residual or recycled have been omitted, and attempts have been made to only include those with well-dated, secure contexts with a relatively narrow date range. Initially, the date categories were established by centuries; first, second, third, fourth, and fifth (figure 112). This was to get a general impression of the pattern of chronological change and to highlight periods where better definition should be sought. It should be noted that due to some dating ranges spanning more than one century, some objects have been included on more than one distribution map. Unfortunately, phasing is different for each site, and it is not possible to correlate all dating information within the same scheme.

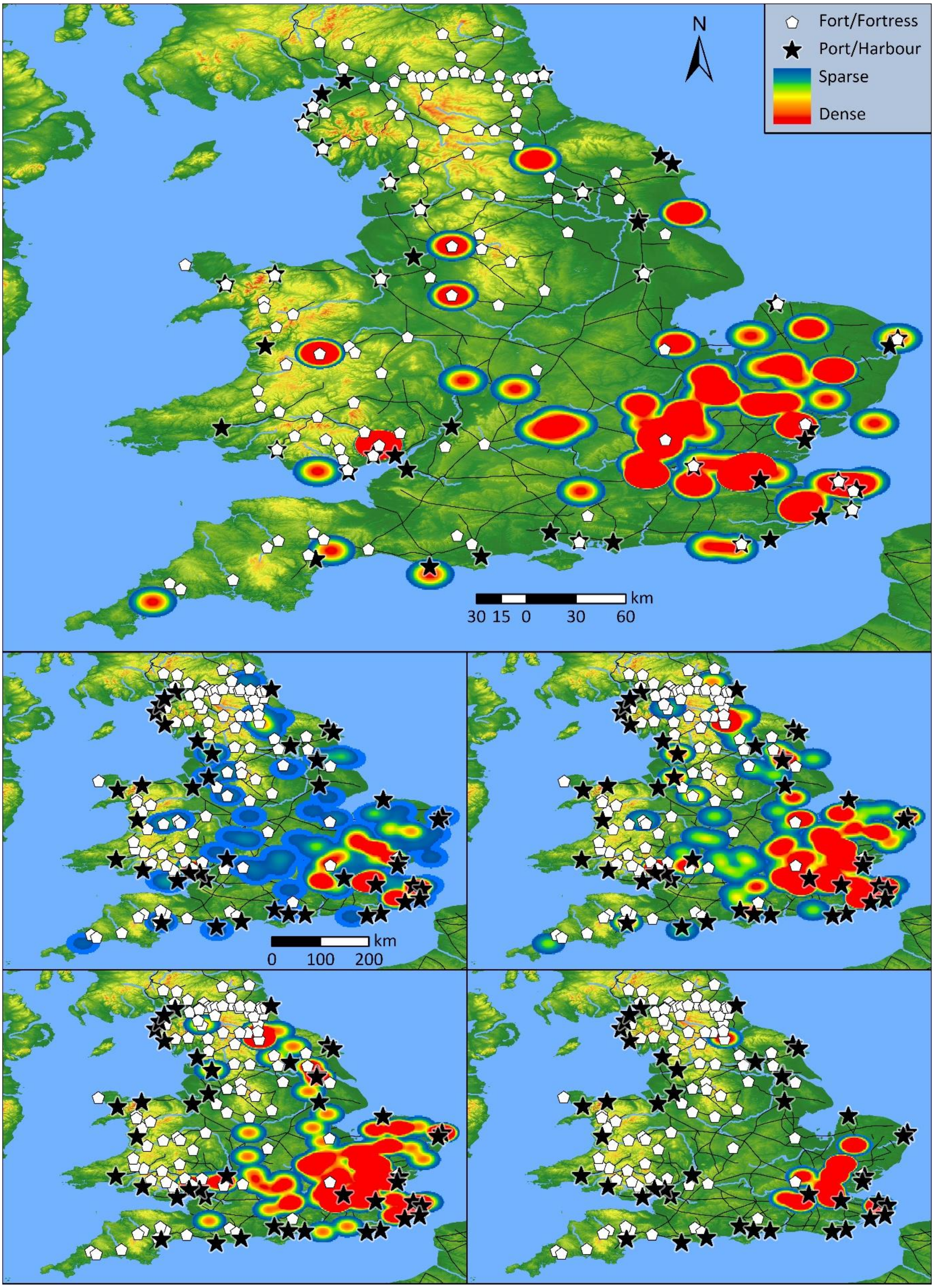


Figure 112- Chronological distribution of lava at rural sites, top first century, middle left second century, middle right third century, bottom left fourth century, bottom right fifth century.

As expected, the rural areas around Colchester, London, Richborough and St Albans see the earliest concentrations of lava. As the first three are early Roman ports, this fits well with what is currently known about the modes by which lava entered the province. The role that St Albans may have played will be subject to further investigation as part of the urban dataset in Chapter 6. Other sites that have lava from this earliest period include rural settlements in the north and Wales that are close to forts or fortresses, though none is present at the sites around Hadrian's Wall. The concentration of lava seen in the south-east of England continues into the second and third centuries, which follows the trend expected when considering the importance of North Sea trade during this period, and the movement of goods between the Rhineland and Britain as seen by other material culture types. Other than the south-eastern region of Wales, there is very little lava to be found in Wales after the second century, while it is more prevalent in the area around Hadrian's Wall in the second and third centuries, which fits well with current historical narratives relating to the movement of troops during these periods. It appears that large volumes of lava were reaching rural settlement sites in specific areas of the province in the first century, while in the second century, distribution was more widespread but not at the concentrations seen in the earliest period.

There is a pronounced contraction in the number of sites showing a presence of lava from the third century onwards and it is likely that much of the lava still visible on the heatmap for the fourth century represents querns or millstones that are residual. However, there is no clear way of defining the extent to which residuality has affected the distributions seen. As explained in Chapter 4, it must be assumed that there is a time lag between when a lava quern was last used and the point at which it reaches its final deposition location. It has been speculated that the import of lava milling tools largely ceased after the third century and the distribution maps support this idea, though they do not prove it completely. One way of exploring this further is to look at sites where occupation commenced after the mid-third century and the probability that lava was present. This reduces the chance that any lava present could be residual, though it does not eliminate the possibility that lava was brought from elsewhere as recycled or reused stone. Overall, there were 23 sites within the dataset that were dated to AD 250 or later, 16 of which produced only non-lava milling tools, while 7 produced lava (figure 113).

Of the sites that produced lava, most cannot be confidently shown to have produced securely dated lava of a late Roman date. Two, Old Shifford Farm in Oxfordshire and Totternhoe in Bedfordshire probably had earlier phases of occupation after all, raising the possibility of residual material being present (Hey, 1995; Matthews, et al., 1992). The site at Bletsoe in Bedfordshire is only tentatively dated to the mid-third century through sparse dating evidence (Dawson, 1994), while the small

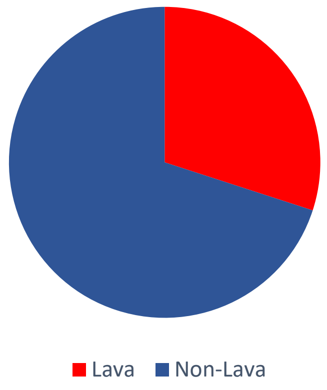


Figure 113- Sites with occupation dating after AD 250 showing percentage with lava (T=7) or only non-lava (T=16) milling tools present.

fragment of lava recovered from the surface of a ditch at Beech House Hospital in Suffolk was not from a secure context (Muldowney, 2008). It is suggested in the excavation report for Hartismere School in Suffolk that the lava from the site was old before it was deposited, as shown by the condition of the fragments (Craven, 2012). Nonetheless, two of the four fragments from Wickham Barn in East Sussex appear to be late Roman in date, and all must post-date the earliest occupation phase that commenced after AD 250 (Butler & Lyne, 2001). The site at Summerton Way in Greater London raises some interesting questions in relation to the distribution of lava at rural sites due to the presence of Mayenware and Eifelkermik pottery. Although the site did yield some second century pottery, suggesting that the lava fragments recovered are residual, evidence strongly suggests that occupation at the site began after AD 250. It is possible that broken lava querns were brought to the site for reuse, and the initial date of their use predates the occupation of the site. Nonetheless, Lakin (1997) has suggested that directed trade with the Eifel may have occurred at the location, and this might explain the presence of lava querns in such a late Roman context. If previous exchange mechanisms that moved lava querns and millstones into Roman Britain had slowed or stopped, it is possible that lava continued to enter the province via other means, such as alongside the movement of late Roman pottery from the same manufacturing region. It is likely that this did not occur on the same scale as previously, as Mayenware pottery is not abundant in Britain (Fulford & Bird, 1975), and is mainly distributed in the south-eastern region of England, with 90% of sherds recovered from Canterbury, Colchester, London and Richborough (Tyers, 1996d).

However, the exchange of lava querns may have continued under different conditions, as opposed to the redistribution to rural areas via urban and military sites as seen in the earlier periods. The finds and other evidence at Summerton Way suggest a high-status site, which may have offered the occupants more options in terms of trade and exchange with regions further afield. This is a situation that is not likely to be replicated for most Roman rural sites and could explain the relative deficit of rural sites with securely dated late Roman lava. It is possible to examine late Roman lava distributions with that of late Roman Rhenish and East Gaulish pottery, and this may help to establish whether such a correlation may have existed.

Conclusion

The analysis of the rural data has produced some interesting results, some of which will require further investigation to fully determine their potential significance. As objects that have long been associated with military life, this is the first time that lava querns from rural contexts have been subject to detailed examination, and it is apparent that they were just as significant within the rural sphere as the military. Large volumes of Roman lava milling tools have been identified on a range of rural sites in Britain and their use was common, especially in areas of south-east England and East Anglia. It is probable that in the east and south-east, lava querns entered civilian circulation via ports on the east coast, predominantly London and Colchester, though Richborough, Reculver and Rochester may also have been involved. Lava was redistributed from the ports and other urban areas, reaching rural settlements by river and road networks. In the north, west and Wales, redistribution appears to have occurred via military sites, and mechanisms of exchange seem different to those experienced in the south of the province. Rural sites around Hadrian's Wall provide an exception to this. Though data is scarce for the region, rural sites in the north-east show that lava was not reaching rural settlements in the areas immediately surrounding the frontier, implying that the movement of imported goods beyond military sites is subject to different processes than in the south. The distribution of lava fits closely with the model of North Sea trade, as described by Morris (2010), in that lava milling tools were transported from the Rhineland to the east coast of Britain. However, the south coast shows a deficit of lava, where the production of querns of indigenous stone types may have impacted the exchange of imported milling tools.

Lava distributions by settlement type broadly follow imported and 'Roman' type objects, such as writing equipment (Eckardt, 2018; 2015), though their prevalence at farmstead sites in the south-east and East Anglia is somewhat unexpected if considering this pattern. However, the natural geology of some regions does not yield the stone varieties necessary for grinding and milling, and suitable stone would have been brought from other areas to fulfil this requirement. East Anglia and London are such regions, and the concentrations of lava in these areas conforms to the general theory of supply and demand. This is supported by the fact that significantly fewer farmsteads away from these regions appear to have used lava milling tools. From this we can explore the theme of connectivity, and what this may have meant to people living in different social groups. Roadside settlements and villa sites had greater access to imported lava, regardless of geographical location, while farmsteads and small town/settlement sites experienced connectivity and access relative to their proximity to urban and military sites. Data relating to the thickness of a quern prior to deposition also supports this idea, as lava querns were deposited at vicus and villa sites when they were thicker and less used than at small town/settlement sites, where wear was much greater prior to deposition. Better access to replacement querns is likely to have been a factor that determined the intrinsic value attributed to a lava quern, and relative connectivity to exchange systems would have had an important role to play.

The chronological data has also confirmed some suppositions with regards to the use and distribution of lava milling tools in Britain and shown that it fits the patterns seen of other imported finds categories. The initial influx of lava into Britain in the first century is confirmed, and the concentrations around London and Colchester show where it was entering the province for redistribution. Exchange of lava is widespread by the second century and begins to contract in the third and fourth centuries, though high volumes in the south-east and East Anglia continue to be deposited during this period. The site at Summerton Way, however, has inspired some new thought with regards to late Roman period exchange of lava milling tools and the possibility for continued movement of lava into the province, albeit on a smaller scale. The import of pottery from the Mayen region of Germany is a late Roman venture and has not previously been related to the Mayen lava quern trade. The evidence at Summerton Way suggests that exchange of these products may have been related, though this is likely to have occurred through different mechanisms of exchange to the earlier redistribution via urban and military sites. The occurrence on the same sites of Mayen lava, Mayenware or Eifelkeramik pottery should, therefore, be the focus of such future research.

Similarly, other future work should include a detailed study of the interplay between urban, military, and rural sites with a thorough exploration of the chronological shift in distributions between different site types within similar exchange and trade catchment areas. This will be covered as a case study for the Chichester and Fishbourne Palace area in Appendix 3, but more should be done to address similar research questions for other regions in Britain.

Chapter 6. Day to Day Grind of Urban Life: Lava Quern and Millstone Use in Romano-British Towns

Introduction

The distribution of imported lava milling tools at urban sites in southern Britain has been well-attested and is likely to have been a result of connectivity to ports and centres of manufacture or distribution via state-imposed infrastructure (see previous chapter, where this issue has been discussed from a rural perspective). This may have allowed for access to a range of goods that did not always exist for more remote rural or northern locations (Laurence & Trifilò, 2015, p. 104). Major towns, such as London and Colchester, show us that the Roman period urban populations were consuming an array of imported and exotic goods from many parts of the empire (for example see Laurence & Trifilò, 2015; Eckardt, 2015). This chapter aims to examine the use, distribution and deposition of lava milling tools from urban contexts to more fully understand the social and economic significance that they may have held in Roman towns. It will investigate themes relating to the urban economy, social and ritual identities, changing technologies and scales of food processing activities, and changes in the consumption and distribution of imported goods. The chapter presents data that sits alongside that of the rural and military sites to provide comparison for the different processes and patterns that are identifiable across the datasets. It can also be examined alongside the investigations into Chichester, Fishbourne and its hinterland (Appendix 3), as this showcases the possible relationships that urban and rural sites may have held with regards to the use of milling tools and food processing within the wider landscape within and around an urban centre.

Before examining the role of urban sites in the distribution and consumption of lava milling tools, it is first necessary to identify what is meant by an urban site. Urban life in the Roman world is often associated with a large population size, industrial activity, commerce, administration, and government. However, a degree of ambiguity is generated when the term 'town' is employed to describe small towns, *vici*, *municipia*, *civitas* capitals and *coloniae*, as the social and economic conditions experienced and created by populations within each would have been different. The extent to which these were controlled or managed by the state would also have differed enormously; the status of the town and the period of governance would have been significant factors (Wacher, 1995, pp. 17-23; Jones, 2004; Hingley, 2005; Creighton, 2006, pp. 70-78; Mattingly, 2006, pp. 255-291). Determining the given status of a town is not always possible and can be further complicated by chronological changes in status, of which we rarely have any knowledge. Verulamium provides one example in that it was referred to as a *municipium* by Tacitus but when this promotion was given is still a matter for debate, as is whether Tacitus fully understood the constitutional meaning attributed to the word (Bogaers, 1967; Frere, 1964; Niblett, 2001, p. 66). Similar debates exist for London, Colchester, and many other towns; mostly due to the complexities of dealing with incomplete and anachronistic historical accounts (Mattingly, 2006, pp. 260-286). This thesis does not aim to scrutinise the legal status of towns, nor to determine which should be applied to the case studies in question. For the purposes of the analysis here, the most important archaeological distinction to note is that the two selected case study sites, Verulamium and Silchester, are major towns; identifiable as such from the presence of major public buildings, the implementation of a grid system, defensive structures and their roles as administrative centres (Wacher, 1995; Jones, 2004, pp. 162-165). A study on the 'small town' at Dorchester-on-Thames has been included in the appendices as a means of exploring an urban area that was (probably) of lower status and population (see Burnham & Wacher (1990, pp. 1-6)) (Appendix 2), but this example stands alone in terms of detailed examination of a 'small town' site. The quern numbers for Dorchester-on-Thames were very low and not comparable with the two major urban sites.

Verulamium

Background to the site

The Roman town of Verulamium is situated on the south-eastern edge of the Chiltern dip slope on a chalk plateau that is cut by small river valleys, such as that of the Ver (figure 114). Evidence suggests that the area was settled prior to the development of the town during the Late Iron Age (Wacher, 1995, pp. 214-215) and the surrounding countryside was dominated by arable fields and grassland indicative of deforested land associated with agricultural activity and a settled population (Dimbleby, 1978). During the pre-Roman Iron Age, other sites in the vicinity, including Braughing, Welwyn and Baldock, held good connections with continental Europe as shown by the presence of imported pottery, coinage, metalwork, and wine, with changing burial practices influenced by continental traditions. The settled regions immediately around Verulamium[3] did not see such an influx of imported goods or traditions, and the impact of continental associations does not appear to have taken effect until the early first century AD, when material culture and burial rites begin to conform more closely with that seen at Braughing and Baldock (Niblett, 2001, pp. 32-33).

Verulamium is often described as an *oppidum* at the time of the Claudian conquest (Woolf, 2007; Moore, 2017; Hunn, 1992, p. 48). The extent to which this description is valid is not the focus of this thesis, but burial evidence indicates a stratified society with the establishment of an elite class

[3] Often referred to as Verlamion for the pre-conquest town, and Verulamium as post-conquest (Niblett, 2001, p. 33).

(Hunn, 1992, p. 51). Verulamium and its surrounds are thought to have been within the territory of the *Catuvellauni* when the Claudian invasion occurred and this group is reported to have been the most dominant tribe in southern Britain at the time (Frere, 1983, pp. 1-28). It is entirely possible that the *Catuvellauni* were held to a treaty instigated by the invasions of Caesar prior to the occupation of Britain as a province, or that hostages had been taken to ensure their compliance with Roman rule. The exact circumstances regarding the political and social relationship between Verulamium and Rome is not fully known or understood, but it seems certain that prior connection to the Roman world existed (Mattingly, 2011, pp. 76-86; Creighton, 2000, pp. 81-92).

It is possible that a faction of the tribe located in Verulamium was more sympathetic or apathetic to Roman rule, and the town may have been treated favourably after the invasion, suggested by what appears to have been a continuation of wealth in the hands of a local elite (Niblett, 1999, pp. 412-413). Alternatively, the elaborate burial at Folly Lane suggests that a direct relationship existed between the deceased and Rome, or that imitation of the Roman elite was enacted in the funerary ritual and presentation of grave goods. Such similarity between expressions of identity from client king to Roman governor had the potential to generate the impression of continuity, easing the transition from indigenous to imperial rule (Creighton, 2006). A current lack of structural evidence for a fort at Verulamium, either in the early conquest period or thereafter, also feeds into this narrative. However, more recent investigations completed by Pitts (2014) examining finds evidence, specifically fineware pottery and brooches, have strongly suggested that the Roman period foundation of Verulamium had a military association, similar to the finds profile for London. It should be noted that the outcome of the study by Pitts (2014) has produced evidence directly in contrast to the suggestions of continuity by Niblett (1999), Frere (1983) and Millett (1990). Other military material culture, such as weaponry and armour, is frequently present at Verulamium, and the possibility of an early military association should not be readily dismissed. How this may or may not relate to a military occupation of the town, domination, or merely a military presence is yet to be determined fully (Niblett, 2001, pp. 56-58; Frere, 1983, pp. 3-5).

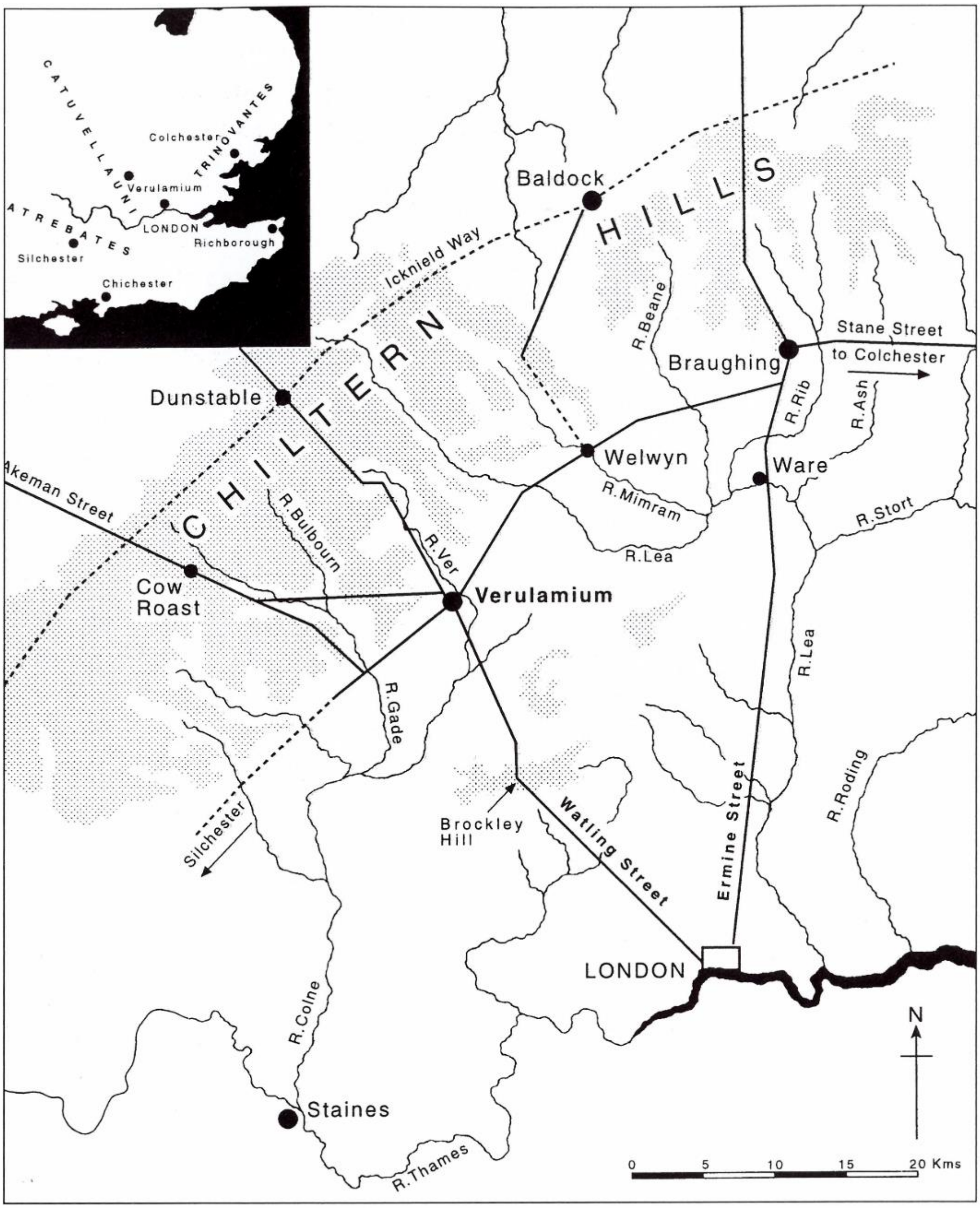


Figure 114- Location of Verulamium and other nearby important sites (Niblett, 2001, p. 30).

Occupation and structural evidence in the post-conquest period show how the earliest Roman town developed, with a movement of the population from the plateau edge to the lower valley slope occurring around AD 60-100. The centre of the development was located at the central enclosure where the forum/basilica would later be constructed. A bathhouse was built, alongside workshops and dwellings to form a small settlement of approximately 10-12ha, with a focal area of wealth at the centre. At least two masonry structures existed, including the bathhouse. Tacitus defines the status of Verulamium during this period as a municipium, which, if true, would have meant that certain privileges had been bestowed onto the town by the emperor and this can be correlated with the evidence present at the site (Bogaers, 1967; Frere, 1964; Niblett, 2001, p. 66).

Historical accounts tell us that Verulamium was sacked, and presumably burnt, during the Boudiccan revolt of AD 61, alongside Colchester and London (Webster, 2004, pp. 93-95). Unlike Colchester or London, the 'burn horizon' that often defines the Boudiccan fire in these cities does not exist at Verulamium and few buildings can be connected to such an event. However, for those buildings that were destroyed, recovery was slow and may have been dependent on the increasing importance of nearby London (Frere, 1983, pp. 7-8). Once initial recovery had started after the Boudiccan fire, probably around the Neronian and early Flavian periods, expansion of the town appears to have occurred rapidly and suggests an increase in population. Major public buildings were erected in the town at around this time, including a replacement bathhouse, a *macellum*, several temples and, possibly the forum/basilica. The roads were metalled, and water was piped into the parts of the town, indicating high standards of living were in place by the end of the first century AD. Private houses remained relatively basic in their construction throughout this post-Boudiccan phase, while workshops for metalworkers are also known to have existed (Niblett, 2001, pp. 67-81) (see figure 125 in section on distribution for plan of Verulamium).

The rapid expansion continued into the early second century, and the two entrances to the town through the Fosse via Watling Street were given gates and gatehouses, both evidently grand structures. Many of the features of Verulamium by the early second century would have presented a vision of wealth to the outsider, and private domestic buildings began to be replaced with larger more elaborate constructions. Multiple workshops were built on the route from the London gate to the forum, a prime location for commercial enterprises (Frere, 1983, pp. 10-12; Niblett, 2001, pp. 89-96). Pottery making was prolific in the area, occurring along Watling Street and around the town (Lockyear & Shlasko, 2016, pp. 22-23; Niblett, 2001, pp. 102-103), while metalworking, and especially iron smelting were also important industrial activities in the immediate region. Added to this, the products of agriculture from the wider area are likely to have been brought to the town for exchange and taxation, all of which contributed to the wealth of the town. Aside from being a market town, Verulamium was also an important administrative and religious centre and would have served multiple roles to the inhabitants and the neighbouring populations (Niblett, 2001, pp. 108-112). The affluence of Verulamium may have spread into the hinterland. Several villas in the surrounding area were also prospering by the Antonine period (for example, see Neal, et al., 1990), though the respective wealth associated with these sites may have been unrelated to that of the urban centre.

Other signs of economic activity, that are likely to have been continuous, include the possibility of grain processing at Verulamium. There must have been large-scale arable agriculture undertaken in the rural areas around Verulamium, as shown by the large granary at Gorhambury villa (Neal, et al.,

1990, pp. 40-48). Three smaller granaries have been found within Verulamium, but these were destroyed by the Antonine fire, while a larger tower granary appears likely to have existed from the third century (Niblett, et al., 2006, pp. 173-180). Multiple corn-drying ovens have also been found in the town and its surrounds. Environmental evidence shows that grain was probably threshed and dried prior to storage and that these processes had probably occurred by the time the grain had arrived at the town (Niblett, 2001, pp. 106-107). It has been speculated that a mill existed on the Ver from foundations recovered that may have belonged to such a structure, adding to this evidence that indicates centralisation of food processing was occurring (Rogers, 2013, p.
139).

A large fire occurring between 155-160 AD destroyed much of the lower part of the town (Niblett, et al., 2006; Frere, 1983, p. 13). The pottery industry appears to decline also towards the end of the second century, possibly a casualty of the effects of the fire in the town. The *macellum* was rebuilt as a masonry structure, indicating its continued importance, and continued to be used until the end of the Roman period (Frere, 1983, pp. 7-10). Evidence for large-scale butchery at the site in the third century shows a commercial scale of meat production, and the by-products of this industry would have supported other crafts, such as leather working and tanning (Niblett, et al., 2006, pp. 182-185; Niblett, 2001, pp. 105-106). Other parts of the town do not appear to have recovered quickly, and some commercial activities associated with the workshops shows no sign of rebound until the end of the second century. Wealth still appears to have been prevalent and by the early third century, building within the town resumed at pace with numerous large private houses that had mosaic floors, hypocausts, and painted wall plaster. Prosperity is most visible in the town walls that were built in the early third century (Frere, 1983, pp. 16-17). It was during this period that the Ver was canalised, possibly to drain the pre-existing marshland, though it may also have provided a sufficient head of water for the operation of mills further downstream (Rogers, 2013, pp. 89-132).

Fortunes appear to have changed slightly by the end of the third century, and parts of the town and neighbouring villas show evidence of decline. It is possible that the collapse of the nearby iron industry may have impacted the local economy. Despite this, decline was not uniform across Verulamium. Activity, rebuilding and other signs of occupation around the forum area continues well into the fourth century, continuing in some cases into the fifth century. It seems probable that though a decline was experienced, that Verulamium continued to be home for people from the late Roman and into the early medieval era (Niblett, 2001, pp. 125-136).

The Dataset

Lava from querns or millstones was recorded from various locations within the town and three sites from the extra-mural areas: Verulam Hill Field, King Harry Lane, and Folly Lane (see figure 125 for locations). Most of the data for the town and all the data for Verulam Hill Field was recorded by in-person examination of the lava milling tools. Publication information was used to add a further thirteen examples to the town dataset. Data from the latter two sites was compiled using only published information. In total, 126 groups of lava querns were recorded from in and around the town: 71 from Verulamium itself, 34 from Folly Lane, 18 from King Harry Lane and 3 from Verulam Hill Field (see Chapter 3 for description of what constitutes a 'lava group'). Though this appears to be a substantial assemblage of lava querns and millstones, it should be noted that 31 of these lava groups do not have site or context information, making it impossible to establish the likelihood of them belonging to the same object. This missing context information also caused some issues in terms of using supplementary quern data from publications, as there was the potential to duplicate the data for undiagnostic fragments recorded in person. For example, the publication by Niblett, et al. (2006) lists eight lava quern fragments recovered from *insulae* III and XIII. As many of the fragments recorded at the museum were missing context information, it was impossible to know if these were the same fragments in the publication. Therefore, the published examples may have been recorded twice, though those without findspots do not feature heavily in the discussion relating to distribution and undiagnostic fragments were not used to examine typological differences. Due to the age of the excavations within the town itself, context information was generally patchy, and it is entirely possible that fewer objects are represented than is currently shown here. The issue of redeposition must also be considered as many of the lava groups are heavily fragmented and one quern or millstone may easily have been deposited within multiple contexts.

Conversely, it is highly probable that the collections stored by Verulamium Museum are only a sample of what was excavated, as querns and millstones tend not to be fully recorded and have often been relegated to spoil heaps, especially in older excavations. The excavations at Gorhambury Villa, a site close to Verulamium, can be taken as an example (Neal, et al., 1990). The excavation report details that Millstone Grit and lava were the most common materials used for querns at the site. Only two samples of lava were retained, but it must be assumed that much more was excavated at the time. Unfortunately, no quantification of the lava appears to have been carried out, making it impossible to determine the extent to which it was present and the minimum number of querns or millstones that may have been there. The numbers within the dataset may, therefore, significantly under-represent the true picture of lava quern use in and around Verulamium, which also has implications for comparisons with other sites. Considering the proximity of Verulamium to London and Colchester and the long chronology of excavation at the site, large volumes of lava should be expected.

Manufacture

The Millstones

Of the 126 groups recovered from in and around Verulamium, 38 could be identified as either a quern stone or a millstone (see Chapter 2 for definitions), with the percentage of the assemblage breakdown shown in figure 115. As has been seen in other assemblages, the number of unidentified lava fragments is high; the largest identifiable group is hand operated querns (25% of the total), with a smaller number of millstones (5% of the total) identified. Though the number of lava millstones seems very low (6 examples), it is relatively high when compared to sites such as Chichester, where only one lava millstone was recovered from within the town walls. In fact, it is a high number of millstones of any material type from an urban context, as can be seen from sites such as Cirencester and Gloucester; both towns produced only a single individual indigenous stone millstone despite extensive excavation (Shaffrey, 2021, pp. 23-25). From the six millstones, 3 (50%) were upper stones, one (16%) was a lower, and two (33%) were unidentified.

The types of millstone from Verulamium vary and though the sample size is small, it is possible to make comparisons and observations. The range of diameters is relatively broad but generally within the 'normal' range of sizes when compared to the diameters of lava millstones from all of Roman Britain, though allowances must be made for the estimation of diameters from fragments (figure 116). The variety indicates that different types of millstones were entering the town, and this may have occurred as a development of millstone type over time from the same manufacturing region, or because of differing supplies of millstones due to it being a specialist product. In the Eifel region where Mayen lava is sourced, that millstones were probably produced near the harbour of Andernach, and multiple workshops may have been involved to create a greater range of types (Mangartz, 2008, p. 90). Two of the millstones are just at the upper quartile, or the top 25%, of sizes in Britain indicating that they are slightly more unusual. The lava millstones in the upper quartile of size are distributed throughout southern Britain and do not show any specific pattern of use in terms of site type or location (see Chapter 3). These would have been manufactured to fit the specifications of the mill they were to operate within and are likely to have been expensive and high-status tools. They show that grain must have been processed at scale in Verulamium.

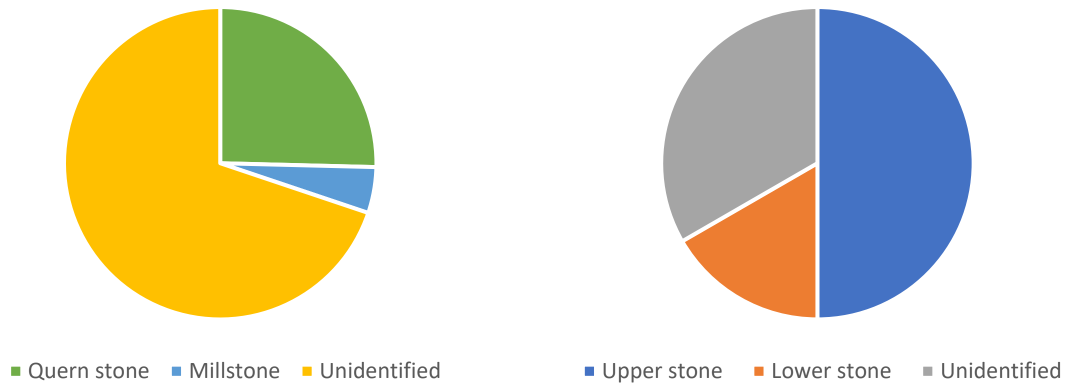


Figure 115- Left, percentage of assemblage identified as quern or millstone T= 126. Right, percentage of millstones identified as upper or lower stones T=6.

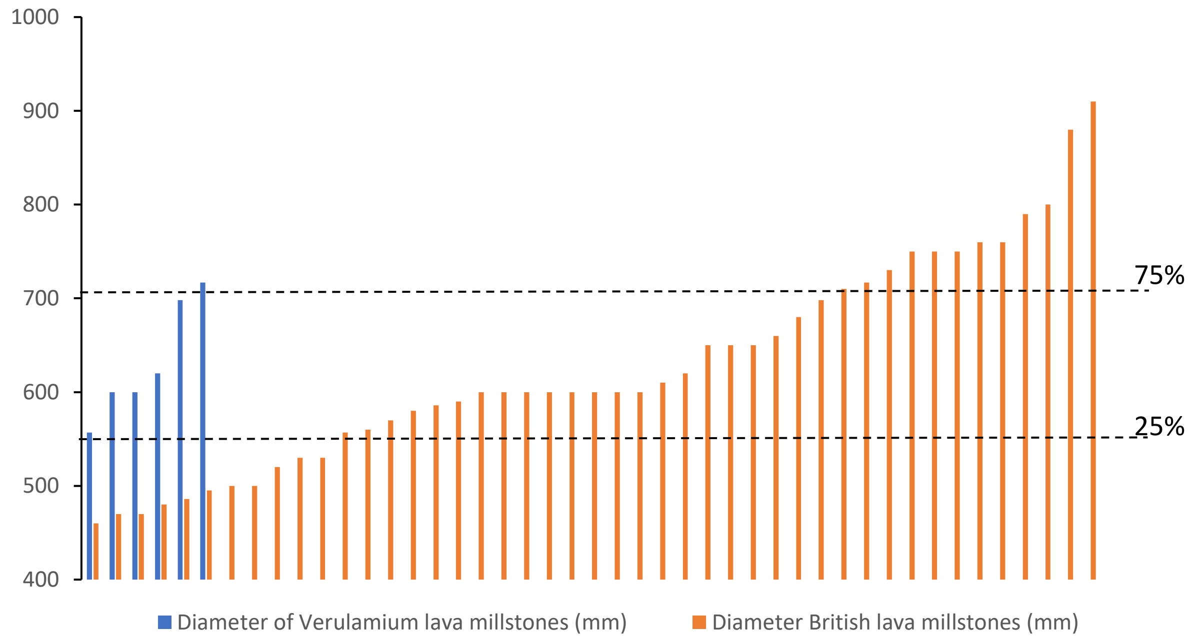


Figure 116- Histogram to show the diameters of the lava millstones recovered from Verulamium (T= 6) compared with those of Roman Britain (T= 45). The lines indicate the upper and lower quartile of diameters from the British lava millstone data.

Another indication that large-scale grain processing took place is the presence of a highly unusual millstone fragment recovered during excavation work in 1938 (figure 117) (CAT 0995). The findspot was within *insula* XXVIII, just southeast of the museum (see figure 125). During this work, part of a metalled Roman road was cut through, implying that material closely associated is likely to be Roman in date, including the millstone fragment illustrated. The projected diameter is large at

717mm and falls within the dimensions attributed to a millstone. It has a thickness of 70mm and there is no indication that there was ever a kerb present on the upper surface. The central hole is likely to have been circular in shape, with an estimated diameter of 165mm. The edges are straight and vertical with no signs of linear tooling and the grinding surface has radial dressing, a characteristic that is typical of the Roman period. The decoration has no known parallel in Roman Britain and does not appear to be related to the functioning of the object as a milling tool. It consists of a six-pointed star pattern with spear-shaped leaves radiating outwards from the points in low relief. Only one section of the pattern is visible on the fragment, and the rest is reconstructed below, which assumes a regular and repeating pattern.

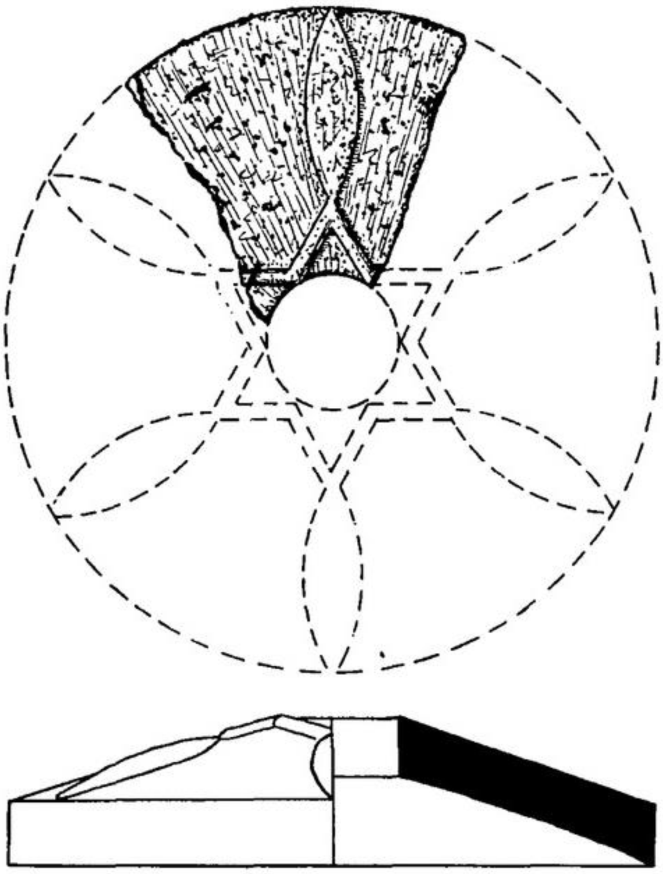


Figure 117- Fragment of decorated lava millstone (left) (copyright Verulamium Museum), reconstructed view of the decoration on the millstone if complete (right) (Corder, 1943, fig 1) (CAT 0995).

The most interesting aspect of this fragment is the way that it does not at all conform to the standardised lava querns or millstones found on other Roman sites and, other than the concave grinding surface and surface dressing, it has none of the typical characteristics. However, millstones of lava appear to have been less standardised, probably due to their unique functioning and operation as specialised equipment. Raised kerbs are not necessary if there is no handle to be fitted, which could be the reason why it is absent on this stone. Unfortunately, there is nothing visible on the fragment to indicate how the stone may have been rotated, and its identification as a millstone is based on its projected size from the curvature of the outer edge. The upper surface design is unique. Querns and larger sized querns/small millstones are sometimes inscribed with text, though these tend to appear predominantly on military sites and may have been used to identify individual milling tools by *contubernium* or unit (Carroll, 2005). Although this presents a different form of personalisation, a degree of functionality can be attributed to inscribed forms of decoration using writing, which is different to that seen on this example.

Though the precise provenance of this lava used to make the millstone is not known, there is a high probability of being Mayen in origin. Geochemical analysis would need to be completed on the stone to confirm this. It is possible that the millstones were finished closer to the site of the mill, in order that precise measurements to accommodate the mechanism could be met more easily. The decoration could, therefore, have been the addition of a local stonemason who was employed to carry out the specialist work required to finish production of the millstone, and the design may have been unique to the stone, or to the particular craftsperson who carried it out. It is likely that the design was added during the original stages of shaping/finishing the stone, as it is of a moulded form (Shaffrey, pers. comm). This means that it was probably associated with its use as a millstone and is unlikely to represent adaptation of original form or be a later addition to the stone.

In terms of the mechanical operation of the millstones from the assemblage, there is, unfortunately, very little evidence. Few features relating to the mechanical parts were present on the surviving fragments and millstones were predominantly identified based on their size alone. Two examples provided further evidence in the form of possible millstone fittings. The first does qualify as a millstone with a diameter of 557mm (Shaffrey, 2015), but could be identified as a large quern if the fittings indicated that it was operated by hand (CAT 0997). However, the description for this fragment in Frere (1983, pp. 80-81) suggests that it may have had a hole into which a lifting mechanism would have been fitted (figure 118), resulting in a more confident millstone classification. The other larger millstone fragment from the same publication that measures 698mm in diameter is described as having the same characteristic (CAT 0998). Though described in the finds report as being a possible handle socket, this feature is more likely to be related to its use as a millstone as lava querns from Mayen were not fitted in such a fashion. Nonetheless, lava querns were often mended or adjusted to work in different ways to the original standardised designs and the holes on the upper surfaces of these two upper stones may have been added later to allow for continued or modified use. An example of this is seen in the Housesteads assemblage, where lead 'plugs' were added on either side of an iron bar fitted over the central hole, possibly to act as a rynd or to allow for an adjustment of the angle of the grinding surface (see figure 180 in Chapter 7). The holes of these millstones could have existed to accommodate a similar type of fixture, but interpretation becomes difficult without viewing the completed object. It does also raise the possibility for a different type of lava quern or millstone to be present here, as those manufactured away from Mayen may have not been standardised to the same criteria as those produced in the Eifel region. However, the most likely interpretation is that the presence of this feature corresponds to use in mechanically rotated mills, especially when considered alongside the size of the stones.

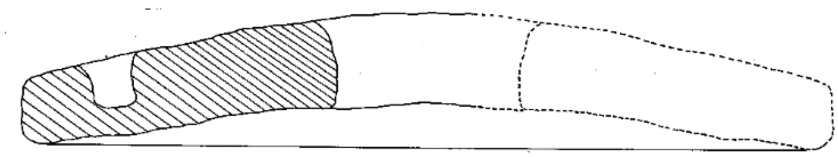


Figure 118- Millstone of lava from insula XXVIII showing a hole in the upper surface that may have allowed for a lifting mechanism to be fitted (Goodburn & Grew, 1984, pp. 80-81) (CAT 0997).

The Miniature Milling Tool

In stark contrast to the larger millstones in the assemblage is one example of a complete miniature lava quern upper stone, with a diameter of 235mm (figure 119) (CAT 2679). This is a highly unusual object that is sadly without stratigraphic information. As the artefacts stored at the museum are predominantly from within the Roman town, it is probable that it is of Roman origin, but another period cannot be ruled out. The condition of the quern stone is excellent, which could imply that it is of a later date, but the smaller size of the object makes it more robust and less vulnerable to damage meaning it may have preserved better. The dressing on the grinding surface of well-defined harps is characteristic of the Roman period, though little else of the quern resembles that of the standardised lava stones manufactured in the Mayen district.

Figure 119- Miniature lava quern upper stone (CAT 2679) viewed from the top and bottom surfaces (© St Albans Museum).

Many miniature querns of indigenous stone types have been found in Iron Age and Roman period contexts in Britain. Miniature querns are often misidentified or misreported, as has been shown by McLaren & Hunter (2008) for Iron Age and Roman period examples from Scotland, meaning that there is likely to be a much larger number of these artefacts in museums and archives than currently known. Roman period miniature querns of indigenous stone types in England have been tentatively identified at Ramsgate, Kent (Fry, 2009) and in the South-East Cheviots, Northumberland (Topping, 2008, p. 353). In mainland Europe, miniature querns of sandstone have been found in the Lower Danube region (Watts, 2019, pp. 391-408) and the Paris Basin of France (Lepareux-Couturier, 2014, pp. 155-156), all attributed to Iron Age or Roman contexts.

Viking era versions are known from Norway, and these have been correlated with the examples recovered from Shetland to show parallel periods of use and similar functions (Hansen & Larsen, 2000, pp. 115-119). Other examples are known from Lagore, Ireland (Co. Meath) (McAlister, 2013, p. 4). The Roman and Iron Age miniature querns from Scotland, and those from Viking and Medieval Shetland tend to mirror their larger counterparts with some precision, reflecting the design, function, and mechanical operation of full-sized versions. How these objects were used and their meaning, however, has seen interpretative differences. Traces of wear on the Roman and Iron Age miniature quern stones shows that they were used, possibly for grinding seeds or similar small volume substances. Conversely, those from Shetland do not present wear traces and are often made from different materials to those of locally produced full-sized querns or millstones and have, therefore, been interpreted as toys to help socialise children into future adult roles (Hansen & Larsen, 2000, pp. 114-115).

The miniature quern from Verulamium would ordinarily be identified as a millstone due to the underdrift method of fixing the rynd, but the method of rynd fixing may not necessarily define its method of rotation (Shaffrey, 2015, pp. 73-78). It does not resemble or reflect the highly standardised design of the hand operated lava querns, all of which have an overdrift rynd fitting, and cannot be identified as a miniature version of these. Unfortunately, the object was not available for examination and was not recorded in-person, meaning that it is not possible to confirm that signs of wear are present on the grinding surface. From the image provided by the online collections, wear does appear to be visible, but this would need further investigation. The holes on the upper surface may have been used to accommodate other fittings and are not dissimilar to those found on runner (upper) millstones, possibly used to lift stones or to fix the stone to the rotational device. Due to the small size of the stone, such lifting mechanisms would not be necessary, indicating that this is possibly a model, replica, or toy millstone.

From the full dataset of lava milling tools from Roman Britain, there are several parallels (table 10). Although similarities exist between these objects, none could be described as identical, and they all have variations in design. The example from Verulamium is probably the best preserved and well-manufactured and the closest parallel is the upper stone fragment from the A14 road scheme excavations (figure 120). It was recovered from a modern context but may be residual Roman; no milling tools were recovered from post-Roman contexts other than the miniature quern, suggesting an earlier date. This was also produced in the style of a miniature millstone, with an underdrift rynd and a harped grinding surface dressing. It had clearly held an iron rynd, discernible from the residue left behind (Banfield, in prep). Unlike the Verulamium miniature, the upper surface had been roughly worked and there was no further evidence for millstone fittings. The rough upper surface is like an example from the Norris Museum in Huntingdonshire (Shaffrey, pers. comm), which is near to the site of Fenstanton Gravels where the A14 miniature millstone was found. This also presents an underdrift mechanism and holes for a possible lifting mechanism in the upper surface (figure 121). Together, these three objects should be classified as millstones and through they cannot be dated with any confidence, a Roman date should be considered as a strong possibility.

Figure 120- Miniature upper lava millstone recovered as part of the A14 road development scheme in Cambridgeshire (CAT 1483). Provided here as a parallel to CAT 2679 (photo by author).

Figure 121- Miniature upper millstone recovered from the local area of Huntingdonshire and stored at the Norris Museum (photo by Shaffrey, n.d).

Table 10- Summary of other miniature lava milling tools recovered in Britain.

Collection/ Excavation	Findspot	Context Date	Diameter (mm)	Upper/ lower stone	Under/ overdrift	Dressing
St Albans Museum, Hertfordshire	Not known	Unknown	235	Upper	Underdrift	Harping
A14 road scheme, Cambridgeshire	Fenstanton Gravels	Modern	210	Upper	Underdrift	Harping
Norris Museum, Huntingdonshire	Local find	Unknown	210	Upper	Underdrift	Possibly pecked
Norris Museum, Huntingdonshire	Local find	Unknown	225	Lower	N/A	Not visible but signs of vertical tooling at sides
	Southampton French Quarter	Post-medieval	250	Upper	Unknown	Harping with vertical tooling at sides
Thameslink, London	Not known	Post-medieval	Unknown	Unknown	Unknown	Not visible but signs of vertical tooling at sides

The other three miniatures are less comparable with the Verulamium stone, though they all have vertical tooling on their sides. This is a feature that is typical of a Roman period Mayen lava quern, and it is possible that these represent replica versions of the hand operated lava querns. For the Viking era miniatures recovered from Shetland, it was also found that both miniature querns and millstones were present, and these were interpreted as gendered toys: mills for male children and querns for female (Hansen & Larsen, 2000, p. 115). How well this theory fits with the evidence provided here would require further investigation. As Roman lava is not usually found in burials, this cannot currently be established. XRF analysis would help provide a method by which the date of the milling tools could be explored, as Mayen lava was not exported to Britain after the Early Medieval period and was superseded by lava from the quarries of Niedermendig (Kling, 2008, p. 141). Where and why these objects were produced would also require further thought. The lack of standardisation present implies that there were multiple locations where these objects were produced and it seems likely that they were made specially, in small numbers and probably local to the place of use. The level of skill applied making the miniatures appears to vary from one example to the next, and there is nothing to suggest centralised production. Use wear analysis should also be conducted to provide a clearer idea of how these items may have been used.

The Querns

A total of 32 quern stones were identified, all of which were recovered from within the town except one example from King Harry Lane. Of these, 30 were diagnostic and could be identified in terms of whether they comprised fragments of upper or lower stone. A large percentage of these (56%) were upper, or probably upper stones, with a smaller number of lower or probable lower stones (38%) (figure 122); it should be noted that lower stones tend to be less identifiable due to their lack of features. Meanwhile upper stones are both more identifiable and are more likely to be fragmented due to the way they wear and their mechanical fixture points, meaning they are more likely to be counted multiple times when recording. The percentages shown here are, therefore, representative of other sites in Roman Britain where fragmentation is common, as will be shown in the comparative discussion later in this chapter. It is probable that most of the undiagnostic fragments of lava once belonged to quern stones, as opposed to millstones, as these are more common in the archaeological record and that querns are highly underrepresented here.

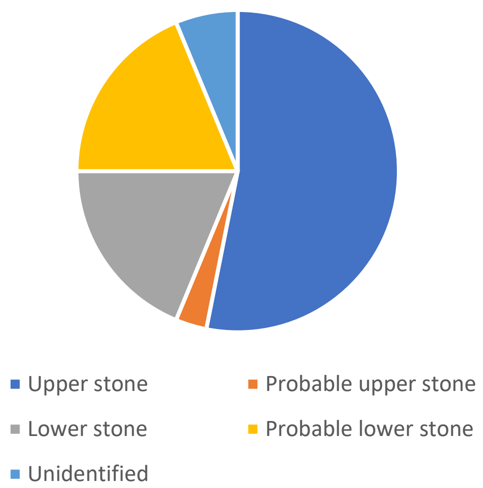


Figure 122- Verulamium quern assemblage showing percentage of upper and lower stones present (T= 32).

There were 21 querns that had estimated or measured diameters, the majority of which were estimated due to the fragmentary nature of the querns from the town. These ranged from 360 to 460mm, which is within a relatively normal range for a Romano-British lava quern assemblage. As Mayen lava querns are highly standardised objects, only 25% of all British examples fall below a diameter measurement of 400mm, and 25% measure over 425mm. This means that half of all measured lava querns in Britain have diameters that fit within a very narrow range of 400-425mm (figure 123). A similar pattern of measurements is present in the Verulamium assemblage, with 50% of the querns measuring between 400-420mm. These are clearly as standardised as those found elsewhere in Britain and are very likely to have been sourced from the same location, Mayen in

Germany. The location of Verulamium within the catchment area of the North Sea trade routes (see Chapter 2) is the most probable explanation.

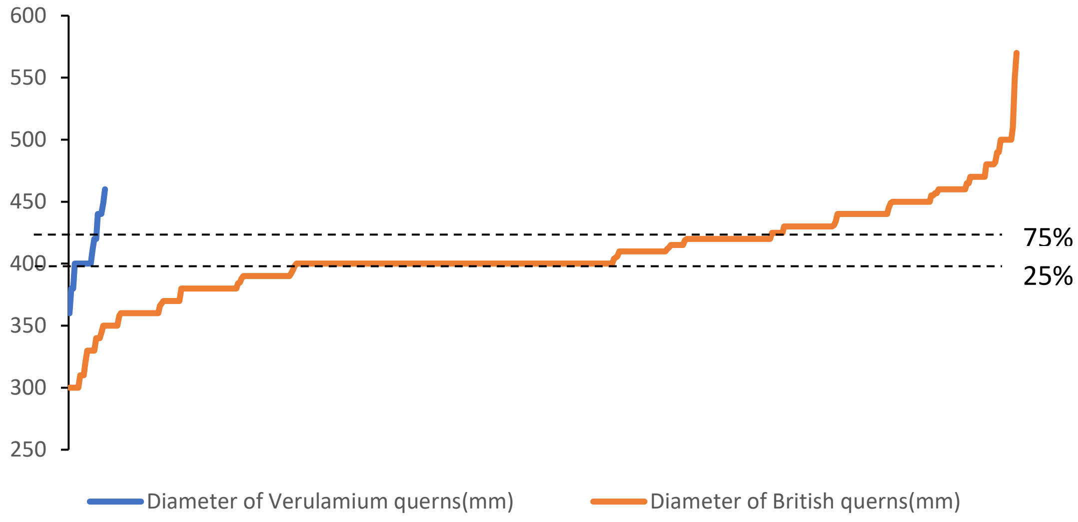


Figure 123- Graph showing the different diameters for lava querns from Verulamium compared with Britain. The 75th and 25th percentile for the British assemblage is show as dotted lines.

A similar picture is presented by the other features of the quern fragments, and most display the attributes of the standardised design of a Mayen lava quern. Of the 18 upper stones, 11 had a kerb and the same number had the typical quartered upper surface dressing, while 25 from the entire assemblage showed signs of vertical tooling on the outside edge. There were a few exceptions observed, including one upper stone fragment that had an unusually shaped rynd chase for a lava quern (figure 124). This may represent a different style of fitting, be a way that the object was mended to extend its use life or been altered to allow for it to be reused for a different purpose. The other features of the object are very standard, and so it probably shows a refitted rynd, in a similar way that some of the querns at Vindolanda were found to have been repeatedly mended, especially in relation to the rynd, which was vulnerable to damage by wear (Chapter 7).

Figure 124- Fragment of lava quern (CAT 2594) showing an irregularly shaped rynd chase that may have been the result of mending or reuse.

Distribution

From within the town walls, lava was retrieved from ten of the *insulae* (figure 125). Due to the lack of context data for some of the lava groups, it is not possible to discount the possibility that lava was also found at other *insulae* at Verulamium. Similarly, as there is no excavation or sampling strategy outlined for any of the sites, the dataset should be treated with caution as it likely presents incomplete information. It should be noted that no lava was originally recorded for the earliest excavations, those completed in *insulae* I-III by the Wheelers (Wheeler, 1932; 1936; 1938). The one fragment that was catalogued for *insula* III was only published in the later report by Niblett, et al., (2006). This indicates that it was not standard procedure to record, conserve or curate querns during these early investigations. However, these *insulae* were also excavated in subsequent projects during the 1950s and 1980s, and so it becomes challenging to examine the possible reasons for an absence of data in certain areas of the town.

Folly Lane, which like Verulamium, had a large area of excavation, was similarly zoned (figure 126) and finds from the site were catalogued according to their findspot within these areas. It should be noted that although this site is best known as a ceremonial and burial site, it saw changing uses at different stages of the Roman era and can be considered alongside the urban data as being related to urban activity. Distribution of deposition on an intra-site basis can be useful to examine as it can help us to understand the relationship between material culture and specific activity areas, structures, economic zones, or ritual places. King Harry Lane and Verulam Hill Field were smaller scale projects, meaning that zoning was not used as part of the excavation strategy. Finds could be correlated with their findspots at King Harry Lane and analysed in terms of context of deposition, which was also carried out for the larger sites where context information is available. Unfortunately, the information from Verulam Hill Field was not sufficient for distribution analysis to be undertaken. The number of lava groups from each area of the town and extra-mural areas is shown in table 11. Although Verulam Hill Field, Folly Lane and King Harry Lane are described here as extra-mural, the town walls were constructed in the third century, and its presence will not be applicable to all periods of the town’s history. The term extra-mural is used for ease of description.

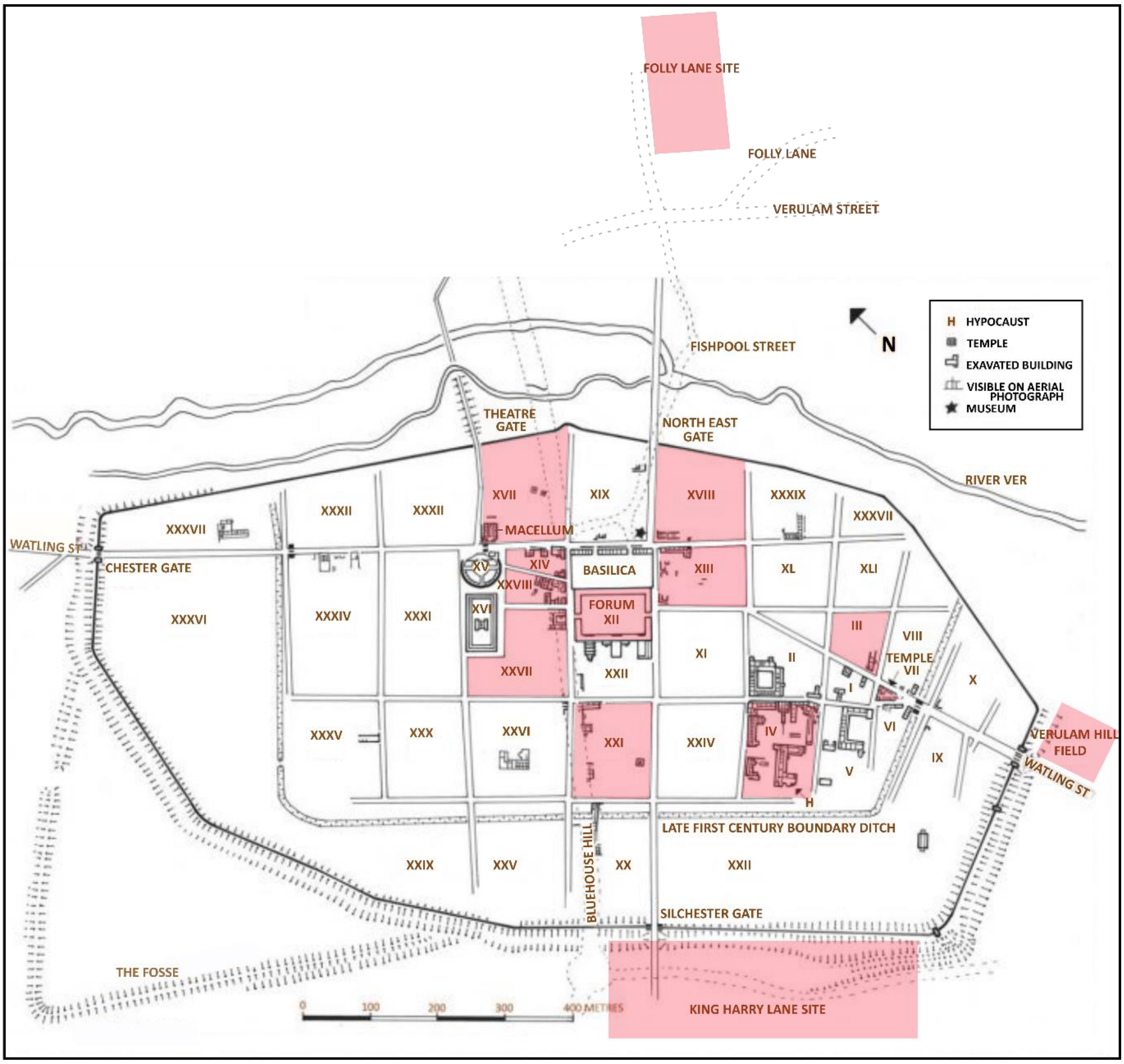


Figure 125- Map of Verulamium showing the different insulae of the town and areas of excavation covered in the data analysis. Locations where lava was recovered is shown in red (after Niblett (1999) and adjusted from St Albans and Hertfordshire Architectural and Archaeological Society (2019)).

Across the three extra-mural sites at Verulamium, a similar number of lava groups were recovered as were recorded from the excavations within the town. Details from the publications at Folly Lane and King Harry Lane show that lava comprised approximately half of the overall quern assemblages at these sites. Unfortunately, the Frere publications for Verulamium do not provide details for all querns and millstones excavated, but the sample of stone types that have been catalogued present a similar picture in terms of lithologies and volumes when compared with the data from the more recent excavations at Folly Lane and King Harry Lane. Overall, the data suggest that lava milling tools were abundant at Verulamium, and that lava and non-lava types occur within the town and in the extra-mural areas, possibly at similar ratios. Though Folly Lane, Verulam Hill Field and King Harry Lane have generally been classed as funerary and ritual sites, these areas of the town have also provided evidence for industrial activity, the dumping of domestic refuse (Niblett, 1999, pp. 416-417) and domestic occupation (Stead & Rigby, 1989, pp. 4-11) and probably served different functions at different times. These sites and their surrounding locales may have seen occupation 'overspill' from the main part of the town at times when the population was expanding beyond the previously designated town limits, such as during the late first and early second centuries. The presence of querns in these areas is, therefore, not surprising, and indicates that grinding activities occurred both within and outside of the town, where different parts of the population resided or worked. As stone is often recycled and reused for construction or for resurfacing, this could alternatively simply indicate the locations where stone objects were deposited as part of building projects, or refuse areas where rubbish was dumped. More detailed analysis of context of recovery could help to highlight if this was the case, and this will be completed as part of the investigation into deposition.

At Folly Lane, zones P and J show the greatest number of lava groups, and these are located towards the south-eastern corner of the site. Zones B, C and G also show relatively high volumes, and these zones are clustered in the northern-most end of the site. The data imply that there are small concentrations of lava in these parts of the site, and that this may relate to the use or deposition of lava milling tools within these zones. Interestingly, zones B, C and G are within the ceremonial enclosure, making a total of twelve lava groups recovered from this part of the site. Tempting as it is to derive a ritual association with lava querns from this distribution, it is necessary to emphasise that most examples were dated to the mid-to-late third century or fourth century when the ceremonial role of the site was in decline (Niblett, 1999, p. 417). This is more likely to represent the dumping of rubbish during phases when the infilling of ritual shafts and levelling of the site occurred, with parts of it turned over to agricultural use by the early fourth century (*ibid*).

Overall, 25 out of the 34 lava groups for Folly Lane belonged to these later phases, indicating that querns may have been broken up to reuse for construction or as hard-core for resurfacing and levelling. In zones P and J, two groups of *in-situ* lava were found incorporated into floor surfaces dating to the fourth century, while the excavation report comments on the use of broken up querns, predominantly of lava and Millstone Grit, as post-packing in the late Roman agricultural buildings that were built after ceremonial use of the land ceased (Niblett, 1999, p. 100). Another example of

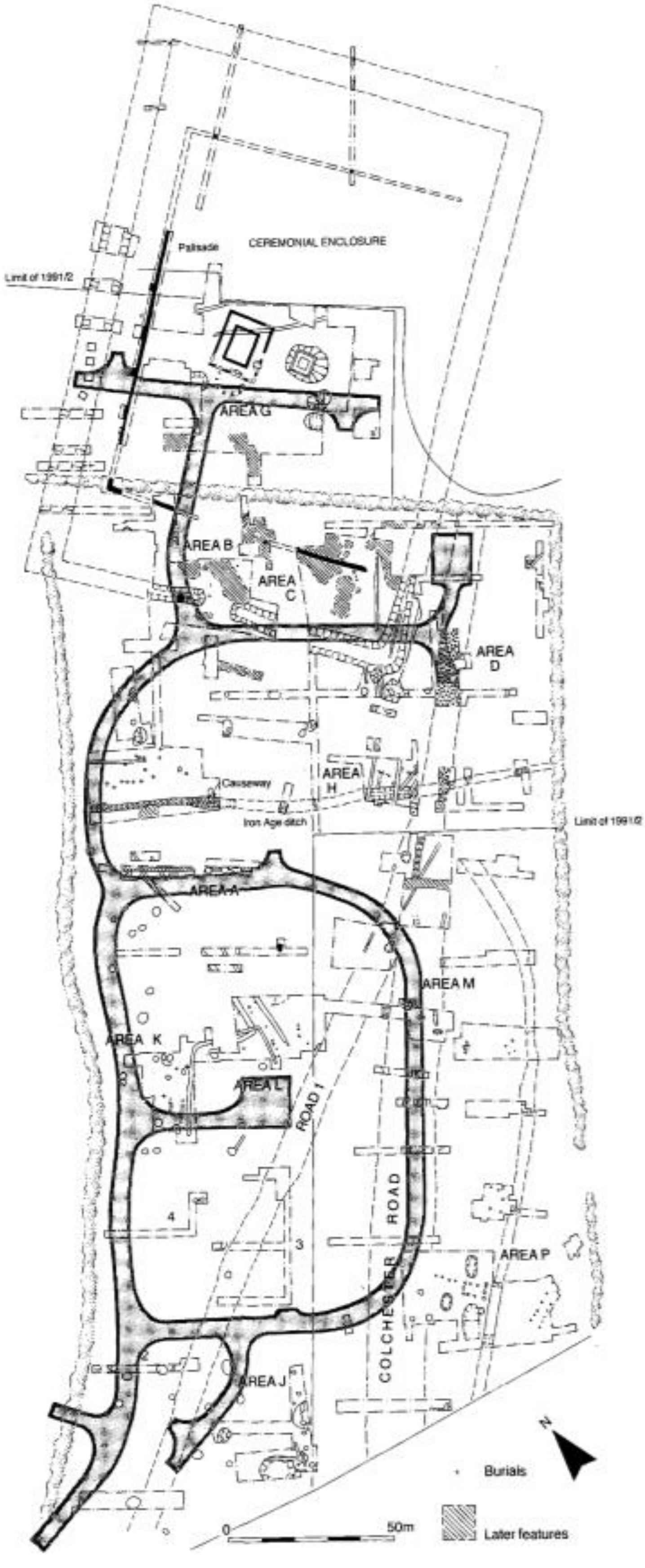


Figure 126- Site plan of Folly Lane excavations indicating the location of different areas/zones (Niblett, 1999, p. 3).

Table 11- Number of lava groups recovered from sites in and around Verulamium, quantified by site zone where information is available.

Site Location	Site Zone	Number of lava groups	
Folly Lane	A	1	
	B	4	
	C	4	
	G	4	
	H	1	
	J	5	
	K	1	
	M	3	
	P	7	
	2	2	
	Not specified	2	**TOTAL=34**
Verulamium	Insula III	(1)	Possibly recorded twice
	Insula IV	1	
	Insula VII	5	
	Insula XIII	1+ (7)	7 possibly recorded twice
	Insula XIV	14	
	Insula XVII	2	
	Insula XVIII	1	
	Insula XXI	1	
	Insula XXVII	1	
	Insula XXVIII	3	
	Site 9	1	
	SW of forum	2	
	Not specified	31	**TOTAL=71**
Verulam Hill Field	Not zoned	3	
King Harry Lane	Not zoned	18	

reuse of lava during this period is found in the inclusion of lava quern fragments in the flue of a corn drying oven. Querns are sometimes reused to line ovens and hearths, and to backfill corn dryers, an observation that is not always commented on in excavation reports. A similar pattern of lava accumulation is seen in zones P and J, where ten of the twelve lava groups were dated to the later phases of the site and are likely to have been used in similar ways. Niblett (1999) discusses that the number of querns available for reuse is indicative of the scale of grain processing in the area, yet the condition of the querns suggests that this occurred in an earlier phase. Though this is likely to be true in terms of chronology, it is difficult to establish where the grain processing may have taken place. The movement of refuse over large distances for recycled building material should not be underestimated. Huge volumes of ironworking waste in the form of slag were moved from

Southwark to areas north of the Thames in Roman London (Starley, 2003). The broken querns at Folly Lane may have come from any area in or around Verulamium and may be more relevant to interpretations of the wider economy of the town than that of a specific area.

The data for the lava milling tools at King Harry Lane is more precise in terms of where the lava was recovered, but little detail is available on the fragments themselves and the chronology of deposition. All the querns were retrieved from phases of occupation that occurred after the site had ceased functioning as an Iron Age cemetery and had become a settlement (Stead & Rigby, 1989, pp. 4-9). This occupation phase existed between AD 60-250, giving a very broad date range for the deposition of the querns, which could not have been deposited prior to the Roman period due to the date they started to be imported into Britain (see Chapter 4). Four lava groups can be more closely dated to the second century and one to the late first century. However, this does not provide the precision necessary to explore chronological changes in quern distribution at the site. Nonetheless, spatial distribution does provide a glimpse into possible patterns of consumption and deposition. This has been mapped onto the site plan in figure 127, alongside the locations for querns of other stone types (i.e., not lava). The locations for lava are marked in red, while those of non-lava are marked in blue. Exact locations are not provided in the excavation report, and so entire features or approximate findspots have been highlighted.

The placement of the Late Iron Age and early Roman cemetery that predated the Roman settlement phase of the site has been shaded. The plan in figure 127 only allows for the location of earlier graves to be illustrated where there are fewer later Roman features, which is on the right side of the plan. On the left, the extent of the cemetery is demonstrated by the shaded area, but the density and location of the burials cannot be shown due to the high number of later Roman features that obscure the ability to visualise the interaction between the earlier and later phases. The cemetery appears to have had clear limits on the north and east and west sides, while on the southern edge, it was bounded by a ditch (Stead & Rigby, 1989, p. 80). The location of the cemetery is significant despite the repurposing of the area for habitation, as it is highly probable that its previous use would have been known to the new site occupants. It is interesting to note that the evidence for occupation in the Roman period is more intensive on the western side of the road, where burials were sparser. Though it is likely that the later phases destroyed some of the burials making the density appear less, it is also possible that the most significant area of the cemetery, towards the east, was respected by the subsequent occupants.

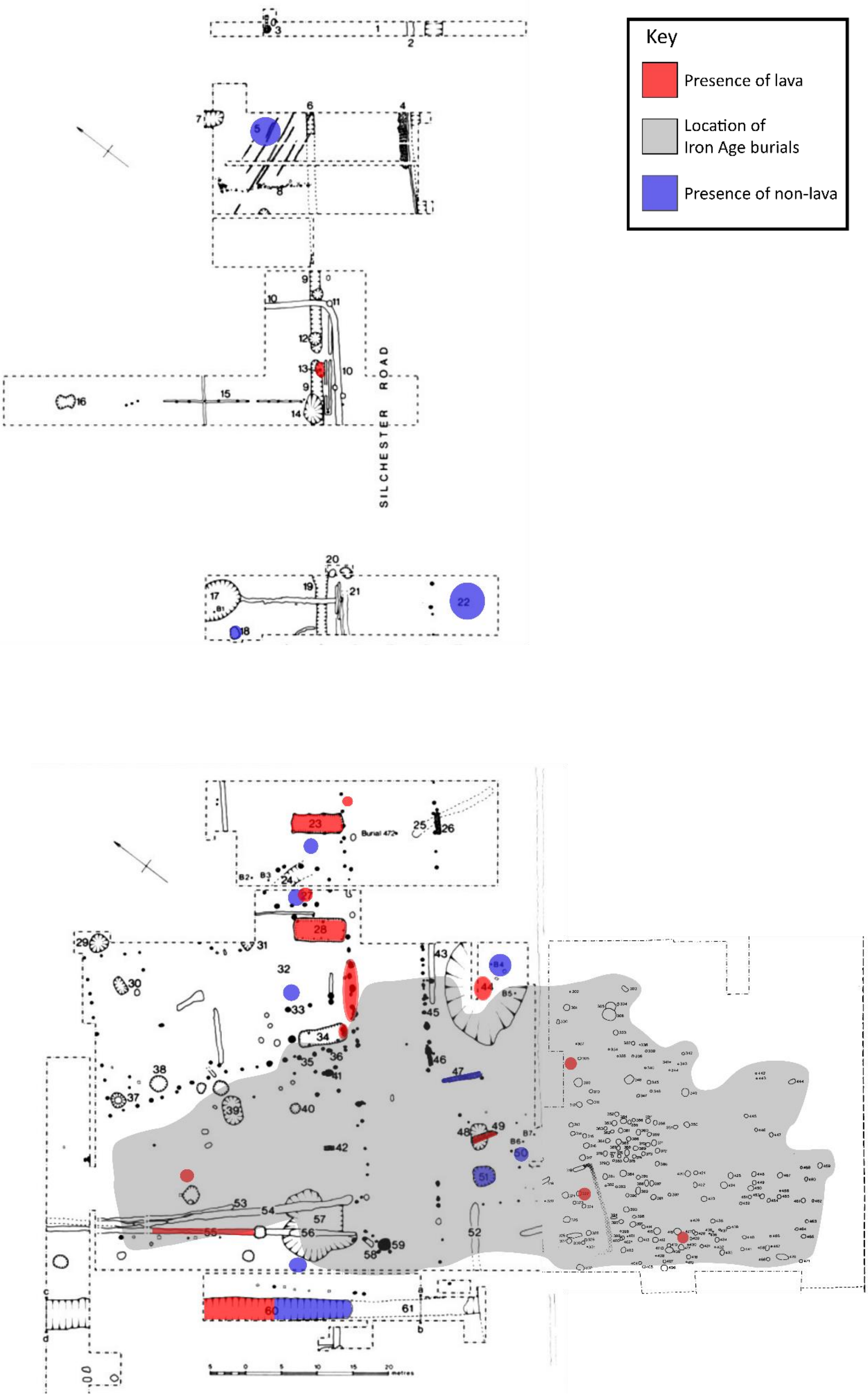


Figure 127- Location of lava and non-lava milling tools at King Harry Lane site, after Stead & Rigby (1989), fig 3, 4 and 182).

This also correlates with what is seen of lava quern distribution at the site, with twice as many recovered from the western side of the road than the eastern. It is not known whether this is also the case towards the northern part of the site where Roman period occupation may have occurred more intensively on either side of the road, as only the western side was extensively excavated in this area. It would be interesting to see if quern deposition becomes more evenly distributed away from the location of the burials. It is likely that quern deposition coincides with the location of domestic and industrial activity areas, as opposed to the distribution necessarily reflecting selective deposition patterns that avoid the cemetery. However, there is a possibility that the use or disposal of domestic or commercial food processing tools in mortuary contexts was not deemed appropriate.

The distribution of querns close to the road also provides some interesting data for discussion. Though it cannot be assumed that these demonstrate activity areas where food processing occurred, it could be used to argue that grinding and milling may have taken place there. Unfortunately, the excavation did not cover a wide enough area to determine whether the concentration of querns finds decreases away from the road, but the current picture does imply this was the case, for both lava and non-lava milling tools. Roads and roadsides are often utilised in traditional societies to dry and process crops after harvesting (figure 128), and it is possible that similar behaviours occurred in the past. They provide the hardened surfaces required and the ease of access to centralise the process of gathering the crop from various fields in the vicinity before transporting the finished product elsewhere. This theory would need to be supported with environmental evidence but provides an interesting research question worth exploring. Currently, the trend seen from the distribution can only be taken as indicating possible deposition of querns close to the road, which could suggest accumulation of rubbish in these areas or a particular deposition practice or preference.

Figure 128- Processing of rice at the side of the road in the central highlands' region of Dalat in Vietnam, specifically drying, de-husking and bagging of rice (photos by the author).

Within the town itself, the distribution of lava milling tools is difficult to establish due to incomplete data, especially findspot information. Furthermore, there is a high probability that different excavation strategies were used in different *insulae*, and that sampling and curation of material culture was not uniform over the long duration of archaeological excavation by different teams of archaeologists. This makes the data analysis problematic, as it becomes challenging to compensate for these differing strategies without knowledge of what they may have been. However, as most of the dataset comprises lava querns retrieved during the Frere excavations, it can be assumed some uniformity of approach was applied to the collection of the lava. The sometimes very small fragments that were retrieved and kept in the museum collections indicates that we are examining a significant proportion of what was present at the time of excavation. What cannot be assumed is that lava was absent in the *insulae* where excavations took place but where lava was not recorded, especially in the earlier excavations. We may only examine the presence of lava and its possible concentrations in specific locations.

Overall, this does not furnish us with a great deal of information, though it is worthwhile to examine the distribution of lava in correlation with other evidence for food and grain processing, and grain storage within the town to attempt to corroborate the possible interpretations. From the volumes of lava recovered from the town, the most significant concentration can be seen in *insula* XIV where 14 lava groups were recovered. This is of importance as *insula* XIV is located adjacent to Watling Street, which would have served as a major thoroughfare and was located opposite the *macellum*. The *macellum* was constructed around the Neronian to early Flavian era and was a major public building, with maintained use through the whole Roman period of the town (Niblett, 2001, p. 105). It saw several phases of rebuilding and existed as a stone structure by the second century. Volumes of butchery waste indicate that this was an area where meat was processed at scale, possibly prior to its sale at the *macellum*, where other types of food were probably also exchanged or sold, and this is most prevalent in the third century. A commercial level of enterprise relating to the processing of meat was probably being undertaken at Verulamium (Niblett, 2001, pp. 105-106), and it is possible that this was the centre for other similar large scale food processing activities. The volume of querns recovered nearby could be indicative of grain processing at a similar scale occurring close to the markets, possibly for sale or redistribution via the *macellum*. This should be compared with the evidence at Chichester, where large numbers of lava and other querns were found at the Cattlemarket site outside of the town. Environmental evidence and butchery suggested large scale food processing occurring within a designated area at the site and were indicative of a thriving market area where livestock and grain were brought from surrounding rural areas for processing and probable sale or exchange (see Appendix 3). The possibility that this represented a location where taxation on rural production occurred is also worth considering.

The surrounding rural areas around Verulamium are likely to have been used extensively for arable agriculture, and a large granary at Gorhambury Villa can be used to argue for this idea (Neal, et al., 1990). Three smaller granaries existed in the town that were destroyed by the Antonine fire, all within *insula* XIII. It is not known whether replacement structures were built afterwards, and if they were, these did not occur in the same location. However, a large tower granary is known to have existed by the third century in *insula* II, and this would have held a significant volume of grain brought from the rural hinterland. Environmental evidence indicates that the grain had been dried and threshed prior to storage, and that these processes were undertaken before the grain was brought into the town (Niblett, 2001, p. 106); possibly at the roadsides as suggested by the quern distributions at King Harry Lane where some grain may also have been ground to fulfil more immediate needs. The cluster of lava querns near the *macellum* and the large-scale storage of grain in the town is indicative of centralised food processing, a pattern that is typical of what would be expected of an urban environment with a population engaged in crafts or industry that preclude the ability to engage in self-sustained food production or processing. Structural remains on the River Ver have been speculatively interpreted as a mill (Rogers, 2013, p. 139) and the recovery of millstones from the town also supports the idea of mechanically rotated mills in the vicinity. The querns from near the *macellum* suggest that these were used at scale for processing, and whether these were largely replaced by mechanical means of grinding is difficult to ascertain without a better-defined chronology of quern and millstone use in the town.

Of the fourteen lava querns recovered from near the *macellum*, eight could be assigned dates that were more specific than simply classed as Roman (Table 12). These predominantly fall within a late first to mid-second century date range, which matches our current understandings of the peak of the lava millstone trade in Roman Britain. Interestingly, this means that most of the dated lava is from contexts that predate the fire that destroyed large parts of the town, including the *macellum* around AD 155/160 (Niblett, et al., 2006; Frere, 1983, p. 13). Though it seems likely that artefacts that predate this period are much easier to date, it does the raise the question of whether the event of the fire altered the use of the space around the *macellum*. The previous structure was replaced with a masonry building and it probably took some time for this to be completed. The new *macellum* was a grander design but was smaller when compared to its predecessor, indicating possible alterations to its previous uses. However, the possible reduction in lava does not necessarily denote a reduction in the number of querns and more work would need to be done to see what was occurring in relation to the chronological change in milling tools of other stone types in the vicinity.

Related to the possible large-scale grain processing occurring at the site near to the *macellum* is the grain storage area in *insula* XIII, which was subject to detailed analysis by Niblett, et al., (2006) in an article that aimed to produce a more cohesive and interpretative account of earlier excavations that were reported in a more piecemeal way at the time of the original separate investigations. Examination of environmental and structural evidence concluded that both wheat and barley had been stored at the site prior to the second century, with a change to only barley for malting by the third century once rebuilding had replaced the storage area after the Antonine fire (Niblett, et al., 2006, p. 180). It appears that the event of the fire may have resulted in some changes in the way that commercial activities were organised, including that of the storage, processing and possible sale of grain products. It is interesting to note that at the grain storage site in *insula* XIII most lava was recovered from reuse contexts; specifically those associated with surface make up and levelling. These were predominatly dated to later phases; from the fourth century onwards. This contrasts to those found near to the *macellum*, which were mostly dated to before the fire.

Table 12- All fourteen querns recovered from insula XIV with their allocated date period.

Lava quern catalogue No	***Museum accession No***	***Allocated date range***
999		fifth century
2557	1980.932	Roman
2588	1980.979	175-275
2594	1980.984	Roman
2595	1980.981	Roman
2596	1982.163	Roman
2597	1982.160	150-155/160
2598	1980.980	Roman
2609	1980.978	85-105
2611	1982.162	85-105
2612	1980.982	150-160
2614	1980.991	Roman
2616		155/160
2617		155/160

However, it would seem that the groups of lava querns from *insulae* XIII and XIV may have been in use at similar times, but with those in *insula* XIII being reused. It is worthwhile to note that the change in the use of the site to that of a malthouse and brewery would probably have negated the requirement for lava milling tools, as these are likely to have been unsuitable for the job. Lava was a popular tool for grinding grain as the natural vesicles in the material could cut the grain more easily to produce flour. In beer production, the barley needs to be dehusked, an outcome that is best genrated by crushing the grain. Sandstone, grit or conglomerate querns would have been more suitable for this processing, and it is possible that lava was rejected in favour of these. This could explain the absence of lava from post-fire contexts when barley became the dominant grain type and wheat ceased to be stored at the site. However, there were no querns of indigenous stone types recovered that may have replaced those of lava, and it may be the case that all processing took place elsewhere, making the absence of lava in secure later contexts less relevant.

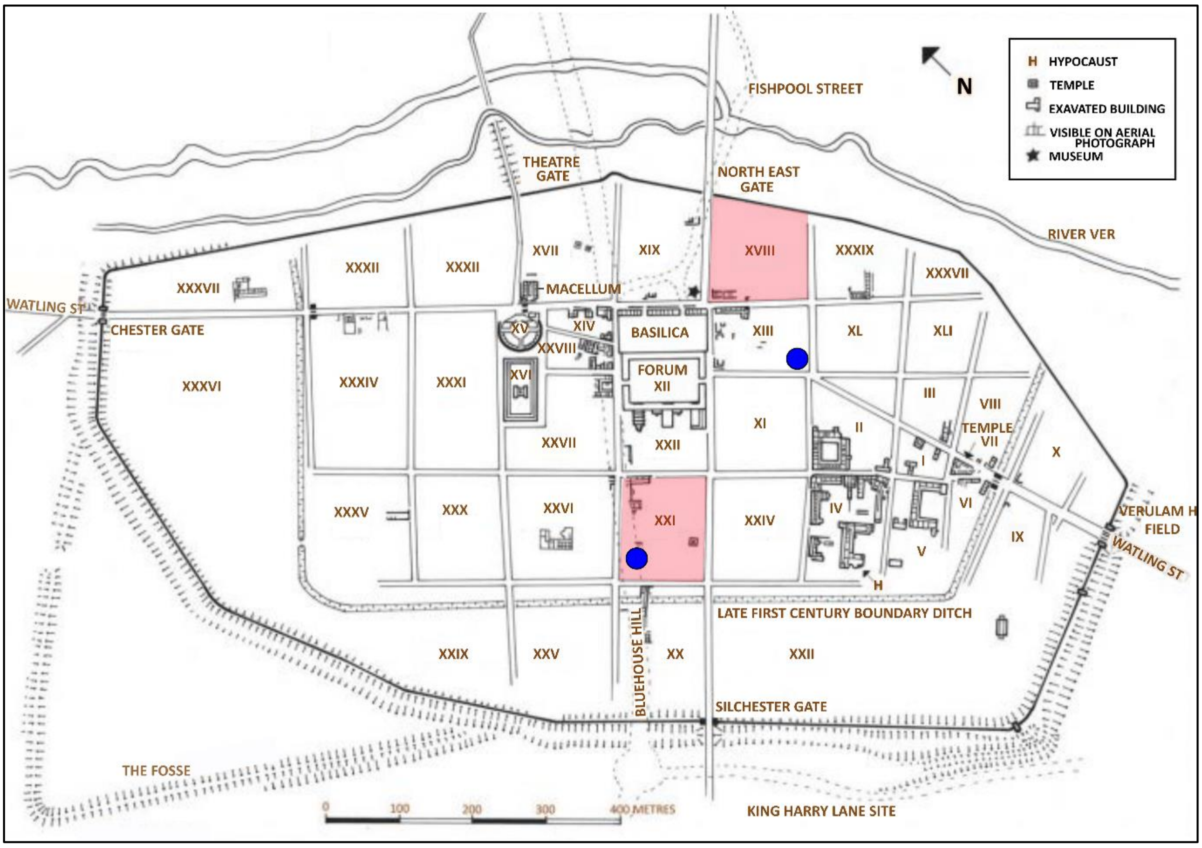


Figure 129- Plan of Verulamium showing the locations where lava millstones were recovered in red. Approximate locations of the granaries are indicated by blue dots. (Plan after Niblett (1999) and adjusted from St Albans and Hertfordshire Architectural and Archaeological Society (2019)).

Of the six millstones that were recorded at Verulamium, all were recovered from within the town itself, which could provide further evidence that centralised processing of grain occurred there. Only three of these could be allocated a location and interestingly, two of these are within close proximity to the granary at *insula* XIII both being found in *insula* XXVIII, not far from the possible grain processing area near to the *macellum* (figure 129). Again, care must be taken as the distribution only identifies the locations where lava millstones were deposited and may not relate to activity areas where grain was processed. However, it curious to note the general clustering of lava milling tools in the northern part of the town. The fact that millstones are present at Verulamium should indicate that grain was processed at scale, as it is unlikely that these objects would have travelled to the site as recycled building material unless they did so from the area directly around or inside of the town. Unfortunately, only two of the examples are dated: One from *insula* XXVIII to the period of the Antonine fire and within fire debris (CAT 0997), the other from *insula* XXI to the mid-fourth century and recovered from rubble indicating a possible earlier date for original use (CAT 0998). Again, it is interesting to note that in the northern part of the town in *insula* XXVIII, the lava millstone must have been in use at the time of the Antonine fire, or the period preceeding it. The consequences of the fire appear to have caused a major a change in operations and the use of lava, for both querns and millstones, possibly ceased or decreased significantly in this part of the town at around the same time.

Primary Use

For the Verulamium dataset, there were 13 upper stones and 9 lower stones that provided suitable measurements for thickness (figures 130 and 131). These have been plotted alongside the data from the entire lava quern dataset from Roman Britain, with a total of 422 upper stones included but excluding the probably unused querns from the excavations at 1 Poultry that would skew the data considerably. For Verulamium, the sample size is not very large making it a challenge to interpret the data with confidence, though for both upper and lower quern stone thicknesses suggest that these are largely within the 'normal' range when compared with the data from all lava querns in Britain, which lies between 48mm and 72mm. This may seem relatively thick, but as it is a measurement taken at the edge, this is the part of the upper stone that is least effected by wear and so would remain thicker than the centre that tends to wear away completely prior to the quern becoming defunct. Three examples from Verulamium fall within the lowest 25th percentile for upper quern thickness, CAT 2612, 2603 and 2599 and these were all excavated from within the town. One upper stone was within the highest 25% percentile for thickness and was also from within the town walls.

However, these examples are not very different from the normal range, suggesting that there was a fairly standard thickness that a stone would reach before it was no longer used as a quern and deposited.

There are some differences seen in the lower quern stone data, though again, the small sample size provides some interpretative issues. Most of the lower stones fall within the 'normal' range for thickness, which lies between 32mm and 55mm, with one falling slightly below. There are three stones that are within the top 25% of lower stone thicknesses, two of which are not greatly different from the normal range. One, however, is very thick (CAT 2559) and is an anomaly within the Verulamium dataset, having few parallels within the British dataset with a thickness at the edge of 110mm. This is a possible unused, or very little used quern stone and has a similar thickness to the 'new' querns from 1 Poultry. The reasons why this exists within the assemblage will be investigated within the section on reuse, as evidence on the stone implies that it may have been repurposed. Whether this example was broken on arrival is a possibility. The chance that this may represent a quern roughout may also be considered, though this is unlikely. The high level of standardisation for Mayen lava querns implies that they were centrally produced and the evidence at Mayen fully supports this theory (Chapter 2).

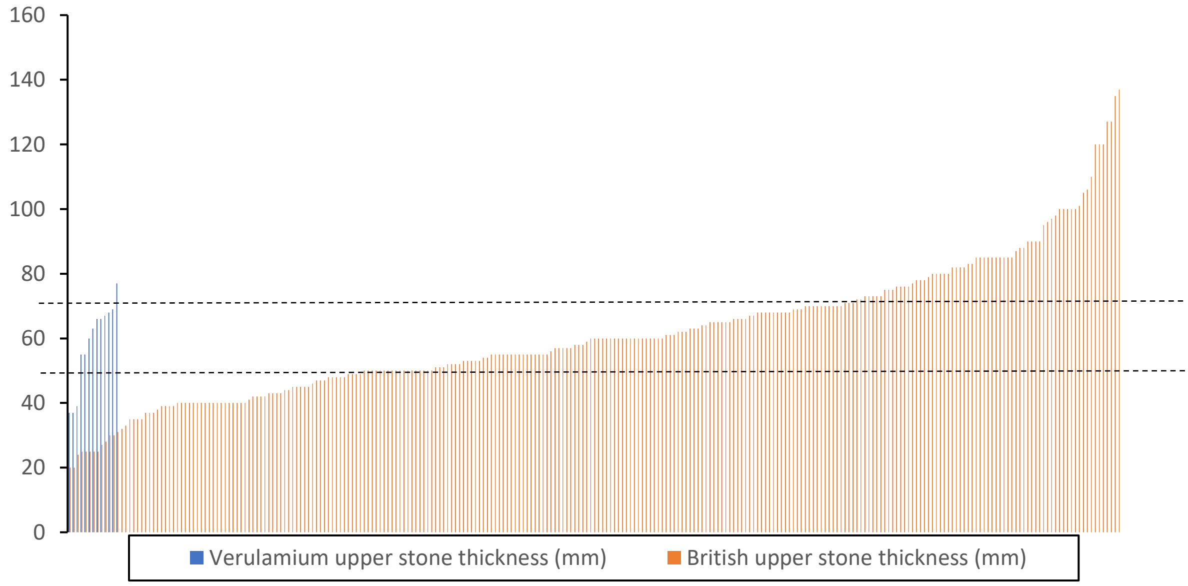


Figure 130- Graph showing the edge thickness of upper stones from Verulamium (T= 13) compared with those from all Roman Britain (T= 248) excluding those from 1 Poultry. The 25th and 75th percentiles are indicated with dotted lines.

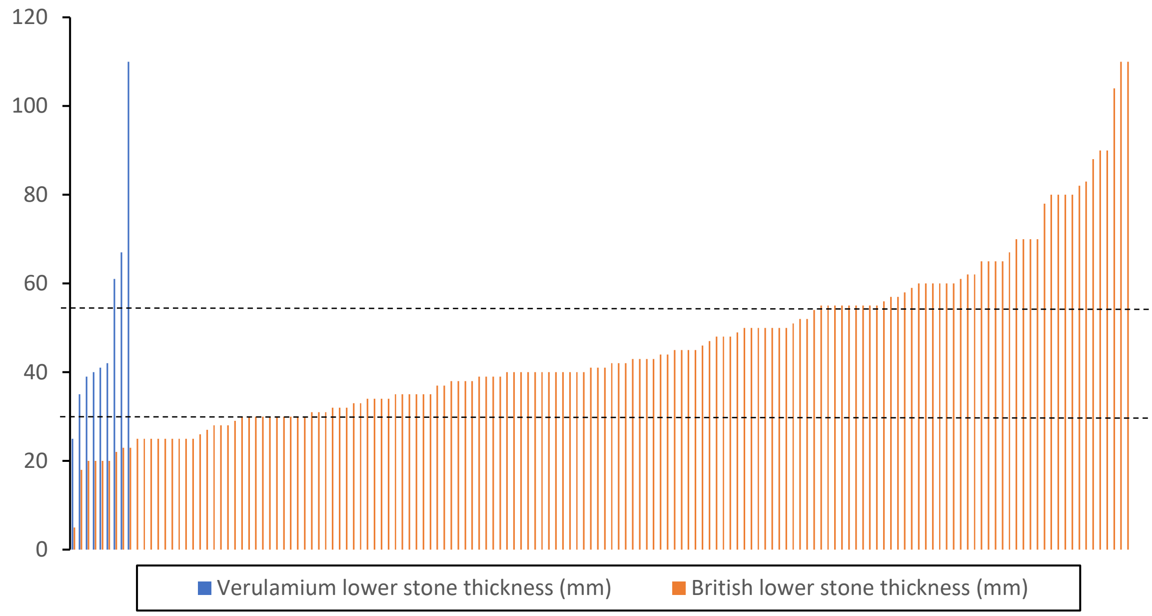


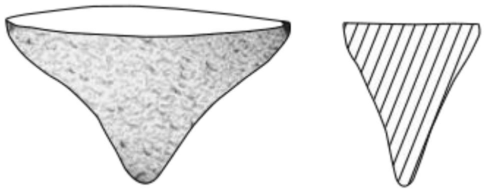
Figure 131- Graph showing the edge thickness of lower stones from Verulamium (T= 9) compared with those from all Roman Britain (T= 138) excluding those from 1 Poultry. The 25th and 75th percentiles are indicated with dotted lines.

Reuse/Modification

Though there is little to be identified from use-wear analysis due to the fragmented state of most of the lava groups, there are two examples that show some possible adjustments that may have been related to their primary function as milling tools. These are both lower stones that appear to have had part of the lower part of their sides chipped and removed, with clear tool marks present on one (figure 132). Quern stones with chipped edges are not unknown in the archaeological record and these have been identified on examples formed from indigenous stone types, such as Lodsworth Greensand. The intention behind this behaviour could relate to deliberate breakage of the stone as part of a ritualised act, as this is a phenomenon that can be observed for querns from the Iron Age and earlier (Watts, 2014, p. 9). However, this chipping does not appear to have been completed with the general aim of breaking the entire quern stone and looks carefully and deliberately performed. The resizing of upper or lower quern stones is another possibility, to 'marry' them to other stones once their original pair stone had worn out. As upper stones are more likely to wear faster, it is likely that lower stones were reused and reworked to allow continued use. However, as lava querns are highly standardised, the extent to which reworking was necessary should be questioned. As imported products, it may also be worth considering the likelihood that a single unpaired stone could be procured to replace a worn upper for a reusable lower. Lava lower stones were possibly paired with uppers of other stone types, though the practicalities of doing this and the effect it had on the processing of grain should be explored.

Figure 132- Lower quern stones(left) that have been chipped at the bottom edge. Top image CAT 2605, bottom CAT 2592 (photos by author).

Figure 133- 'Napoleon hat' type lava quern (right) manufactured in the Mayen district. The unusual shape of the lower surface has been interpreted as a point for bedding the stone into the ground prior to use (after Röder, 1955, fig 1).



Observations of the chipped lava lower stones do not suggest that the aim was to resize the stones, as the focal area of chipping is near the underside of the quern, leaving part of the original edge vertical and intact. The result is a 'bowl' type profile as the lower surface gradually cuts away underneath the stone, a slightly less extreme version of the 'Napoleon hat' type lava querns that predate the rotary versions manufactured at Mayen (figure 133). The interpretation for the unusual shape and style of this type of quern is that it was bedded into the ground to provide greater stability for when the stone was in use. This information allows us to speculate that a similar purpose may have existed for the chipping of the sides of the rotary querns, and that these may have been adjusted to fix them to the floor or other surface, allowing for greater stability during the grinding process. Unfortunately, as these two examples are fragments, little can be confirmed with regards to how they were worn, as this can also be indicative of a fixed position quern stone. There are several examples of querns that have been found *in-situ* fixed into position this way (Cool, 2006, p. 74), such as a non-lava lower stone that was found set into the surface of a workbench at Vindolanda (Bidwell, 1983, fig. 29). It is highly probable that this practice was carried out elsewhere and perhaps adjustments needed to be made to a quern to allow for it to be appropriately fixed. However, a similarly chipped quern stone would need to be recovered from a use-context for this theory to be confirmed and more work needs to be done to examine whether other altered lower stone examples exist in other assemblages. The implications of having fixed position querns would indicate that grain processing was occurring at a scale where space could be permanantley set aside for the activity to be undertaken. This might relate to centralised processing, commercial endeavours, or elite persons with large areas of space where domestic activities could take place.

Instances of reuse are difficult to identify in an assemblage that is so fragmented, but there are occasions where this is visible, both in terms of the effect on the object and/or the context of deposition. There were six objects that showed possible evidence for repurposing (table 13), all of which were recovered from within the town. Of these, four show signs that they were reused for other processing activities, such as for sharpening knives or blades. These were found to have surfaces that were not identifiable as being the result of original use as a quern, due to a change in texture, wear, or shape. For example, CAT 2566 was worn very thin and, if still part of a complete stone, would not have had the weight necessary for it to be used for milling. Both the surfaces were worn smooth and flat, and these could not be attributed to wear from rotary or oscillatory grinding. The fragment had also been reshaped (see figure 134 below).

The geology in and around Verulamium does not provide a ready supply of stone suitable for ground stone tools and stone brought into the town for other purposes is likely to have been reused regularly. Lava was clearly a popular and common choice for milling tools at Verulamium and its reuse is likely to relate to this. It is surprising that there are not more examples of reuse, as it would be expected that with the size of the assemblage this would similarly increase. However, the high level of fragmentation across the assemblage might relate to reuse and the deliberate breaking up of querns to accommodate this. Though there are fragments that could correspond to natural breakage from wear, several are more difficult to explain, such as body fragments that would not have been vulnerable to damage (figure 135). This type of fragmentation has often been correlated with ritual deposition, especially in the Middle Iron Age, and could explain the damage seen. However, many of these fragments lack the context of deposition needed to establish such interpretations.

One other of the reused lava quern stones has been summarised in the section on manufacture (CAT 2594), as it is unclear if the unusually shaped rynd chase is a production feature, a sign that the stone was mended for continued use or be related to a possible reuse of the stone for other functions. Unfortunately, it is not possible to correlate this possible adjustment to any specific type of reuse, though it appears that the shape assumed to be a rynd chase has been deliberately and carefully cut into the stone. The only other example of possible reuse may also be identified as a possible 'roughout' quern stone that was not completed and is between stages of production (CAT 2559). It is unique within the British lava quern dataset and shows some very interesting characteristics. The stone is clearly identifiable as a lower stone and has many of the standardised features associated with those manufactured at Mayen, such as the convex grinding surface and

Table 13- Summary of lava querns showing signs of reuse in Verulamium.

CATALOGUE NUMBER	% OF STONE REMAINING	DESCRIPTION	EVIDENCE FOR REUSE
2557	2	Very small fragment with thickness of 11mm	Both top and bottom surfaces are worn very smooth and not identifiable as original surfaces.
2559	100	Possible unused lower stone that has been broken into multiple pieces.	Original harped dressing is visible on the grinding surface, but this is altered with a heavily inscribed swirled pattern. Central hole appears to have been widened and there are visible signs of redrilling that may have fractured the stone (figure 134a).
2566	1	Small fragment that has been reshaped and 'squared off'.	The stone has been reshaped for reuse and wear indicates that processing other than grinding may have taken place (figure 134b).
2594	25	Large piece of upper stone with unusually shaped rynd chase.	The shape of the rynd chase could indicate that it has been adjusted to accommodate a different use (figure 124 in 'manufacture').
2616	Unknown	'fragment…reused since it has 2 adjacent planes which lie at an acute angle. Upper surface is fairly flat, but others are rough' (Frere, 1972, p. 158).	Object not seen in person, but publication describes surfaces that may have been reused for other processing activities.
2684	3	Small fragment with a smoothed and curved shape.	The shape and texture of the surfaces must have been produced from other processing activities as these are would not have occurred from grinding (figure 134c).

harped dressing on the grinding surface. However, the lower surface of the stone has not been fully hollowed out as would ordinarily have been done probably to make the stone less cumbersome. It appears that attempts had been made to do this, but the job had not been finished to the level that is normally observed on other querns. There are clear tooling marks on the lower surface to show where these attempts had been made (figure 136).

Figure 134- Examples of quern stones from Verulamium that show possible signs of reuse. a- complete lower stone that is shattered into fragments with swirled incisions on grinding surface CAT 2559 (© St Albans Museum), b- small thin fragment with two it has been reshaped for reuse CAT 2566 (photo by author), c- thin and curved fragment that has one very smooth surface CAT 2684 (© St Albans Museum).

Tooling marks are usually very visible on the lower surfaces of lower quern stones, but the apparent incompleteness of this example is highly unusual. The only other evidence that could indicate that this was a quern roughout is the signs that show that the stone had been drilled to create the central perforation. Grooved marks in the centre of the stone show that a rotational motion had been used and this may also correspond to the swirled incisions found on the grinding surface of the stone. However, this evidence could also relate to the reshaping of the central hole so that the stone could be repurposed. Whatever the reason, the stone must have shattered because of the drilling, and the multiple fragments were deposited. There are clear signs of the original production and intention to use the stone as part of a quern, a purpose that from its thickness and lack of wear was apparently not undertaken. It may already have been rejected as a suitable stone, and the decision made to repurpose it. The 'overwriting' of the original dressing on the grinding surface to produce a swirled design may have been intentional, or it may have been a by-product of the process of repurposing.

Figure 135- Body fragment of lava quern that may have been part of a quern deliberately broken as it does not correlate with normal breakage due to wear or other vulnerabilities. The left side if the image shows the grinding surface CAT 2571 (photo by author).

Figure 136- Underside of CAT 2559 showing the tooling marks where the underside had started to be hollowed out (photo by author).

Deposition

Of the earlier lava groups at Folly Lane, three (CAT 2623, 2624 and 2650) were recovered from shafts, ABZ, DKM and AAB. These shafts are within a larger group of similar features that have been interpreted as having a ritual function due to their frequency, placement and the finds recovered from them. Folly Lane has many of these 'ritual shafts' alongside ovens, which are also found at the temple sites in *insulae* VII and XV and are likely to have been used as part of ritual activities (Niblett, 1999, p. 100). Alongside the lava, the shafts also yielded large volumes of animal bone (including dog and horse), coins, glass, items of personal adornment, a 'deliberately' bent key and a chisel. The pottery assemblages from these contexts are unusual, and it was found that fragments from shaft ABZ could be refitted with those from a 'paired' shaft nearby indicating that these were contemporary. They included fragments from complete vessels, all closed forms, such as jars, beakers, flagons, and face pots. Two fragments from separate Eifelkeramik vessels were found within shaft AAB, and it is interesting to note that these may have travelled to Verulamium alongside the imported lava querns (see Chapter 2). The contexts could be dated from the mid-second to early third century, when many of these ritual shafts were dug and then filled in (Niblett, 1999, p. 99). It is possible, therefore, that the lava recovered from the three shafts may also have been ritually deposited. However, the interpretation of these shafts and their contents as remains of ritualised activity remains questionable. The 'ritual pits' at Silchester were subject to nuanced investigation with regards to the pit deposits, stratigraphy, and the finds recovered. It was found that there was no clear way to prove or disprove that there had been a ritual aspect to the placing of these deposits and finds in the pits involved (Eckardt, 2006). Fulford (2001) has also argued strongly for a more theoretically informed and evidence-based approach when identifying ritual deposits from rubbish disposal, and the 'ritual shafts' at Verulamium would benefit from more in-depth scrutiny of this kind with regards to the interpretations presented by Niblett (1999).

Unfortunately, the lava fragment groups recovered from the ritual pits are not described in the excavation report, but it would be interesting to see whether these comprised pieces of the same quern in the same way that fragmented pottery appears to have been split between two other shafts. The degree of fragmentation and the possibility for its destruction to have been a purposeful act would also be of interest. Deliberate fragmentation and deposition of querns in ritualised contexts is a phenomenon that is well-recognised in prehistoric archaeology with querns of indigenous stone types (e.g. Brück, 2006; Watts, 2014) but is less well-understood in terms of Roman era practices. The use of lava in such contexts implies that the material may have been less significant than the function of the object, and that it was selected for deposition for this reason. The frequent presence of ovens at ritual and religious sites in and around Verulamium indicates that food preparation and consumption may have been involved in some of the ritual activities carried out there. Querns and ceramic vessels may have been similarly employed and deposited afterwards (Niblett, 1999, p. 94).

A further parallel example to this depositional behaviour can be seen at the site of Mount Pleasant, which was a rescue excavation completed in the 1960s at an area 175m to the south of Folly Lane, where a continuation of the ceremonial landscape appears to have existed. Here, two deep shafts were uncovered, interpreted as possible wells (Hertfordshire HER number 14005 and 14006). These were of a similar chronology to those at Folly Lane, with the primary infill dated to the second century with a third century upper fill. The shafts contained coins, a fragment of lava, pottery and the disarticulated humans remains from three individuals: a male, female, and an infant. The presence of lava in a third possible ritual shaft from a similar phase and location strengthens the possibility that lava querns had been ritually selected and deposited. However, details for this excavation were poorly recorded and remain unpublished making it impossible to establish where in the shaft the lava was recovered. Quantities of third century domestic refuse has been found in sinkage hollows in the upper fills of shafts and pits in and around Folly Lane and without clear context and stratigraphic information, it may be that the lava constitutes intrusive rubbish. The weathered and undiagnostic nature of the lava found at the site indicates that this is a possibility.

Overall, the pits at the sites around Verulamium present an interesting possibility for lava to have been ritually deposited, possibly as part of practices that involved the preparation and consumption of food. However, there are many other potential explanations, and it is important to recognise the difficulty involved when interpreting such deposits. What classifies an object as part of a 'structured' deposit is a heavily debated topic (Hill, 1995; Fulford, 2001; Garrow, 2012), and interpretations often rely on more detailed stratigraphic information than that currently available for the specific examples mentioned here. Even then, connecting the meaning and intent behind the deposition of different objects within the same feature, possibly as part of different 'events', is a complex process that lacks any certainty regardless of how theoretically informed that process may be. This was found to be the case at Silchester during the detailed investigation of the late Roman pits completed by Eckardt (2006), and that site will be explored in the next section. Residual and intrusive material, alongside the recutting of features adds another layer of complexity. It is only possible to discuss the probability that lava was ritually deposited, which in the case of Verulamium, appears highly likely due to the nature and context of the deposits involved.

Verulamium: Conclusions

Overall, the lava milling tools from Verulamium present some interesting results and can add to our interpretations of urban life. Verulamium was located within a region that both depended on imported milling tools and was able to access them easily via exchange routes on the eastern coast. Consequently, a significant amount of lava has been recovered from the Roman town, though the true volumes may not have been fully captured in this analysis due to the age and retention policies of some of the excavations. As a town that had good access to lava products, querns were deposited after their primary use was no longer possible but were not heavily worn when compared to other querns from the full British dataset. Much of the dataset shows that the querns from Verulamium were of an average thickness prior to deposition, with some examples that were considerably thicker than the Romano-British average at the time of their disposal. However, many fragments were found to have been reused for other purposes, probably another outcome of the local geology that also was not able to provision whetstones, hones, or other ground stone tools.

Distributions of deposition have highlighted some possible activity areas related to quern use, such as the area around the *macellum*, but were generally associated with reuse and levelling contexts, with a large volume of probable residual material being used in this way. Ritual deposition of lava seems possible at Folly Lane and Mount Pleasant where late Roman pits appear to have been used for this purpose. There may have been a relationship between querns, pottery vessels, and the preparation and consumption of food as part of ritual activities, with these objects being deposited afterwards. More research and better stratigraphic information would be needed to explore this more fully.

In terms of the economy, Verulamium yielded a high number of millstones, indicating that centralised grain processing was occurring in or close to the town, probably after the period of the Antonine fire when lava querns cease to appear in secure primary contexts. The apparent transition from small granaries to a large tower granary also suggests that centralisation was occurring, and this probably involved the nearby villa estates that also provide evidence for large-scale storage of grain products. These changes could be related to changes in the status of the town and the development of more specialist economic and administrative activity. The centralisation of beer production provides one example of this, with the development of a brewery and malthouse appearing around the third century. This does not appear to have utilised lava querns in its operations, which may have been due to the impracticalities of using lava for this purpose. Overall, evidence appears to suggest that, over time, small-scale domestic grain processing using querns may have been rejected in favour of the consumption of ready-ground flour. The presence of a millstone in Antonine fire debris suggests that this transition had commenced by the mid-second century. However, it would be necessary to examine the non-lava quern data to establish this fully, as the current data may only relate to decreasing amounts of lava entering the province and reaching Verulamium.

Silchester

Background to the Site

There have been numerous excavation projects undertaken at *Calleva Atrebatum* (Silchester) (Figure 137) with the earliest archaeological records dating to 1864, and the site remains one of the most well-known and researched Iron Age and Roman towns in Britain (Fulford, 2021, pp. 1-4). Extensive earlier excavations, which largely took place in the Victorian era, were undertaken to reveal the full plan of the town grid. Many of the querns from the dataset were recovered during these investigations, and it is likely that these only represent a small number of those excavated (Shaffrey, 2003, pp. 144-145). From the volume of Roman material that has since been recovered from the

Victorian excavators' rubbish dumps in *insula* IX, it is clear that querns and bulk finds were selectively retained, with perhaps only the larger or most diagnostic examples kept. If any specific discard policy existed, this is not documented, and it is impossible to know what proportion of all recovered material was retained or why some objects were selected over others (Fulford, et al., 2002, p. 229). Furthermore, the early excavations were completed without an understanding for the importance of stratigraphic relationships and much of the data produced fails to address important research questions, such as those related to the Iron Age phases of the site.

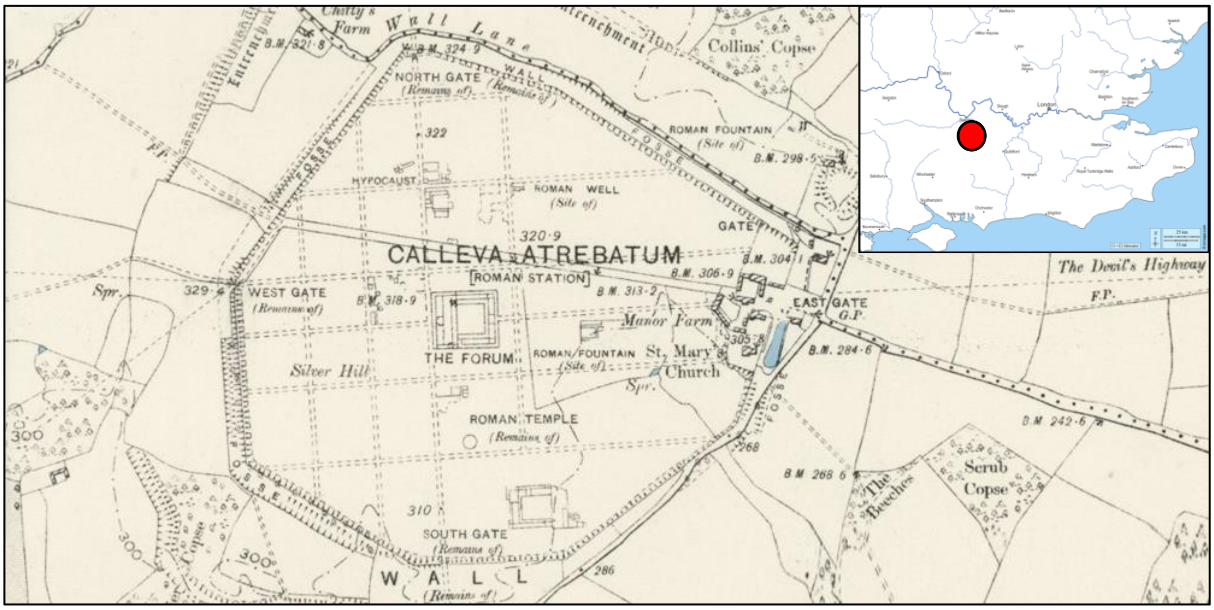


Figure 137- Location of Silchester Roman town (© Ordnance Survey).

Investigations have continued into the present day using modern techniques and approaches, such as environmental sampling and geophysics (Fulford, 2021, pp. 8-19). These more recent excavations have predominantly focussed on *insula* IX (Fulford & Clarke, 2011; Fulford, et al., 2006; 2018a; 2020), with smaller-scale investigations conducted at the forum-basilica (Fulford & Timby, 2000), the temple in *insula* XXX (Fulford, et al., 2017), the amphitheatre (Fulford, 1989), and the bathhouse (Fulford, et al., 2018b; 2019), while an extensive geophysical survey completed by Creighton & Fry (2016) examined the town and the extramural landscape.

Silchester is in central southern England, in a region that is thought to have been within the tribal territory of the Atrebates. Probable tribal leaders of the Atrebates have been identified from coins, whose distribution patterns are taken to indicate the possible changing geographical influence of the tribe over time (Creighton, 2000, pp. 75-79). Initial settlement of the town has been dated to 20-10 BC from coin and ceramic evidence, though it is possible that other parts of *Calleva* might reveal earlier phases (Fulford, 2021, pp. 32-34). The town was enclosed by a series of earthworks that may have been constructed as defensive boundaries (Wacher, 1995, p. 272; Creighton & Fry, 2016, pp. 322-325), while the town itself was organised into a grid system of lanes fronted by timber buildings. Finds from a timber hall in *insula* IX indicate high-status inhabitants who enjoyed a range of imported foodstuffs and commodities with connections to Italy, Gaul and Spain and were engaged in social practices that did not conform to those commonly seen elsewhere in Iron Age Britain (Fulford, 2021, p. 36). This indicates that, at Silchester, there were pre-existing contacts with the Roman world, which may have influenced the experience of the town's inhabitants during and immediately after the Roman conquest of AD 43. This is a pattern that has been observed at other southern urban/oppida sites (Creighton, 2006, p. 24). Evidence for economic activity and industry includes objects related to the production of coins, textile working, weaving and carpentry. Agricultural production involved the cultivation and processing of grain and there are also indications that animals grazed nearby (Fulford, 2021, p. 41). Most querns dated to this era were sourced from the Upper Greensand quarries at Lodsworth (Shaffrey, 2021, pp. 7-8).

The response of Silchester to the Claudian invasion remains unknown, but the population of the town may have initially opposed the invasion forces (Fulford, 2021, pp. 51-52) and the inner earthworks may have been constructed at this time as a means of defence (Wacher, 1995, p. 272). A current lack of evidence for any permanent military stronghold at the site could be used to argue otherwise, yet Fulford (2021) discusses that the surviving population of any attack may have fled or were enslaved, negating the need for any permanent military structures. Boon (1969) also suggested that the presence of the military may have been very temporary. A possible military *principia* provides the only structural evidence for a potential military phase in the early conquest period at *Calleva* (Wacher, 1995, p. 272). However, this identification remains controversial for a number of reasons (Creighton, 2006, pp. 72-75; Millett, 1990; Fulford, 1991), while an assessment of contemporary finds evidence has not shown any obvious military or state associations (Pitts, 2014). This building is now more often referred to as a 'proto-forum', yet a possible military role cannot be absolutely ruled out (Fulford, 2020a, pp. 5-6). Soldiers may have been accommodated in a manner that is not archeologically visible or obvious. The central location of *Calleva* within a road system vitally important for the movement of goods and troops does imply that some form of policing would have been valuable and essential, but this need not have been achieved through fortification or military occupation. As Fulford (*ibid*) and Boon (1969) strongly argue, plentiful finds of early Roman military equipment and material culture associated with the military show that a presence is highly likely.

This 'courtyard building' provided ceramic evidence for imported olive oil and wine brought from various parts of the empire, including Spain, France, the Aegean and Italy, dried fruit from Palestine and fish sauce (Williams, 2000, pp. 219-220). This stands in direct contrast to *insula* IX, which presented far more restricted sources of foodstuffs, and is likely to demonstrate a difference in status between the inhabitants occupying the two parts of the town (Fulford, 2020b, pp. 587-588). By the Neronian period, timber buildings were still prevalent but in a different style, while more grand structures, such as a masonry bathhouse and the amphitheatre, were also constructed (Fulford, 2021, p. 72). Spelt wheat and hulled barley were the dominant food source, while the consumption of more exotic imported foods, such as figs and lentils also occurred to a lesser degree (Lodwick, 2020; Fulford, 2021, pp. 61-72).

It was towards the end of the first century, around AD 85, that the revised grid system for the town was set out, orienting the streets on a north to south axis from the earlier north-north-west to south-south-east alignment (Fulford, 2020a). This was a major undertaking and may have occurred as part of a single process of renovations, including the infilling of the inner enclosure ditch system and the establishment of the adjusted road network. It is interesting to note that the changing layout of the town was not felt equally by all inhabitants and that conversion to the new system occurred in some instances, but not all. Meanwhile, public buildings were being constructed to conform with the alignment, such as the timber forum basilica that replaced the courtyard building, a possible *mansio* in *insula* VIII, temples in *insula* VII, and the public baths that replaced the Neronian bathhouse. The establishment of the forum basilica was a significant development in that it reveals the formalised introduction of centralised self-governance to the town and its surrounds, while the possible *mansio* emphasises the importance of Silchester as a transport and communications hub (Fulford, 2021, pp. 76-102).

The second century saw *Calleva* reach its pinnacle in terms of population, activity, and investment, including the replacement of the timber forum basilica with an impressive masonry structure (Fulford & Timby, 2000, p. 68) and renovations and remodelling of the amphitheatre (Fulford, 1989, p. 36). A defensive rampart was constructed around the town towards the end of the second century, possibly in response to potential threats (Fulford, 1984, pp. 235-237). Timber domestic buildings in i*nsula* IX were also rebuilt with masonry foundations and this development appears to have been replicated elsewhere across the town, though purely timber buildings continued to be used (Fulford & Clarke, 2011, pp. 327-329). The economy of the town may have been largely supported by the traffic of people moving through on their way to other destinations, and that of the rural production of its hinterlands, including elite rural estates. Crafts and industry are difficult to pinpoint, yet it is likely that a range of locally produced goods would have been available. Evidence suggests small-scale pottery production, forging of iron, tanning and bone working, but textile working is much less evident (Fulford, 2021, pp. 123-124). Imported goods and foodstuffs were widespread during this period, indicating a culture of consumption for a population of relatively well-connected and wealthy inhabitants, while grain processing does not appear to have occurred on the small and localised scale seen in previous periods (Robinson, 2011, pp. 283-287). Evidence suggests a process of economic change had occurred around this time and that it affected the range and scale of industry at *Calleva*, alongside the culture and practices associated with the preparation and consumption of food. This includes a marked decrease in the number of milling tools present, as the organisation and scale of grain processing appears to have experienced a similar change (Shaffrey, 2021, pp. 26-27).

The impressive stone wall that surrounds *Calleva* was a late Roman addition, being constructed in the late third century (Fulford, 1984, pp. 66-73). Further refurbishment works took place on the amphitheatre around this time (Fulford, 1989, pp. 37-49), while the forum basilica saw a change in function and appears to have been converted to a metalworking workshop, though other evidence still indicates use by high-status individuals (Fulford & Timby, 2000, pp. 68-78). Buildings in *insula* IX were demolished, to be replaced by smaller structures that finally conform to the first century altered grid layout (Fulford, et al., 2006, p. 249). The changes in structural arrangement and size coincides with a change in industry, with greater evidence for smelting and smithing occurring within what are probably small domiciles or workshops (Fulford, et al., 2006, pp. 252-255).

Fourth century occupation of the town is harder to identify, simply because these were the phases explored in the earliest investigations of the town when modern excavation techniques were not applied. We do know that the bathhouse saw some refurbishment and that the late Roman style of hypocausts and mosaics in the town indicate that renewal and investment was occurring elsewhere. Building was still occurring in *insulae* IX and III, where gravel-filled foundations show a town that was still changing and developing (Fulford, 2021, pp. 158-163). Imported goods in the form of wine from Turkey, olive oil from Tunisia, and figs were still clearly available and consumed, while evidence for the consumption of more locally produced foods, such as spelt wheat, barley, beef, mutton, and hazelnuts occurs more frequently. Cultivation and animal penning appears to have occurred within the town itself and local provision may have generated much of the population's dietary needs, while grain would have been brought from the surrounding countryside. Grain processing evidence is, again, lacking, suggesting that this may have been a completed using mills as a centralised activity, or simply carried out elsewhere (Robinson, et al., 2006, pp. 216-218; Ingrem, 2006, p. 188; Shaffrey 2021).

The Dataset

The dataset used for this study was compiled by Ruth Shaffrey of Oxford Archaeology, who has generously shared her data to allow for an in-depth study of lava use at the site to be explored. It includes lava millstone or quern fragments from 62 contexts, with a further 548 fragments from milling tools of other stone types to provide a broader analysis for the use of lava at *Calleva* (figure 138). This data has been analysed previously by Shaffrey (2021) in an integrated approach to examine changes in grain processing at Silchester and its hinterland more broadly. The scope of this current work aims to specifically explore lava use by detailing the object biographies of lava querns and millstones at Silchester. The objects in the dataset were recovered from excavations dating from the Victorian era to the present day and finds records are, therefore, inconsistent in their detail depending on the era of excavation, especially with regards to context of recovery. However, all finds can be assumed to be associated with Late Iron Age or Roman activity as there is no significant medieval activity on the site. Some objects were recorded using published accounts, while others were recorded in-person by Ruth Shaffrey. The dataset presents the largest assemblages of querns and millstones from a Romano-British urban site. This provides a unique opportunity to fully explore the role of food processing, grain consumption, the stone trade, and changing uses of specific stone types for milling tools within a Roman period urban environment. Furthermore, it also allows for an investigation into the chronological changes in quern and millstone use during the Iron Age to Roman period transition.

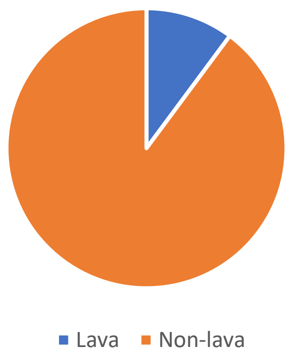


Figure 138- The number of querns or millstones of lava in the assemblage compared with those of other stone types (T= 610).

Like other datasets in this thesis, the lava from Silchester was very fragmentary and it was not always possible to identify the features of a quern or millstone (figure 139). There were only five occasions when the fragments were at least a quarter of the full circumference of a quern or millstone, with most of the dataset comprising small or very small pieces. This has produced some interpretative issues, for example in identifying features from manufacture and use-wear. The chronology of the dataset is, however, excellent and provides a much-needed glimpse into how changes in lava use may have occurred at the site over time.

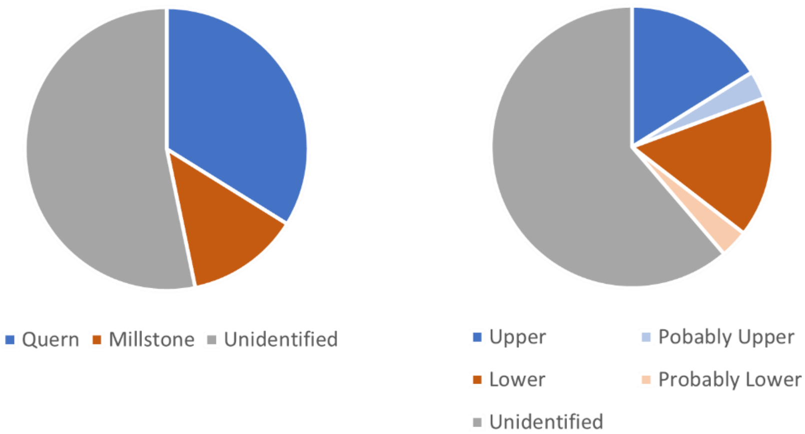


Figure 139- Number of lava fragments identified as derived from querns or millstones (left), and the number of fragments identified as upper or lower stones (right) (T=62).

Manufacture

Millstones vs Querns

Due to the fragmentary nature of the dataset, the manufacture features of these lava milling tools were less readily identifiable than they would have been for more complete examples. There were 12 upper, or probable upper and 12 lower, or probable lower stones within the dataset. Their diameters are shown in figure 140, where the data from upper and lower stones has not been separated. The differentiation should not make a difference to the distribution of diameters due to the necessity of pairing stones of equivalent sizes. The diameters of those identified as millstones are shown in red, while those of quern stones are shown in blue. Millstones were identified from their size (500mm or larger), or because they possessed millstone features, such as holes for iron fittings for lifting (figure 141). Though the dataset is relatively small for Silchester, it is notable that there is little differentiation between the diameters of millstones and quern stones. At other Romano-British sites, a trend is seen whereby the millstones are significantly different in size to those of the quern stones. At Silchester there is not the normal ‘leap’ in diameters that would ordinarily occur, usually around the 500mm size.

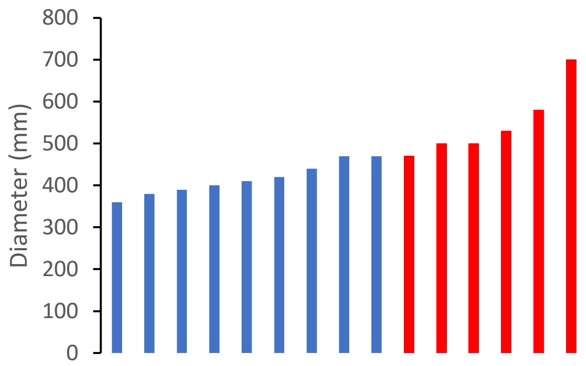


Figure 140- Diameters of both upper and lower quern stones and millstones from Silchester, with those identified as millstones shown in red, with quern stones shown in blue (T=24).

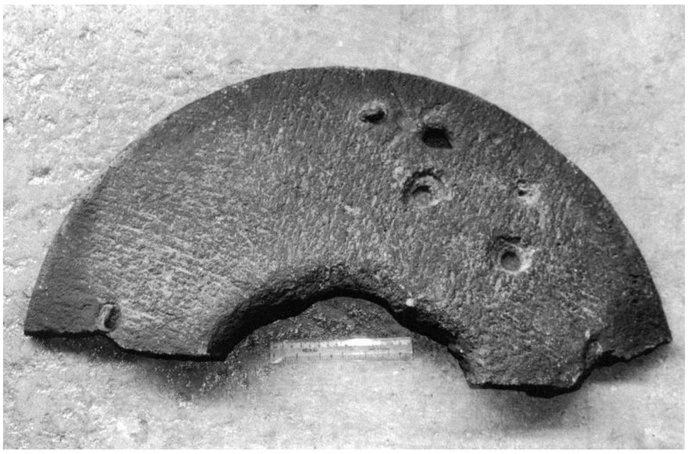


Figure 141- Lava millstone from Silchester showing holes that would have been used to accommodate iron fittings, possibly for lifting the stone as part of its function (CAT 0919) (photo provided by Shaffrey, 2021).

Two examples of 'Pompeian' style milling stones, as identified by Allen (2012), have a relatively small diameter (estimated to be around 470mm and 500mm) when compared to the more typical disc type lava millstones and these have slightly skewed the results (CAT 0870, 0871). As this is a different style of millstone with a diameter that is variable depending on where the fragment is on the stone, these diameters cannot be directly compared to those of disc type millstones (see Chapter 2). These objects have blurred the separation between querns and millstones and should be discounted from the general analysis of size. After their removal, it appears that there are three size categories present in the dataset: those clearly identifiable as querns in the smaller group, those clearly identifiable as millstones in the larger group, and a central group (figure 142). This varies from what is ordinarily observed in the size data, whereby querns and millstones are relatively easy to differentiate (see Chapter 4). In this case, the two objects in the 461-480mm range have been classified as querns, while a single object measuring 500mm in diameter has been classified as a millstone. Upon further investigation, it appears that the measurement for this single example was a minimum diameter and that the stone may have been significantly larger. This resolves the issue and shows that this method of differentiation still works well, so long as the data are carefully scrutinised.

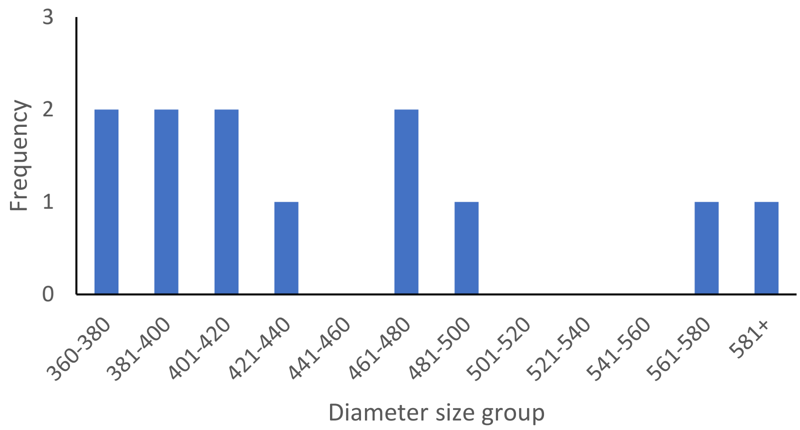


Figure 142- Frequency of mill and quern stones within different diameter ranges.

It is also necessary to question the unusually high number of identified millstones in the assemblage, and whether this is representative of ancient practice at *Calleva*. A total of eight millstones were recorded out of 24 identifiable artefacts. However, it must be remembered that Silchester has been subject to decades of excavation, with many years undertaken using modern excavation techniques, where milling tools have been consistently recorded. A large area of the town has been uncovered when compared to other sites, and this has also improved the chances of recovering a higher number of millstones. However, this does not explain the percentage of millstones (25%) compared to quern stones (75%) present in the dataset from identifiable fragments, which is much higher than seen in the province-wide data (6% millstones and 94% quern stones). This may relate to the deliberate selection of more substantial lava quern examples for retention during the Victorian excavations. Only good-sized or distinctive fragments of any material appear to have been retained (Shaffrey, 2003, p. 145), which in relation to lava, are more likely to have belonged to the larger millstones. The fact that many of the fragments were analysed by a quern specialist may also help to explain this anomaly. It is probable that lava millstones are often misidentified in excavation reports and that there are far more in Roman Britain than have been accounted for. The Silchester data presents the possible scale of this issue and can be compared to Verulamium where in-person data collection has also revealed a relatively high number of lava millstones. This suggests that the export of millstones from Mayen to Britain may have been more significant than first anticipated, especially in relation to urban sites.

There is a greater disparity seen in the diameter ranges for millstones when compared to those for quern stones. If excluding the Pompeian style millstone fragments, the remaining four disc-type millstones showed a possible diameter range between 500-700mm. The range for the quern stones was much narrower, with diameters between 360-470mm and 50% of the querns falling into the range of 385-455mm. Although there needs to be some consideration taken for the estimation of diameters, this is a pattern that is seen elsewhere and is the result of a high level of standardisation for querns and a greater degree of flexibility in the sizing of millstones that were probably made to order (see Chapter 2). In the provincial-wide dataset, 50% of lava querns from all sites have diameters that lie within the range of 400-420mm, which is much narrower than that seen at Silchester. With such a small dataset for Silchester, it is difficult to determine whether this wider range should be interpreted as a meaningful disparity.

The question is, why would a reduced level of standardisation exist at Silchester, and how would this relate to the manufacture of lava milling tools at Mayen? The lack of any evidence for a watermill at Silchester (Shaffrey, 2021, p. 3) and the absence of a suitable body of water to power it may provide one possible explanation. This could have resulted in the need for larger milling tools that could still be operated by hand, or small-sized mills that could be powered by animals or humans. Possible millstone plinths have been recovered in the town in House 3 of *insula* XVIII, and it is likely that these are the remains of mills that relied on this method of rotation (Shaffrey, 2021, pp. 21-22) (see figure 143 for location). The introduction of this technology would have generated a need for milling stones that were larger than the domestic quern, yet small enough to be powered for long periods of time, perhaps by donkeys or slaves. It, therefore, becomes a possibility that some of the larger 'querns' in the assemblage were operated mechanically, alongside the smaller millstones. A lack of diagnostic handle fittings means that it is impossible to identify the method of rotation for any of the fragments in the assemblage and querns have only been categorised if they were found to have diameters under 500mm. A lack of standardisation implies that Silchester may have been obtaining its relatively small millstones directly from the manufacturer, with stones made to order that may not have been significantly different in size from the more standardised lava querns.

The 'Pompeian' Style Millstones

As has been briefly mentioned in the previous section, fragments of a possible upper and lower stone of a Pompeian style millstone have been recovered at Silchester. These were identified and published by Allen (2012), though there remains some uncertainty with regards to this classification due to the extent of fragmentation (Shaffrey, pers. comm). This type of millstone is uncommon in

Roman Britain (Williams & Peacock, 2011), which may be due to identification issues but is more likely to indicate that this particular style was rarely used in the province (see Chapter 2). Animal and human-powered mills are likely to have been important tools for large-scale processing, especially in a town such as Silchester that had a relatively large population and no immediate means of harnessing waterpower to turn its millstones. However, the use of these millstones may not have necessarily been a functional response to the need to increase the scale of processing. It has been suggested by Williams and Peacock (2011) that these mills may have been used in 'patisserie' type bakeries used by specialist bakers to produce highly commoditised foods, the like of which would have been available in Rome and Pompeii. Evidence from the town suggest that the wealth and means to install such technology would have existed, and the range of imported foodstuffs evident in the diet of the townsfolk, even from the early Roman period (Fulford, 2021, pp. 69-72), implies that they were a population open to exploring 'Roman' ways of eating and drinking, which strongly correlates with what is generally understood of Romano-British urban identity (Alcock, 2001, pp. 13-16; Cool, 2006, pp. 172-183). Furthermore, Pompeian mills are of a highly iconic style formed from a recognisably foreign stone and consideration should be given to its presence as an exotic symbol of Roman and Mediterranean culture in a town that was experiencing huge social and economic change. The millstones are likely to have been used around the mid-first century AD (Shaffrey, 2021, p. 21), at a time when long-distance connections to the wider empire and signs of Nero's imperial authority and influence in construction projects are visible at Silchester (Fulford, 2008a; Fulford & Machin, 2021; Fulford, et al., 2019; Greenaway, 1981; Fulford, et al., 2017). The possible use of a highly iconic and techonologically advanced 'Roman' mill may have been associated with this conspicuous messaging of advancement and imperial control.

In terms of provenance, geochemical analysis was undertaken on the lava of the possible Pompeian millstones from Silchester. They were found to probably have been sourced from Mayen (Allen, 2012, p. 266), though the analysis did not draw comparison with geological samples from other alternative lava regions, such as the Massif Central in France where Volvic lava was sourced. A broader approach is necessary with any geochemical analysis of this kind; sample data is now readily available for such comparisons to be made, and includes lava from the Volvic quarries, all known lava sources in the Eifel region (including some individual lava flows), and many of the Mediterranean lava quarries (Gluhak & Hofmeister, 2011; Gluhak & Hofmeister, 2009). A variety of lava sources are present in distributions for mainland north-western Europe, emphasising the need for wider analysis to be undertaken (Gluhak & Hofmeister, 2011; Reniere, 2018). This is not, however, to dismiss the possibility that Mayen was the source, as it is known that Pompeian style mills were produced from Mayen lava, but finished in Andernach (Mangartz, 2008, pp. 76-78; *contra*

Williams-Thorpe, 1988b, p. 286). However, further work is necessary to elimate other lava sources, such as the Volvic quarries of France, which is known to have been the source for a Pompeian lava mill recovered from Princess Street in London and, also, one from Corfe Mullen in Dorset (Williams & Peacock, 2011). The close relationship that Silchester appears to have shared with the south coast and northern Gaul at this time might make a French provenance more likely.

Identifiable Typological Features

Other than the range of diameters seen across the assemblage, there were few unusual features related to manufacture or typology present on the milling tools. The identifiable features of both querns and millstones generally conformed to the expected types, though the possibility for variation should not be excluded due to the heavy degree of fragmentation observed. One identifiable difference relates to the method by which the sides of the querns were formed. Vertical grooved tooling on the sides of both upper and lower quern stones is a highly identifiable feature that is strongly associated with Mayen lava products, and this was visible on nine quern stones from the assemblage, comprising both upper and lower stones (CAT 0868, 0883, 0900, 0910, 0915, 0917, 0918, 0921, 0922). Four other examples (CAT 0914, 0920, 0923 and 0924), varied from this usual style; the sides of three fragments were pecked, while CAT 0920 had visibly chiselled edges. Pecked or chiselled sides were only present on lower quern stones. As this is a small number of cases, it is difficult to draw conclusions as to what this variation might mean. Though it may demonstrate a difference in manufacture style, there is also the possibility that these lower stones were adjusted post-manufacture, removing the linear tooling associated with the production process. As has been seen at Verulamium, the sides of lower stones were sometimes trimmed and cut away, perhaps as a way of fitting the stone into a floor or other surface to permanently secure it in place when in use.

This may also have been a method used at Silchester based on a documented find from the Victorian excavations that is no longer within the museum collections. In the excavation report by Fox (1895), a pair of (non-lava) quern stones were recovered from *insula* X that appeared to be *in-situ*. The lower stone had been fixed onto a base of burnt brick approximately 2 inches (5cm) high (Shaffrey, 2003, p. 144). Such a feature would have enabled the stone to be fitted securely into the floor surface, whilst ensuring that the grinding surface of the quern was raised above the level of the floor. Other interpretations are possible, as the base may simply have been a means of adding more height to the stone. However, there is growing evidence that querns were used in this way, and that fixed position querns may have been common in a domestic setting.

Distribution

Distribution by stone type

Analysis of the distribution of lava and other milling tools at Silchester presents some problems due to the intensity of excavation at *insula* IX that cannot be paralleled with the smaller excavations conducted elsewhere at the site. It should be expected that the volume and types of finds would be different for each part of the town, but comparison is complicated by the difference in scale of investigation; clearly very small assemblages cannot be expected to bear much interpretative weight. Figure 143 shows the number and types of milling tool recovered from different areas of Silchester. These have been broadly categorised by stone type to take into consideration the main lithology groups present: Lava, Lodsworth Greensand, other types of Greensand, and the final group comprising all other non-lava types. This last group included a range of different sources including Old Red Sandstone, Hertfordshire, Worms Heath and French Puddingstone, and Millstone Grit (Shaffrey 2021 and unpublished data). Initial observations indicate that there was variety in the presence of different stone types depending on the area of the town. However, the extent to which this corresponds with the location of use for these different stone types is difficult to ascertain. Chronology must also be considered, as the town saw a long history of development, and access to different stone types would have varied over time. For example, lava was not readily available in the Iron Age. The dumping of material, including stone from deposited milling tools, may have occurred during specific phases of development or demolition. This would skew the volumes of particular types of stone that were more popular in specific phases within certain locations.

As a ratio of all querns and millstones recovered, lava was not as popular as is seen in more easterly settlements in Britain and is typically less present than examples of other stone types. Though there were some areas of the town that had only lava or high proportions present, these were generally small assemblages and do not match the trend seen elsewhere. This shows that although lava was used, it was clearly not as important as Lodsworth Greensand and other Greensand stone types that must have been utilised for most milling activities. It is possible that lava only saw a short period of use, as Lodsworth and other Greensand querns were already readily available at Silchester at the time of the Roman conquest of Britain. The abundance of Roman period Lodsworth querns seen in Sussex (see Appendix 3), the scale of their manufacture and the possible political and social associations between Chichester and Silchester may have made them much more accessible and desirable to the population of Silchester than imported types. As Silchester lacked a local supply of suitable stone for grinding and milling (Shaffrey, 2021, p. 7), the supply of querns (and probably other goods) from Lodsworth to Silchester would have been a well-established and vital exchange

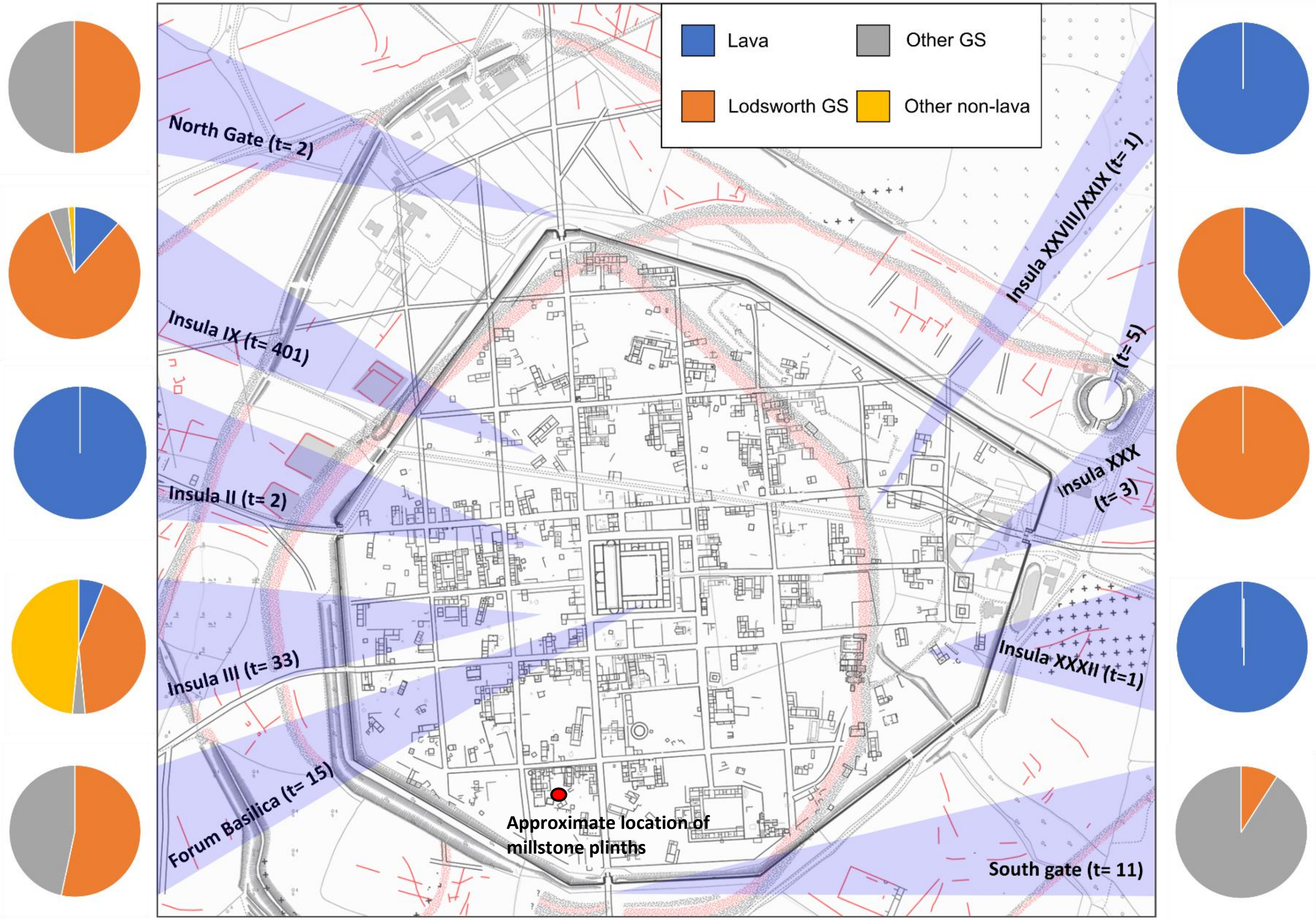


Figure 143- Distribution of milling tools of different stone types in Silchester (backdrop map Creighton & Fry, 2016).

network by the Late Iron Age and it is probable that this continued to operate well into the Roman period (Shaffrey, 2021, p. 15). However, if lava was more popular in later periods, it may not be as archaeologically visible as the earlier stone types due to changing deposition practices or altered use of space. It has been noted that a decrease in milling tools occurs in the late first to early second century at *insula* IX, where the bulk of the Silchester assemblage was excavated (Fulford, et al., 2006, p. 254; Shaffrey, 2021, pp. 20-21). The chronology of lava use in the town will provide some clarification, and this will be undertaken in the following section.

Lava was completely absent at both gates (though assemblages there are very small) and the Forum Basilica, where only Lodsworth Greensand and other Greensand types were present. This is difficult to reconcile with what is known of the Forum Basilica, as excavations in this area have been relatively extensive and multiple phases of occupation have been investigated. As a location that may have seen a military phase (see 'background to the site' for discussion of this), the expectation would be for it to yield lava due to the close associations of this material with the military, especially in the early Roman period. Similarly, its use an elite space should have improved the probability for imported milling tools to be present, in the same way that imported foods were found to be relatively abundant at this location (Fulford, 2021, pp. 71-72). It should be noted that although the number of querns recovered from this area appears to be small, a larger volume of fragments had been recovered from the Forum Basilica than is illustrated here (see Fulford & Timby, 2000, pp. 386-387 for quantification by weight). However, due to complications relating to the quantification of fragmented milling tools and the fact that this data has been combined with that for the grinding and rubbing stones in the excavation report, it has not been possible to include all fragments in the analysis. In total, 36 fragments of quern were identified, but only 15 have been included here. None of these fragments included lava, which further confirms that this is unusual. However, environmental evidence at Forum Basilica indicates that no agricultural activity, including grain processing occurred there (Jones, 2000, p. 512), and the presence of querns, therefore, is probably more indicative of depositional practices (Shaffrey, 2021, p. 19). The context of the Forum Basilica and the gates are, perhaps, less likely locations for grain processing to occur as opposed to more domestic or agricultural settings within the town.

Chronological distribution- Lava volume and comparison with other stone types.

Detailed examination of the changing use of querns and millstones has been undertaken by Shaffrey (2021) and this valuable research can be utilised and summarised here with a specific focus on the role of lava. As has been previously mentioned, changes in the volume and presence of milling tools at Silchester occurred over time. This is represented in figure 144, which demonstrates the extent to which a decline occurs from the late first and early second centuries in *insula* IX. A similar decrease is seen in other parts of the town, though the smaller datasets create some challenges in terms of making trends visible (figure 145). Reasons for this change could be related to a decrease in milling activity within the town in association with a decline in urban populations as the role of the town changed in later Roman Britain, changing deposition practices or more centralised methods of processing. It is likely that all three of these reasons impacted the chronological distributions seen to different degrees in Silchester. The presence of a relatively high number of millstones in the town suggests that large scale processing was occurring within specialist locations. This likely translates into there being fewer activity areas where grain processing occurred, but that this happened at much larger scales within those places. Some of this may have occurred within the town itself, though ready-ground flour may also have been brought into Silchester from the surrounding rural areas (Shaffrey, 2021, pp. 26-27).

In terms of the changing numbers of lava milling tools over time, only data from *insula* IX could be used as there are too few from other parts of Silchester to realistically present any patterns or trends. Chronological information has been presented in figure 146 to display the minimum and maximum numbers of lava milling tools that could be assigned to any one period. The examples that could be clearly allocated to a specific date range are shown in blue, while those that had wider dates ranges spanning two categories are shown in orange. As each milling tool in orange is represented twice in the data, these values have been halved on the chart.

Although the volumes of dated lava milling tools is much smaller than the overall quern dataset, there is a clear trend that does not correlate with what is seen for other milling tools. The early post-conquest period and mid to late first century show the lowest number of lava milling tools at Silchester, with the peak occurring after AD 85. This continues at a relatively high level until AD 250, when a decrease begins to occur, coinciding with a period when the changing role of urban centres is most evident across the province (Woolf, 1999, pp. 37-38). The changes seen do not directly correspond to the period of use for these objects as this only indicates when the lava was deposited. As objects with long use-lives and a high incidence of reuse, it is probable that there is a time lag before lava milling tools enter the archaeological record. As a type of material culture that is associated with the early Roman period, this is an interesting revelation and shows that *Calleva* was different to the eastern major urban centres, such as *Londinium* and *Camulodunum*, where lava is present from the early post-conquest phases (Buckley & Major, 1983, pp. 73-76; Dunwoodie, 2004, p. 51). It must be emphasised again the extent to which the exchange of Lodsworth querns appears to have impacted the adoption of lava milling tools, which occurs much faster in other areas of south-eastern Britain where suitable stone for milling tools was less readily available.

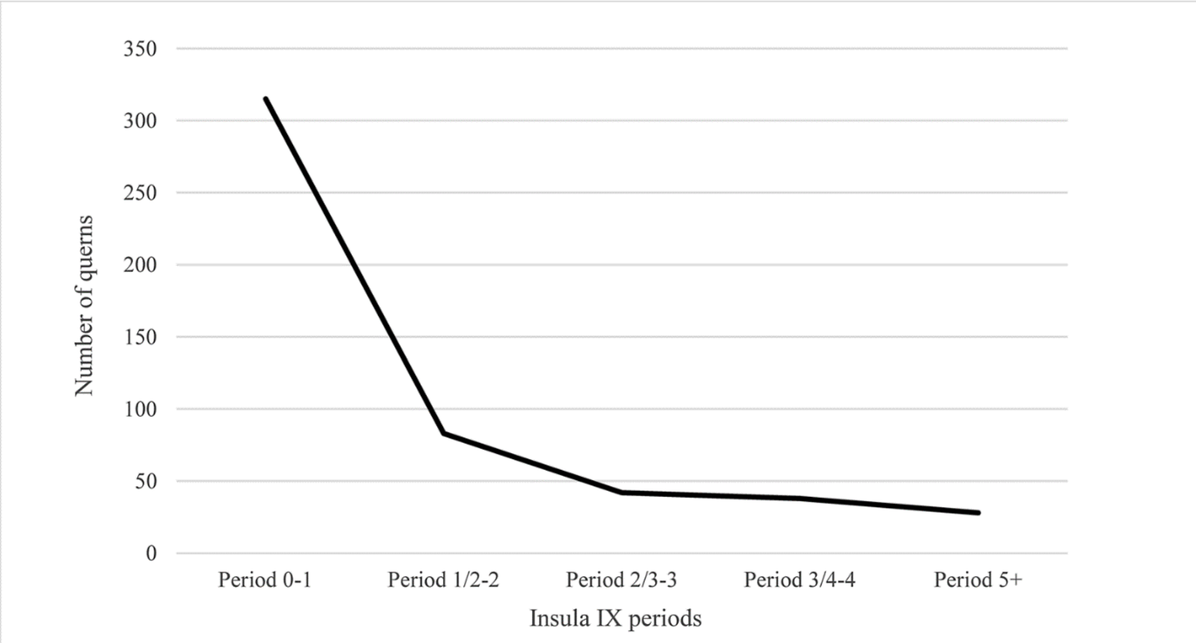


Figure 144- Change in number of querns recovered from insula IX by period (Shaffrey, 2021).

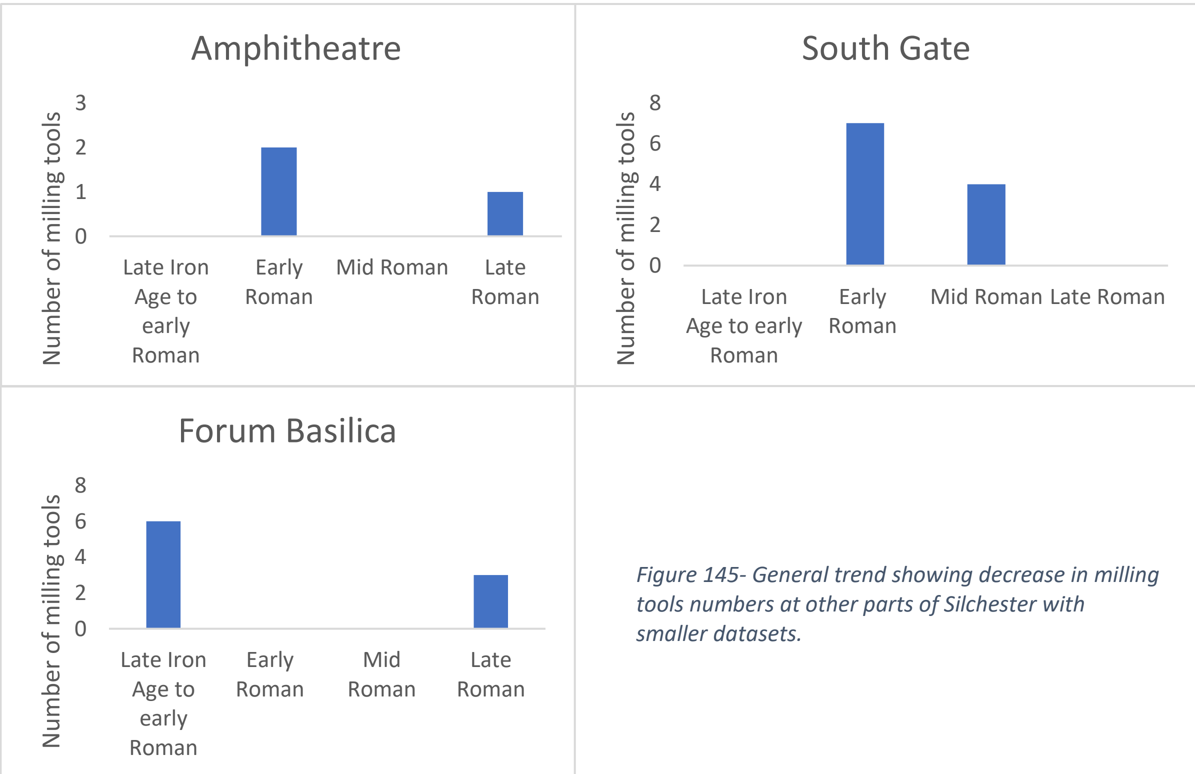


Figure 145- General trend showing decrease in milling tools numbers at other parts of Silchester with smaller datasets.

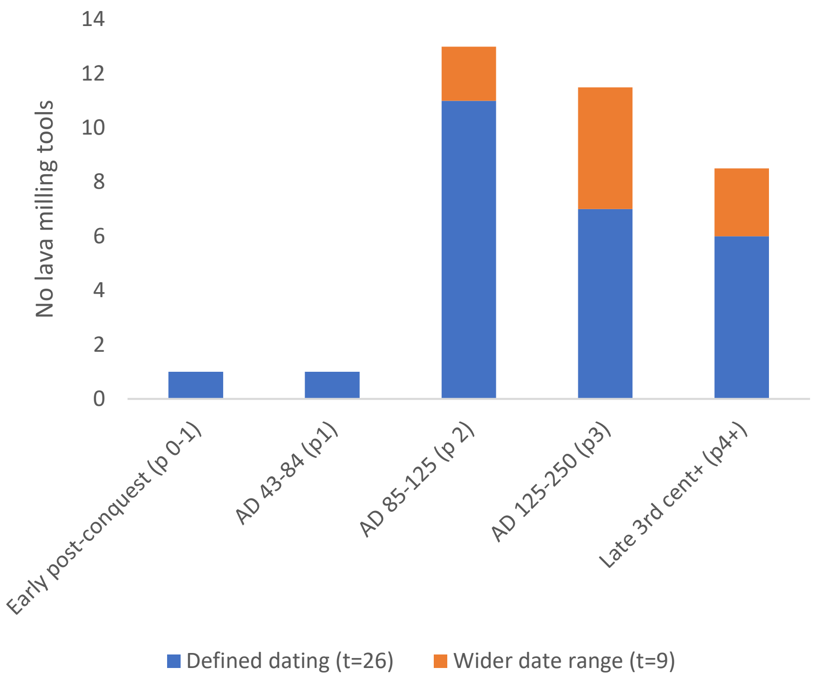


Figure 146- Change in the number of lava milling tools from insula IX over time.

The probable military nature of the earliest settlement phases at London and Colchester must also have played a role in the early adoption and deposition of lava at these sites (Crummy, 1977; Dunwoodie, et al., 2015) and their surrounds, alongside the stronger connections they had to the North Sea trade system in their function as early Roman ports. The Boudiccan destruction that took place at Colchester, Verulamium and London must also be considered, as this would have been a cause for the discard/abandonment of unused or little used products long before they may have ordinarily been deposited. Furthermore, most of the period 2 lava at Silchester was incorporated into levelling deposits or dumped material, blurring the chronology of primary use. It is likely that some of the period 2 lava saw its final primary use in the period prior to final deposition and that mass dumping and levelling events have made this appear to have occurred more suddenly. Nonetheless, the data strongly suggest a later date for lava adoption at Silchester when compared to more easterly towns in the south of Britain.

The relative distance between Silchester and the east coast of Britain might be considered as a barrier to access to lava products, and it would be assumed that this would be a significant factor with regards to the volumes present at the town. However, it must be remembered that the inhabitants of Silchester were consuming a wide array of different imported goods, both prior to and after the conquest period, (Fulford, 2021, pp. 36-39; pp. 71-72). The absence of lava may suggest that in the early and pre-Roman phases of the town, these other imports were entering Silchester via ports on the central southern coast. These are not within the North Sea trade catchment area, and thus were not involved in the distribution of lava querns (see Chapter 2). This would make it more difficult for lava milling tools to 'piggyback' with other goods on their route to Silchester, and easier for Lodsworth stone querns, that were produced close to Chichester and Fishbourne, to be moved along these routes instead.

A transition occurs by the late first century, possibly fuelled by a change in the organisation and scale of processing activities. Shaffrey (2021) suggests that as Lodsworth stone was not often manufactured into millstones, it saw a natural decline in use at locations that had become more reliant on this new form of technology. This seems very likely considering the unusually high number of millstones present at Silchester. However, the increase of lava use in the town at a time where Lodsworth stone shows a rapid decrease in presence also indicates a change in the direction for the movement of goods, with increased focus on the east coast. This probably relates to the instigation of London as a major Roman port being slightly closer in distance to Silchester than Chichester, and possibly more accessible along the Thames valley than Chichester across the South Downs. Lodsworth stone still dominates the mid-to-late Roman assemblages in terms of proportions, though other exchange networks were probably creating a more competitive environment in terms of choice of milling tool. The fact that lava persists into the later periods may be a consequence of residuality but may also indicate that these wider exchange systems continued to operate throughout much of the life of Silchester as a Roman town, and that a connection to the redistribution centre of London had become an important social and economic association.

Changes in other industrial and economic activity within the town must be considered in correlation with changes in exchange networks. If querns were entering Silchester via a specific route, it should be assumed that goods were moving in the opposite direction also, perhaps as products of Silchester, the surrounding countryside, or other production/agricultural areas along the same route. The possibility that Silchester was moving goods to the southern coastal towns, or even exporting goods to the continent via the southern ports remains a means by which Lodsworth querns may have been transported, on the return journey, to Silchester. Examples may have included less archaeologically visible products, such as grain, hides and textiles, the former two of which were commented on by Strabo (Strabo, trans. 1923; Fulford, 2021, pp. 43-44). Textile production, and possibly leatherworking, appear to have been important activities in Silchester in the Late Iron Age and the early Roman period, evident in the number of tools recovered that can be associated with these crafts. Crummy (2020, pp. 279-280) suggests that this large-scale production may have been to supply military contracts or for consumers in growing civilian markets, such as London. These goods could also have been exported to the continent, or redistributed via other towns, such as the rapidly expanding Chichester, which is known to have held strong political and social ties with Silchester during this era. A swift decline in objects related to textile or leather working occurs after AD 85, around the time that Lodsworth querns begin to decline in numbers at Silchester (Shaffrey, 2021, pp. 7-10). If fewer textiles were being produced, fewer journeys to the south coast would be required, resulting in fewer return journeys that would bring the Lodsworth querns to Silchester. Alternative stone types, including lava, would have become more important to fill the deficit as a result, and exposure to new types of milling tools may even have initiated a more rapid transition to the use of mill technology. Other crafts see a similar decline around the same time, and it may be that this avenue for personal economic advancement was halted due to state intervention, such as increased taxation or control of production. However, as is also discussed by Crummy (2020, p. 279), these changes in craft activity may simply have been the result of the changing status and economy of Silchester and the resulting shift to consumerism, as opposed to self-sufficiency. This would correlate with the transition to an increased use of mills and more prevalent centralised grain processing. The possibility that grain processing was occurring away from urban areas or in parts of the hinterland that are less likely to have been excavated is also a possibility. A combination of different factors is likely to have been responsible.

Primary Use

Identifiable features of the lava fragments that can be used to associate them with their primary use as milling tools are difficult to establish due to the fragmentary nature of the assemblage. Signs of primary wear are especially difficult to identify due to the high incidence of reuse seen at Silchester, a subject that will be dealt with in the following section. Traces of wear that are common for rotary querns are present on many of the fragments, including thinning of the area around the eye for upper stones and the creation of a 'lip' around the central hole for lower stones. There is nothing to imply that these were used in any way considered to be unusual. There are two consequences of primary use that can be explored using this assemblage; thickness of stone prior to deposition and dressing style on the grinding surfaces.

Stone thickness

For Silchester, there were 6 upper and 9 lower stones that had measurements taken that were suitable for comparative analysis. As with Verulamium, this data has been plotted alongside that of the whole British lava quern dataset, excluding the querns from 1 Poultry. The upper stones were found to partially lie within the range of 'normal' thickness, between 48-72mm, corresponding with the thicknesses of 50% of all British upper lava quern stones (figure 147). Three stones, comprising half the dataset, fell below this range, although one of these (CAT 0883) was only 1mm short of this measurement. The other two (CAT 866 and 875) were not extraordinarily thin in comparison to this range, with the smallest measuring 35mm. It would appear that a relatively standard level of thickness of upper stones was reached at Silchester prior to deposition.

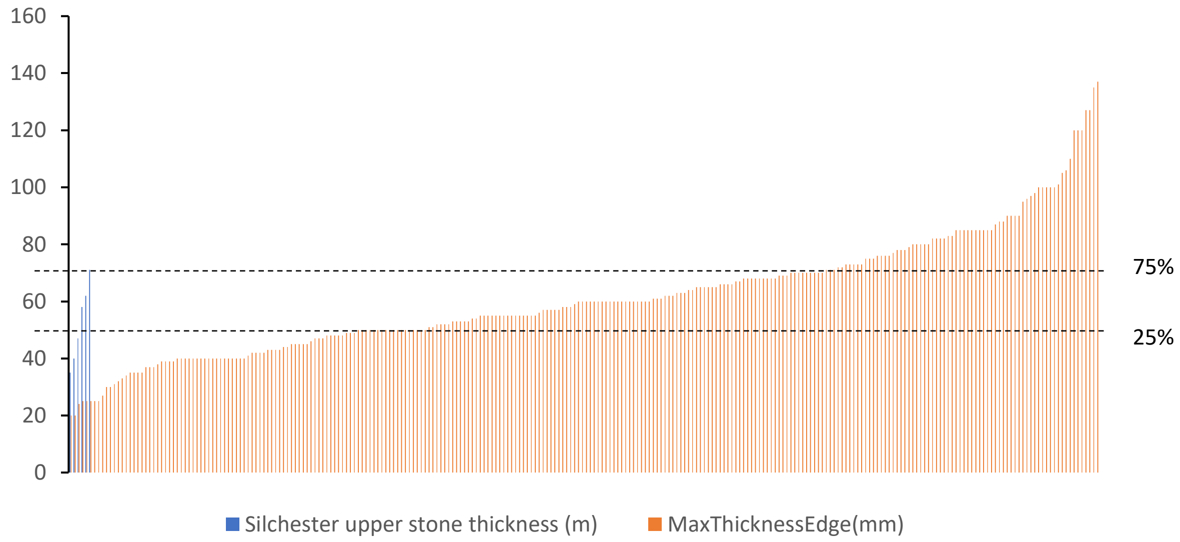


Figure 147- Graph showing the edge thickness of upper stones from Calleva compared with those from all Roman Britain. The 25th and 75th percentiles are indicated using dotted lines.

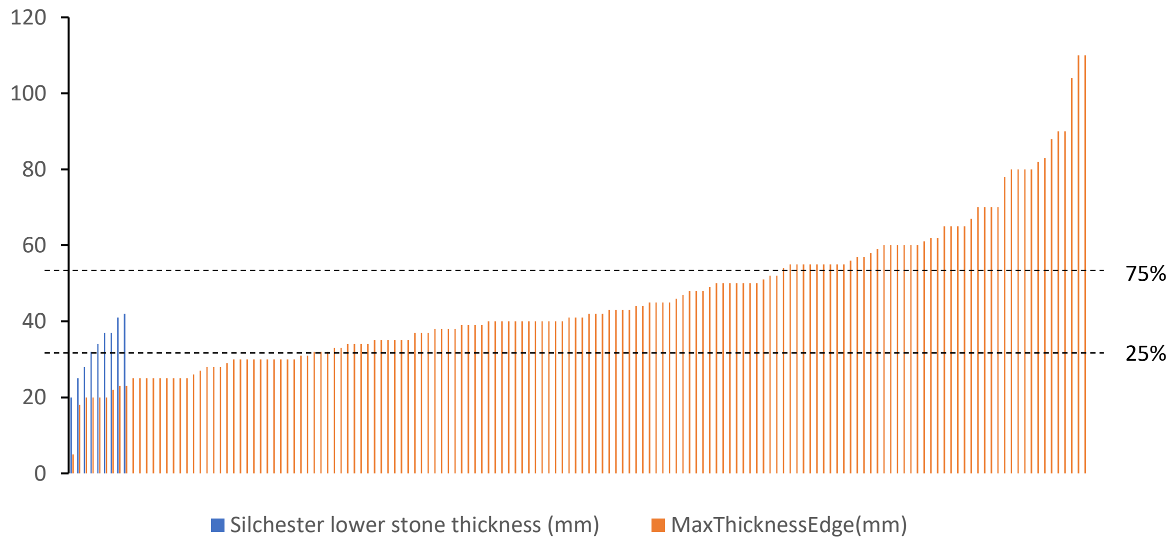


Figure 148- Graph showing the edge thickness of lower stones from Calleva compared with those from all Roman Britain. The 75th and 25th percentiles are indicated with dotted lines.

For lower stones, 50% of the British data (excluding 1 Poultry) lies between 32mm and 55mm, which also accounts for two-thirds of the Silchester assemblage (figure 148). Three examples fall below this range (CAT 0910, 0920 and 0924). Of these, CAT 0910 shows some signs of reuse, and so its smaller thickness may be a result of wear that occurred after its original function as a quern. CAT 0920 was an example showing chipped edges that may correspond to it being reshaped to set it into the ground in a fixed position or general reuse. As a dataset, the thicknesses are on the smaller end of the scale overall and are comparable with those seen from Verulamium. All were deposited once they had reached a thickness between 20-40mm, similar to that seen at Verulamium. However, the thicker examples of both upper and lower stones that were seen at Verulamium are completely absent at Silchester. This implies that lava was more heavily used in a consistent way at Silchester prior to deposition, which may relate to the availability of lava milling tools in a town more distant to the centralised distribution centres of London and Colchester. The lack of suitable local supplies of stone for grinding, milling, and processing activities would also have been a significant factor, as querns and millstones would have been more difficult to replace and were probably more likely to have been reused for alternative purposes once the primary function ceased to be possible. This is a pattern that is also observable on non-lava quern and millstone fragments from Silchester (Shaffrey, pers. comm.)

Dressing style

The style of dressing on the grinding surface of a quern or millstone might be considered to fall under the category of typology, in that dressing would be added to a milling tool in the manufacturing stages of its production. However, milling tools would have been redressed at multiple stages of their use lives due to wear and be more representative of society, culture and the availability of stone working skill. There were very few dressed examples within the Silchester assemblage, and those that had identifiably dressed grinding surfaces were often 'pecked', as opposed to the typical radial or harped style of dressing that would be expected (table 14). Around half the assemblage was pecked, which presents a significantly higher proportion than is seen across the dataset from Britain. It must be noted that pecking is difficult to identify on versicular lava and is much less likely to be commented on than radial or harped dressing, and that this will have skewed the results substantially. However, it is worthwhile considering why the more commonly used method of harping was not more consistently applied to lava at Silchester.

This pattern may relate to stone working skills, as pecking would be easier to apply to a stone and could be accomplished easily by any person with a chisel. Alternatively, pecking may have been used to replicate the familiar style of dressing associated with Lodsworth Greensand querns, becoming a cultural or social choice. The extent to which this might be true is debateable, as the grinding surface of a quern would not be immediately visible and may not have been significant. Nonetheless, querns of indigenous stone types have replicated harped styles of dressing, sometimes with the inclusion of other features reminiscent of lava. The reverse of this process appears to have occurred at Silchester, with the adjustment of new forms of material culture to resemble more traditional ones. This may have made lava querns more identifiable and relatable to a culture of people who were more resistant to change.

Table 14- Comparison for volumes of pecked and harp-dressed querns in the Silchester and British datasets.

Dressing style	*Silchester Quern*	*British Quern*
Pecked	5	30
Harped	6	179

Reuse/Modification

Drawing out the specific aspects of secondary use is a complicated process, but it appears that Silchester experienced a high level of stone reuse throughout the Roman era. This is apparent in the whetstone assemblage, which largely comprises old building material and quern stones from a variety of different stone sources (Allen, 2014). Silchester is located within a geological region with little in the way of immediately available stone suitable for ground stone tools, and these needed to be brought from further afield (Shaffrey, 2021, p. 7). Once at Silchester, it is logical to assume that as much use would be made of such stone as possible prior to deposition, regardless of intended primary function. This may explain why the lava assemblage from Silchester is so significantly fragmented, as lava milling stones may have been broken up to serve other functions after primary use was no longer possible. Although it is highly likely that lava was reused, very few incidents can be identified from the fragments available for study, and even these identifications are tentative. Unlike other stone types, lava does not always preserve well under certain soil and exposure conditions, creating sometimes irregularly shaped fragments on which wear traces can get lost.

In total, four lava fragments could be associated with incidents of reuse: CAT 0867, 0894, 0895 and 0910. Of these, CAT 0867 was identified as having been used as a whetstone and was recovered from an unstratified context at the amphitheatre (Allen, 2014, p. 86). Unfortunately, no details have been provided in relation to this example or how we can tell that it was used specifically as a whetstone. However, this means of reuse seems like a realistic scenario and it would not be surprising if other lava fragments were reused in such a way. The other three fragments can only be associated with reuse due to the presence of unusual regions of wear that cannot be attributed to the normal movements used during milling. For example, CAT 0894 was worn on both the upper and lower surfaces. The grinding surface was used as a rotary quern, while the upper surface was used to sharpen blades within the same stage or at a later stage of the quern's lifecycle.

By far the most common and visible way that lava was reused at Silchester was within levelling deposits, flooring and to create hard surfaces. Lava was not the only quern material that was used in this way, and this may be another reason for the high degree of fragmentation present. The reuse of stone, including that of querns, for this purpose was a common practice in Roman Britain (see Chapter 4). This will be discussed in the next section in relation to deposition.

Deposition

Deposition of lava at Silchester has only been explored for *insula* IX as this was where the bulk of the lava querns were recovered and because excellent context information exists. Location information relating to the feature of recovery alongside categorisation of the feature type was available, and this allowed for a more detailed investigation into deposition than has been possible for other sites in the dataset. It should be noted here that findspots have been used to explore deposition as opposed to distribution. With quern stones, location on an intra-site scale is more likely to correspond to where the object was deposited/disposed of than to where it may have been used. Alternatively, general distributions, such as looking at location data for the whole town (see Figure 143 above), can suggest vicinities of more intense use. This works on the general assumption that querns are unlikely to have travelled far prior to deposition, though they may have been reused, redeposited, and moved about within the localised environment.

The deposition of lava milling tools in *insula* IX shows some interesting patterns (figure 149). In the early Roman period, lava was predominantly recovered from occupation and dump deposits, and in postholes. In the mid-Roman period, levelling deposits are the most common form of deposition, with pit deposition occurring more often in the late Roman period. Although it is tempting to see this as a change in deposition practice, it is likely that much of what is seen here relates to the types of development that were occurring at *insula* IX at each chronological phase. The customary use of timber buildings in the early Roman period can be equated with a higher frequency of postholes and a higher likelihood of lava being deposited into these. Most of the early period lava querns were dated to the period after AD 85, when large parts of the town were renovated, and timber buildings replaced with new timber structures (Fulford, 2021, pp. 76-102). Similarly, there were very few pits at Silchester between AD 85-250 (Fulford, pers. com), meaning that rubbish disposal may have occurred in controlled locations or according to different traditions than that of later phases of occupation.

Querns were sometimes reused for post-packing during the Roman era (see Chapter 4). It is possible that the incorporation of querns into such deposits relates to some form of social or cultural practice, as has been identified for other periods and locations (Brück, 2006; Watts, 2014). However, this is difficult to identify or define as broken quern stones may simply have provided a useful source of suitable stone and deliberately deposited to fulfil a functional requirement that was related to their material properties instead of any specific meaning. They may also have been deposited into middens to become incorporated with household waste that was incidentally used as backfill. At Silchester, two of the four lava milling tools were retrieved from a series of postholes associated with a rectilinear structure or fence line that replaced an earlier roundhouse (Fulford, et al., 2011, p. 3), which may have had ritual significance (Fulford & Clarke, 2009, pp. 9-10; Fulford, 2021, pp. 97-98) (figure 150). This group of postholes contained a range of finds that would be classified as household rubbish such as pottery and animal bone, alongside possible demolition debris including iron nails, CBM and stone tesserae (information taken from Silchester IADB). Though ritual deposition cannot be ruled out, there is nothing to signify that this had taken place or that the lava querns had played a role, and the replacement building does not appear to have held the same significance as the one that had preceded it.

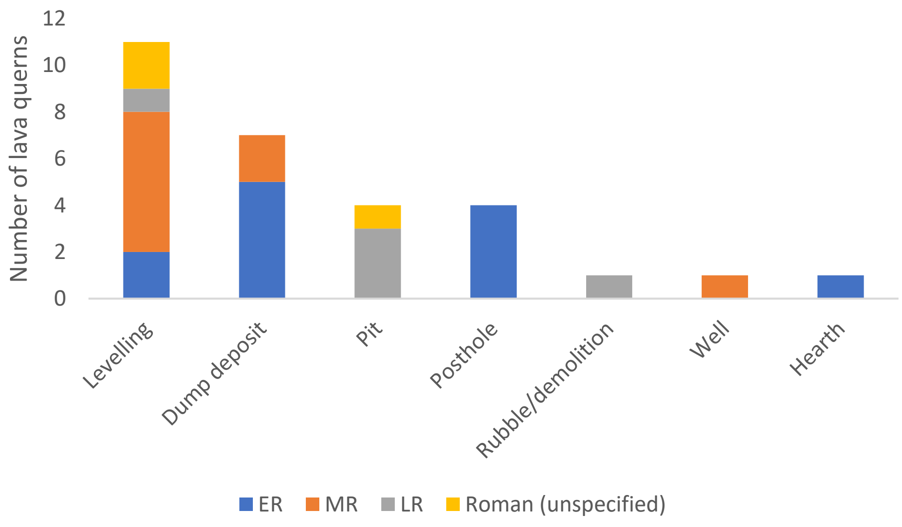


Figure 149- The types of feature where lava milling tools were deposited classified by chronological period.

Figure 150- Plans of excavated area in insula IX showing the features where lava was recovered on the left, and corresponding excavated structures and features on the right. The top two plans relate to the early Roman period 2 (AD 85-125/50) (Fulford, 2021, p. 94), the middle to the mid-Roman period 4 (AD 200-250/300) (Fulford & Clarke, 2011) and the bottom to the late Roman period (AD 250+) (Fulford, 2021, p. 144). A key is provided for each of the site plans, as these do not use the same system for feature identification (access to IADB kindly provided by Dan Wheeler and Nicholas Pankhurst).

Nonetheless, the distribution of deposited lava in the early Roman period can be predominantly identified as either incorporated into postholes and thus into the structure of buildings (CAT 0870, 0871, 0901 and 0907), or deposited within buildings themselves (CAT 0869, 0891, 0905, 0906, 0890 and 0892), except for one fragment that was recovered from an external gravel spread (CAT 0908). One fragment was recovered from a charcoal-rich hearth deposit and though this may not mean it was directly related to the use of the hearth; the deposition of milling tools in hearths and hearth structures has been discussed in more detail in Chapter 4. This provides an interesting pattern of deposition and suggests that quern stones had strong domestic associations, being used, and deposited within areas of habitation where other domestic refuse was allowed to accumulate. Other finds recovered alongside these internal deposits include material that would be defined as domestic waste, such animal bone, pottery, oyster shell and charcoal. That quern fragments were included within such deposits indicates that they were disposed of in similar ways and were probably used close to the home.

The high number of querns associated with levelling deposits in the mid-Roman period probably relate to construction and renovation activities that took place in the early mid-second century when many timber buildings were reconstructed with masonry foundations. The formation of the large town house in *insula* IX was a major building project (Fulford & Clarke, 2011; Fulford, 2021, pp. 112-113) and relevelling of the ground would have been an important step in the reuse of any plot of land that had been previously utilised for construction purposes. Deposition occurred both in and around the structures, wherever a hard standing floor area would be required. As a result, distribution is more widespread and randomised. Finds recovered from the levelling deposits were also much more wide ranging: iron and copper alloy fragments, lead sheet, pottery, animal bone, oyster shell, iron tools and fittings, glass beads and vessels, iron working waste, daub and CBM, among a variety of other small finds were recovered alongside lava and other quern fragments. The material is not only domestic in nature, with evidence of industrial and craftworking waste being present, alongside demolition debris. It is probable that this represents material that had been collected from further afield and dumped to provide a level ground surface. It, therefore, becomes more difficult to associate the querns specifically with domestic refuse and use, and the degree to which residuality exists in the dataset is likely to be significant due to the high probability that large-scale redeposition had occurred.

The late Roman period shows a higher propensity for deposition of lava into pits, which does not appear to have occurred in previous periods. The distribution, including that of the demolition rubble and levelling layer where other lava quern fragments were recovered, is relatively localised, being isolated to a group of features outside of buildings 5 and 1. These pits may simply have been dug as a way of disposing of household and industrial waste generated within *insula* IX, an activity that is much less common in the earlier periods of occupation at the site. Alternatively, they may have been utilised for ritual deposition, with the lava quern fragments forming part of those ritual deposits. One of the pits where lava was deposited, [3235], also contained human remains from a minimum of two individuals and wide range of find types including a brooch, coin, and finger ring. Though these could be considered as unusual within this context, it is very difficult to ascribe these as specifically associated with ritual activity. All three of the pits were found to contain a variety of finds, with some objects that would be considered as personal items and, possibly, of social or cultural significance. However, in a town that had seen several centuries of occupation, perhaps it would not be too unusual for there to be an accumulation of such objects that were no longer useful or wanted (Fulford, et al., 2006; Eckardt, 2006).

Silchester: Conclusions

The excellent contextual information from the modern excavations at Silchester have provided a unique opportunity to examine quern and millstone use in the town in a significant amount of detail. The already established popularity of the more locally available Lodsworth querns is likely to have had an impact on the initial adoption of lava milling tools at the town, and this seems to have occurred more slowly than in the more easterly towns. However, several factors may have been responsible, including the possibility that the southern ports and towns were more involved in the economy of Silchester in the early Roman period, probably a residual effect of the social and economic ties that existed in the Late Iron Age. An increase in lava use is seen after AD 85, which despite the chronological delay in deposition due to the long use-lives of querns, coincides with several other major developments in the town. This appears to have been a period of social and economic change at Silchester. Changes in exchange routes and greater involvement with the eastern towns and ports is likely to have been one factor.

As a location that is geologically poor in suitable stone for milling tools, it is not surprising that lava querns were heavily worn prior to deposition. However, it also shows that access to lava may have been more constrained due to the distance of Silchester from east coast distribution centres and full use needed to be made prior to disposal. Reuse of lava is also visible, both on fragments from wear patterns and in the contexts of deposition. Extensive reuse of lava milling tools occurred in levelling and flooring deposits, and they were also reused as posthole packing. The deposition methods make it impossible to determine whether lava presence can be related to activity areas where grain processing may have been carried out.

The number of millstones recovered from Silchester suggest that large-scale food processing was occurring, either in the town or in the close vicinity. This may have been conducted predominantly using animal or slave mills, which were probably smaller than their water powered counterparts.

Lava millstones appear to have been manufactured to specially ordered sizes, as the range of diameters for the querns and the differentiation between the millstones and quern stones are not as standardised as would be expected for Mayen products. The decrease in overall quern numbers at Silchester suggests that this method of milling may have been introduced relatively early and initiated the decline in Lodsworth products.

Urban Sites: Conclusions

As has been the case throughout this research, interpretations relating to the use of lava milling tools is largely dependent upon the level of detail that can be discerned from the archaeological reports generated at the time of excavation. Roman urban sites that are situated on undeveloped land, such as Silchester and Verulamium, tend to have been subject to early excavation and exploration, resulting in poor recording and missing records. More recent investigations at both towns have, however, provided much needed clarity and context to some of the earlier excavated material. Dorchester-on-Thames provides an interesting comparison as a Roman town that has been built upon and is occupied in the modern day (see Appendix 2); excavation has only been possible on land that has not been developed, or as part of developer-led projects, creating an intermittent view of Roman urban life that is difficult to reconstruct in any detail. Without an established view of the social and economic lives of the Roman inhabitants, there is a lack of context for the use of milling tools and analysis can only produce a minimal contribution to our wider understandings of society and economy. Nonetheless, it does still provide means for comparison with other urban sites, which, alongside the more extensive excavations at Dorchester-on-Thames being carried out by the University of Oxford and Oxford Archaeology, will hopefully bring greater clarity to interpretations relating to the town and its role in the province.

Overall, there are some interesting comparisons that can be drawn between the two urban case studies. With regards to lava volumes, direct comparison is complicated by numerous factors, such as differing retention policies. Nonetheless, it is worthwhile to note that Verulamium yielded the greatest number of lava fragments, followed by Silchester. It is highly likely that Verulamium did make more use of lava for milling tools and that the volumes are indicative of greater lava use when compared to the other two case studies. The proximity of Verulamium to the east coast ports, especially London and Colchester, coupled with the deficit of suitable local stone sources for milling, would have made Verulamium a significant consumer of lava products. Similarly, the theory that Verulamium had an early military phase (Pitts, 2014) is also supported by the lava consumption observed at the town, which is comparable with other urban/military sites in the south. In comparison, Silchester was probably making better use of the southern ports for its imports and was utilising the well-established Lodsworth quarries for its milling needs, negating the requirement for lava imports. By the time that lava started to become more accessible and popular at Silchester, sometime around or before AD 85, the local economy had shifted in favour of more centralised processing and lava querns failed to infiltrate consumer choice in the same way that it had at Verulamium. The earliest fragment of lava at Dorchester-on-Thames dating to AD 70-120 suggests a similar initial later uptake of lava as seen at Silchester, though a great deal more work needs to be done to confirm this.

Another way of exploring this comparison is to look at the relative volumes of lava at the different urban sites in comparison with querns of other stone types. Although only lava milling tools were recorded during data collection for Verulamium, the online collections might be used as a rough guide for what is present within the full archive, as this has catalogued 119 querns, most of which have been identified by lithology. Data collected from Chichester can also be included, and this can be collated with the extensive work already completed by Shaffrey (2021) on quern supply to Roman towns, adding a further two urban sites to the wider dataset, which had already included Silchester and Dorchester-on-Thames (figure 151).

As has been discussed by Shaffrey (2021), the Thames appears to be the defining border between the towns that that had good access to lava, and those that did not. Lava querns and millstones were clearly transported to locations west of London via the River Thames. Proximity to this major transport route must have heavily influenced the degree to which urban populations had access to these products. The addition of Verulamium and Chichester as towns north and south of the Thames has added some further detail to this interpretation. Verulamium, though not located on the Thames, was well connected to London by road and it may also have been accessible by water via the River Ver. The presence of Old Red Sandstone at Verulamium indicates that the east-west route that brought lava to the main urban centres along this main Thames corridor, also operated in the opposite direction. Interestingly, Chichester has a similar profile to that seen at Silchester, though without the presence of Old Red Sandstone. In comparison with Neatham and Winchester, more lava found its way to Silchester and Chichester, indicating that the status of the town may have had a role to play in its access to imported lava products. It appears that multiple factors influenced the types of milling tools that were used at each town, and it would be very useful to be able to identify chronological changes that may have occurred in these proportions as a further way of exploring the Roman stone trade and wider economy.

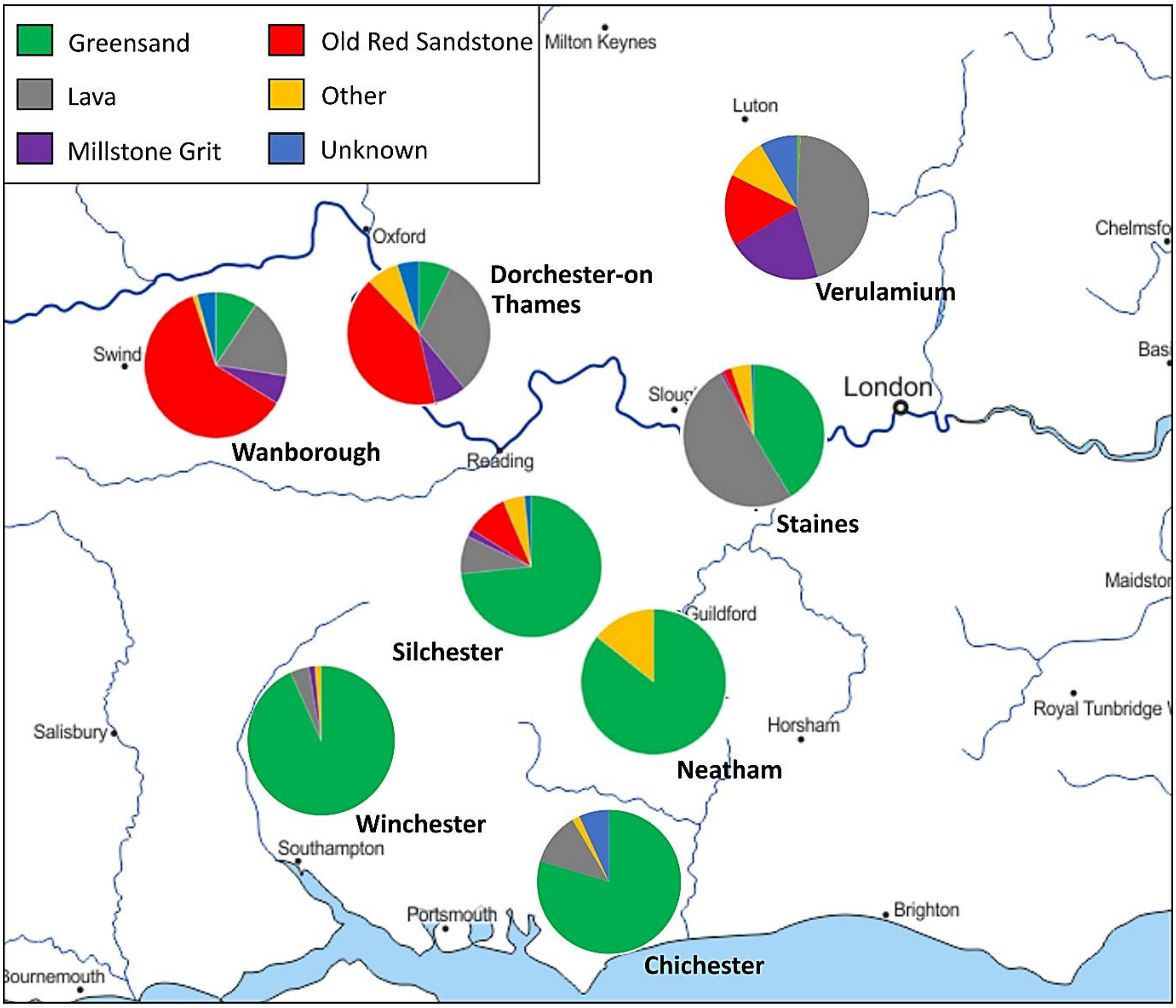


Figure 151- Map of central southern Britain showing the breakdown of stone types used for querns in the Roman period at various urban sites (after Shaffrey 2021, with inclusion of new data from Chichester and Verulamium).

In considering the role of urban centres on the centralisation of grain processing, Silchester, Chichester and Verulamium provide some interesting comparative data (table 15), while no lava millstones were recovered from Dorchester-on-Thames and the number of other millstones is not known. At Chichester, four millstones were recovered in total, with twelve at Silchester. For Verulamium, only the lava millstones have been recorded and the online collections provide no further examples of millstones of other stone types. For these three towns, the number of lava millstones is extraordinarily high considering that there are only 76 recorded in the whole of Roman Britain. These appear to have been at least as popular as indigenous millstone types and show that urban populations may have had better access and the means to import specialist milling equipment, while consumer and cultural choice may have driven demand. The need to feed growing urban populations must have been a significant driving factor for the transition to mill technology and the fact that so many millstones were recovered from each of the urban sites should not be surprising. However, possessing the stone working skills necessary to create a working custom-design millstone and the suitable stone to form it must have provided some challenges to a province that had, hitherto, only been used to hand operated rotary querns. Lodsworth stone and conglomerate are both very difficult to work and the fact that these do not often appear in millstone form indicates that they may not have been suitable for this purpose. Lava may have provided one of the best early choices for the introduction of mechanically driven mills as the skills and materials for production were already available at Mayen.

The high overall number of millstones at Silchester also raises some questions despite the difficulties involved in drawing direct comparison across the three sites. This is because of the probability that watermills existed at Chichester and Verulamium, while Silchester is more likely to have made use of animal and/or slave mills. Watermills are required to be situated near to a suitable head of water, placing them outside of the towns, while animal or slave mills could be located anywhere. The possible millstone plinths in *insula* XVIII at Silchester suggest that these operated in the town itself (Shaffrey, 2021, p. 53), which could explain why more millstones were recovered nearby. Centralisation of grain processing may, therefore, have looked very different across these separate urban landscapes and have been organised in diverse ways. This has implications for understanding how grain and flour entered towns for civilian consumption, the organisation of labour and the distinct ways that urban societies adapted to sustain the population of the town. However, it must be remembered that such organisation need not have been static, and that change would have occurred over time. It is not known whether the evidence seen here relates to civic and state-led provision, or whether the introduction of mill technology was a commercial enterprise. It is difficult to reconcile the presence of millstones with a specific source of capital. However, it can be agreed that a great deal of wealth and probable high social status would have been required to install mills at these sites.

Table 15- Summary of the number of millstones recovered from urban case study sites.

	Nº LAVA MILLSTONES	Nº NON-LAVA MILLSTONES	TOTAL
CHICHESTER	2	2	4
SILCHESTER	8	4	12
VERULAMIUM	6	?	At least 6

The difference seen between Silchester and Verulamium for the extent of use of lava querns prior to deposition provides another noteworthy comparison. Greater extent of wear was visible on the Silchester querns, while those from Verulamium were more likely to be discarded when they were slightly thicker. This is likely to relate to the extent to which lava milling tools were replaceable at each of the sites, and Silchester being further away from the main distribution centres probably forced greater longevity of use. Both sites showed relatively high levels of reuse of lava which, again, is probably the consequence of there being a poor local supply of suitable stone for ground stone tools. Reuse at Dorchester-on-Thames has not been identified on any of the lava fragments, but it is possible to hypothesise that this occurred less regularly due to the local sources of gritstone that provided a ready alternative.

A final observation is the similarity seen in the deposition of lava in late Roman pits at both Silchester and Verulamium. Both examples might have ritual connotations, though the complexities associated with such interpretations creates a barrier to any positive identification of ritualised behaviours involving lava. This is a pattern of deposition that has not been observed at other site types, though the prevalence of lava at urban sites increases the probability that lava would be accidently introduced into 'ritual' contexts. Nonetheless, the possibility for specifically urban cult activity involving the preparation and consumption of food using milling tools should be considered. To fully explore the similarities between the two towns, a more detailed examination of individual ritual pits should be undertaken for Verulamium, in a similar manner to that carried out by Eckardt (2006). This might provide greater opportunity to identify patterns in urban deposition that might relate to ritual actions.

Chapter 7. Milling at the Edge of an Empire: Lava Quern and Millstone Use at Northern Military Sites

Introduction

Lava querns have long been associated with the Roman military, mainly due to the large volume of lava milling tools that were uncovered in some of the earlier excavations of military sites on Hadrian's Wall, such as at Newstead (Curle, 1911). Although the data produced for this research emphasises that lava use was not restricted to military communities alone, concentrations of lava milling tools at military sites show these objects must have played a significant role in everyday military life. There is also strong evidence in continental Europe that Mayen lava querns were initially part of Roman army equipment (Gluhak & Hofmeister, 2011, p. 1616), and this has led to the hypothesis that they may thus have been introduced to Britain at the time of the Claudian invasion (Watts, 2002, p. 33; Peacock, 2013, p. 153). Distribution analysis in Britain has shown that the chronological change in the spatial distribution of lava follows what we understand historically of military campaigns and movements (see Chapter 5).

However, this is not where investigations into the military use of lava milling tools should end. More recent examinations of material culture from military sites have shown the potential that ancient objects have for revealing the lived experiences of those in Roman military society. The most notable of these was completed by Allison (2006) who explored the concept of gendered spaces by comparing known gendered objects and activities at Pompeii with finds evidence from Vetera I, Ellingen and Oberstimm forts on the Roman frontier in Germany. However, the application of spatial distribution analysis in this study has since been criticised as it does not consider the extent to which redeposition may have affected interpretations, while the degree to which specific objects or object types can be classified as 'male' or female' has also been subject to debate (Campbell, 2010; Hodgson, 2014). Aside from spatial distribution (for example, Van Driel-Murray (1995; 2001), and Alberti (2018)) and the highly significant Vindolanda tablets (Bowman & Thomas, 1983; Greene, 2013; Evers, 2011), investigations that have involved any detailed examination of material culture from military sites have been relatively limited.

Currently, there are a wide range of different approaches that are yet to be applied to military site assemblages, though these could potentially inform our understandings of life on the frontier and associated settlements. For example, lifecycle and object biography approaches can evaluate the human-object relationship at various stages of an object's existence (Kopytoff, 1986; Gosden & Marshall, 1999); use-wear analysis can identify how tools can become extensions of the body and how embodied practice might vary according to changing traditions and identities (Harman, 2002; Olsen, 2010, pp. 68-75); typological analysis can help explore how innovation associated with object design can change according to the social, political and economic conditions (Bijker, 1997). The aim of this chapter is to incorporate some of these different approaches and to use these to answer questions relating to the lived experiences of people associated with the military, and to address these within the broader perspectives of frontier life, Roman Britain, and the wider empire.

The case studies examined in this chapter are Corbridge, Chesters, Housesteads, and Vindolanda. These can all be classed as northern military sites, but with very different characteristics and functions: Chesters and Housesteads were fort sites that formed part of Hadrian's Wall; Corbridge may have been part of the original 'Stanegate' system, probably becoming a military storage and supply depot after the establishment of Hadrian's Wall that provided protection at a major river crossing point for Dere Street, and later becoming a town; Vindolanda was also part of the earlier 'Stanegate system' of defences that saw continued use at other periods of Roman military occupation in the north. Despite the variety in the site characteristics, they would all have belonged to the same military network of supply, consumption and society. How this varies or correlates across the sites may give some indication of how uniform or individual everyday practice involving food processing activities may have been. As a wide range of different cultures are represented within the Roman military community, it will be interesting to investigate how food consumption practices and treatment of lava milling tools may have been dictated by the uniting factor of being a soldier or differed to reflect individual/group cultural practices.

This chapter will reflect on lava quern and millstone use at each of the case study sites in turn, examining the artefactual and site evidence for manufacture, distribution, primary use, reuse or modification, and deposition. The analysis will commence with Corbridge, followed by Chesters, Housesteads and Vindolanda. The largest dataset has been produced from the site at Vindolanda, which has been subject to modern standards of excavation and recording.

Corbridge

Introduction and Site Background

The site of Corbridge to the south of Hadrian's Wall, also referred to as *Corstopitum* or *Coria* as its possible Roman name, is in modern day Northumberland and close to the village of Corbridge (figure 152). There is a lack of detailed archaeological records for the site despite the fact that it has been subject to intensive investigation throughout the twentieth century. Corbridge may have belonged to the earlier fortifications of the 'Stanegate system' (Breeze & Dobson, 1976, pp. 20-26), though the certainty of such a system existing remains unproven (Hodgson, 2000). Initial military occupation in the area appears to have been established at the site of Red House, which was a military base approximately half a mile to the west of *Corstopitum*. This change may have been due to the need for a bridge over the Tyne to accommodate the route of Dere Street, the topography dictating where this could be positioned, and the requirement that a strategically important crossing be guarded (Bishop & Dore, 1988, p. 126). This earlier fort, probably dating to the Flavian period, has been interpreted as a possible supply base with open-ended buildings used for storage (Hanson, et al., 1979). There has been more recent discussion as to whether these interpretations should be revisited, as site plans suggest that this area was within the extra-mural settlement and may not constitute a separate site (McIntosh, pers. comm). However, the datable material from Red House is earlier than that of the main fort location and does suggest an earlier phase of occupation that predates many of the main military structures at Corbridge. From epigraphic evidence, it is possible that troops stationed at this early fort, and maybe the succeeding relocated fort, were the elite cavalry regiment *ala Petriana* (Collingwood & Wright, 1965, RIB 1172). Military diplomas indicate

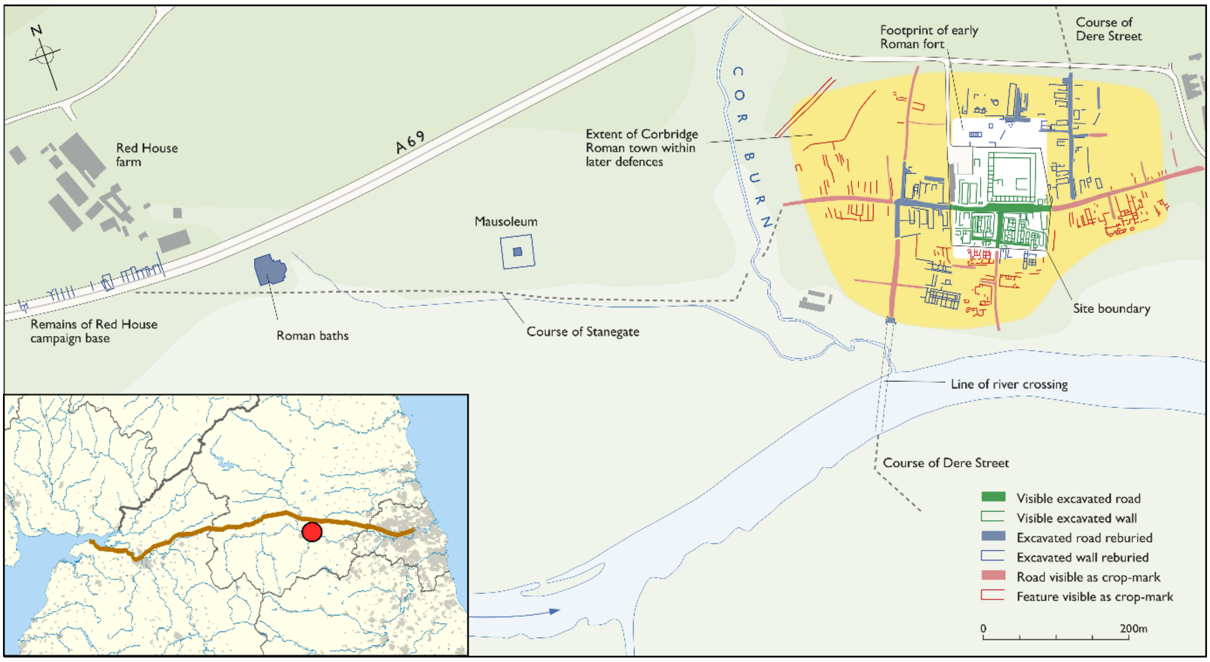


Figure 152- Location of Corbridge on Hadrian's Wall and with respect to the site at Red House and the River Tyne and bridge crossing (Plan of Corbridge © English Heritage Trust; map of Hadrian's Wall, Wikimedia creative commons).

that they were previously posted in Mogontiacum (Mainz), Germania prior to being redeployed to Britain (Clauss, et al., 2022; Spaul, 1994, pp. 180-182).

Occupation at the site known as Corbridge was established around AD 86 (Phase 1) after the dismantling and abandonment of the buildings at Red House (Hanson, et al., 1979, p. 1). The structures interpreted as the primary fort and associated buildings were constructed of timber and daub and were accompanied by turf and timber ramparts and defensive ditches. As this phase of occupation predominantly lies beneath the subsequent structures, the precise extent and dimensions of the buildings are not fully known. However, it is thought that the central range of any possible fort was broader than that of later phases. Estimates of its extent indicate that it was larger than a standard cohort fortification, but smaller than a legionary fortress (Bishop & Dore, 1988, p. 129). This type has often been referred to as a vexillation fortress (Frere & St Joseph, 1974, pp. 6-7; Goldsworthy, 1998, p. 126), though whether any primary fort at Corbridge fully suits this definition is not a topic for discussion here. Identified buildings have included a possible headquarters, a hospital, a granary, potential barracks, and a series of other associated structures. A second phase dating to around AD 103 (Phase 1b) where some of these buildings were modified or repaired has also been identified. Structures associated with this phase were destroyed by fire (Bishop & Dore, 1988, pp. 126-129).

The second main phase, occurring around AD 105-122 (Phase 2) saw the construction of what is termed the secondary fort, also a timber and daub construction. This was more like the traditional style of cohort forts in its layout and form. The central region of the complex has been explored in some detail, and this has revealed: a *principia*; two corridor buildings, possibly used for storage; potential granaries; and three barrack blocks. The full extent of the barracks is not known and so the size of the garrison is difficult to extrapolate without this information. Earth and timber ramparts continued to be used and these saw the possible introduction of gate timbers (Bishop & Dore, 1988, pp. 131-132). The format and structures were not completely removed at the end of this period, though modifications that occurred to the site in the next phase of occupation dating to around AD 122-139 may have coincided with a change in stationed troops (Phase 3). The principia mostly remained unaltered, while the barracks were rebuilt to a different plan to possibly accommodate a different type of garrison (Bishop & Dore, 1988, p. 134).

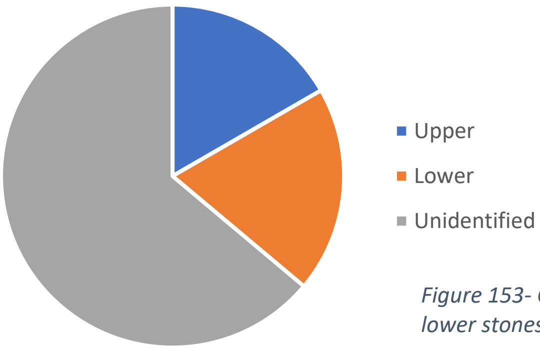
Following this around AD 139-158, the first buildings in stone were constructed within the central range of the fort, although a complete conversion to stone was not carried out and some remained in timber form (Phase 4a). Twin stone granaries in their earliest configuration are likely to belong to this phase. The principia gained stone footings, while a possible timber praetorium was also added. Historical records suggest that this work may have been partly carried out by *legio II Augusta*. The changes continued into the next phase (Phase 4b), with the reconstruction of the barracks with stone footings around AD 158-163. Unlike other forts of the period, a complete rebuild in stone did not occur at Corbridge and the turf and timber defences continued to be used, alongside timber buildings. This might suggest that occupation at the site was continuous, or it might reflect a different purpose to the fort when compared with those built as part of the wall defences (Bishop & Dore, 1988, pp. 135-137). Nonetheless, this phase marked the last to be associated with a fort, which was demolished after AD 163, and the function of the site appears to have changed by the middle of the second century.

The post-fort archaeology has been difficult to reconcile due to the disjointed nature of the investigations that have captured these later phases and the ambiguous nature of the excavation recording. The excavation report by Bishop & Dore (1988) failed to produce any detailed explanation of post-fort activity at the site because of this. More recent work has revealed that Corbridge became a military base and supply station after the fort had ceased to operate between AD 160-185 and was subject to large-scale reconstruction in stone. New buildings included the magnificent twin granaries, a large warehouse structure and *macellum* (Hodgson, 2008). The previously timber bridge was also reconstructed in stone at this time, emphasising the continued importance of the crossing site. The function of Corbridge would have been to store and supply goods for the forts on Hadrian's Wall and along Dere Street, and to manage administration tasks associated with this. It housed detachments from *legio XX Valeria Victrix*, whose main garrison was at Chesters, and *legio VI Victrix* from York (English Heritage, 2016). However, it appears that many buildings were incomplete at the time of a large fire, which was possibly the result of attack. Rebuilding appears not have taken place immediately afterwards (English Heritage, 2016).

After the restoration of stability at the northern frontier in the early third century, Corbridge remained an important military base and saw the construction of two stone walled compounds to house detachments. It is probable that the granaries were rebuilt in this phase, as the continued role of Corbridge as a supply base would have necessitated the storage of grain on a large scale. Around the same time, a civilian settlement grew up around the military activity areas, which gained recognised status of *civitas* by the third century. Continued military presence seems likely, but the character of the later site is largely considered as urban in its nature. Occupation continued at Corbridge, probably until the early fifth century, though the post-Roman transition is not well understood at the site (English Heritage, 2016). This urban phase is likely to be less significant to this investigation than that of the preceding military fort occupation due to the generally early date of lava milling tools in Roman Britain. Therefore, although the site has been classed as military/urban in terms of its character, lava is likely to have been used and deposited when the site was predominantly military.

The Dataset

Data for Corbridge was recorded in person, which allowed for measurements and records to be produced that are consistent with the aims of this research. The dataset comprises 36 lava milling tools, with no millstones identified in the assemblage. From this 20 were recorded in person, 4 were taken from the excavation report for the site at Red House, and 12 were compiled using information stored on the archive database for objects that appear to have been discarded at the time of the excavation. Most of the assemblage comprises undiagnostic fragments or objects that were only briefly described in publication or database information. There were 16 quern stones with diagnostic features, and it was possible to identify 6 upper and 7 lower stones from these (figure 153). This seems slightly unusual when compared to the data from other sites, where upper stones tend to dominate lava quern assemblages. However, the preservation of lava at Corbridge was much better than has been observed for other sites, and this is likely to have contributed to a more equal representation of quern parts. However, it should be noted that the querns in the assemblage are unlikely to be the full number excavated from the site, and we have little record of what the retention policy may have been over the course of the many decades of excavation work. A great many more quern stones would have been at the site, and those recorded here probably represent a small sample of what was present. Other retained querns are kept at the English Heritage stores at Helmsley, but these were not accessible at the time of data collection. Unfortunately, as these have not been identified by specific stone type in the archive database, it has not been possible to include them in the dataset at this time. Interpretations must, therefore, be mindful of this.



Stone part	***Number of objects***
Upper	6
Lower	7
Unidentified	23

Figure 153- Chart and table showing the number of upper and lower stones in the dataset, alongside those unidentified (T= 36).

Unfortunately, chronological and context information is somewhat patchy, which might be expected considering the age of some of the excavations and the lag between the time of excavation and the production of the excavation report. Further to this, only the querns from the site at Red House have been published, as none were listed in the main Corbridge excavation monograph. However, all lava querns in the assemblage can be confidently assigned a Roman date due to the nature of the site, and due to typological characteristics of Roman period lava querns being present on most of the stones themselves. Nonetheless, data analysis focusses on the data that is available, namely detailed examination of the objects themselves and distribution analysis.

Manufacture

The lava querns from the archived collection at Corbridge were relatively well preserved. This might be indicative of selective retention, as most examples retained diagnostic features that are typologically distinctive. Unfortunately, no descriptions or details were provided for the querns that must have been discarded. The presence of these was noted in the excavation documents and utilised in the dataset (16 objects), so for this data there is a record for context of recovery and a general idea of volumes, but nothing pertaining to physical characteristics. Therefore, this section will focus on those lava quern stones that were examined in-person (20 objects), with consideration for the fact that this denotes a sample of the full assemblage. Evidence for manufacture will consider: the diameter of the stone, presence and sizes of kerbs, handle fittings, rynd fittings, and dressing patterns.

Stone Diameter

There were eight stones with diameters that could be used in the analysis, and these can be seen in figure 154, which also presents the diameters of querns from the whole dataset for comparison. The results show that the all the stones with measurable diameters can be classified as querns. There were no identifiable millstones in the collection, and this was also the case in terms of diagnostic features associated with millstones. The Corbridge querns all appear to be of the standardised size and fit very well within common dimensions seen across the rest of Roman Britain. The smallest example was 380mm, and the largest was 410mm, with no unusual sizes within the assemblage. This shows that these querns are likely to be Mayen and from the same location as the bulk of the Romano-British lava querns.

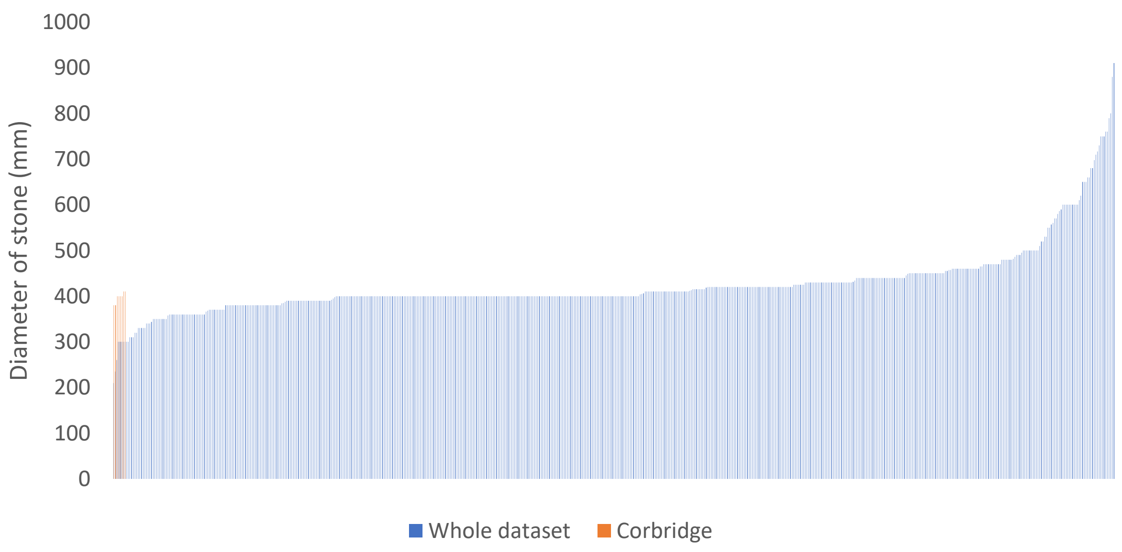


Figure 154- Corbridge quern diameters compared with the diameters of milling tools for the whole of Roman Britain (T=8).

Kerbs.

Of the seven upper stones six had kerbs present. Two of these kerbs were very faint and not clearly visible, while the remaining four were more prominent. One of the faint kerbs was from a stone that was heavily weathered, and so kerb visibility would have been affected by this deterioration of the lava itself. However, the second example was a complete upper stone that was well preserved, and the faint kerb appears to have been an original feature of the stone (figure 155) (CAT 2179). As has been discussed in Chapter 2, the kerb may have played a role in reinforcing the edge of the stone for the elbow handle fitting. Interestingly, this example with the faint kerb does not have any evidence for a handle fitting, despite clear signs of wear from use. It may be worth considering whether an iron band may have fixed the handle to the stone in this instance, evidence for which would be absent if the metal had been removed from the stone prior to deposition. Such a handle fitting would have made the functional purpose of a kerb redundant, but it may have remained in later examples as a visual reference to previous styles. Unfortunately, as the chronological information for the lava querns from Corbridge is poor, it is impossible to determine whether this change occurred over time or was simply a contemporary variation of the standardised lava quern in use across the province.

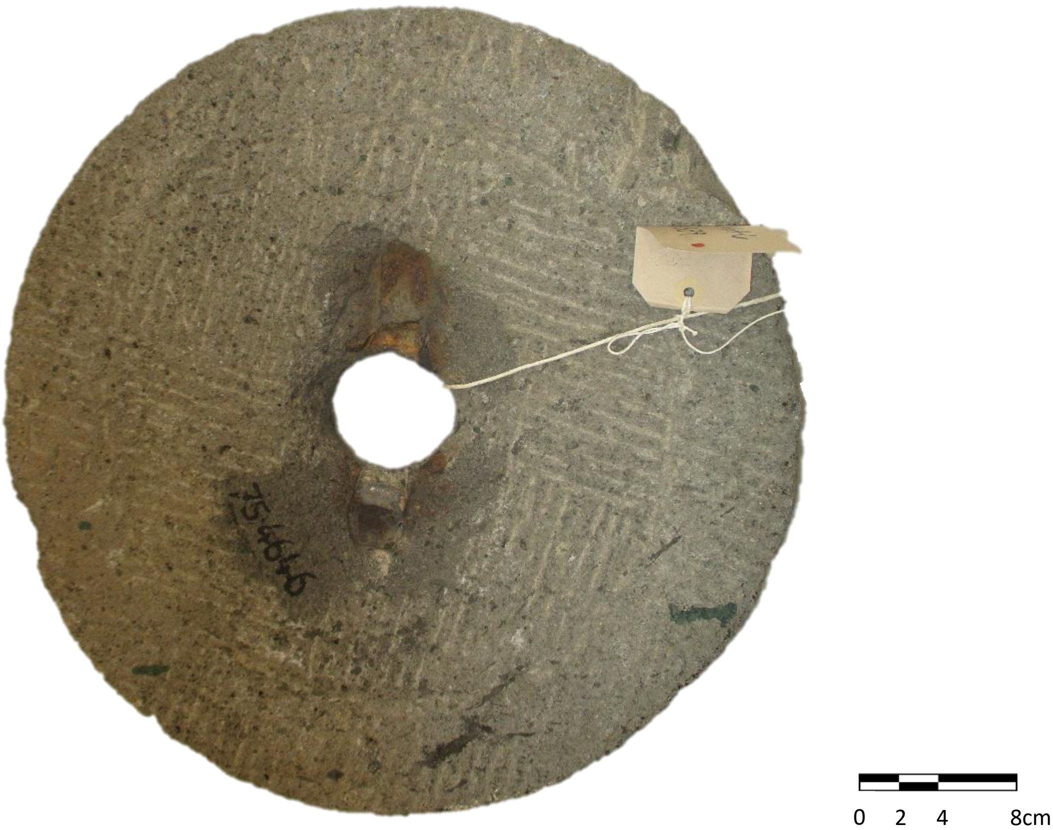


Figure 155- Complete upper quern stone showing a faint kerb and no sign of the standard elbow handle fitting (photo by the author) (CAT 2179).

Handle Fittings.

Further to what has been observed with regards to CAT 2179, two stones did have elbow handle sockets present (CAT 2257, 2188). These were visible at broken edges for both, which is a normal occurrence at a place where the stone is most vulnerable. Both these objects had kerbs, and these were relatively prominent; though other features that would be expected on a standardised upper stone, such as the upper surface dressing and rynd fittings, are not visible due to heavy weathering of the surfaces and breakage. The elbow handle fittings are like those observed at the quern finishing sites at Mayen, which are included in the quern typology produced by Röder (1955). It is thought that these were added to the object at Mayen, and that this explains the high level of standardisation seen across lava quern assemblages. The method of adding an iron band does not, however, appear in this typology. One possible explanation is that quern roughouts recovered from Mayen without elbow handle fittings have been assumed unfinished, as opposed to representing a different type. This method may have produced stones that had a longer use life to those with the traditional elbow socket, as it removed the vulnerability that such sockets created. The iron band would also generate external pressure to the stone to reinforce stability for a brittle stone type that appears to have been sensitive to breakage as the stone thinned. In a similar way to the French Burr stones, it may also have served a method for consolidating several pieces of lava to form a complete stone (Tucker, 1982) or provided a means for fixing a fissured stone. The iron band may, therefore, have been a technological innovation and show development of the original type, or have provided a means for extending the use-life of the stone.

Another possibility is that handles were added nearer the site of consumption. The addition of elbow handle sockets to mended querns at Vindolanda shows that the ability and tools to do this existed in military societies, though there is an argument that these were not particularly successful attempts (see section on Vindolanda). Adding an iron band may have been a less intrusive and potentially less damaging way of creating a handle fitting for a community that was not habitually used to working with lava stone. Further to this, as previously discussed, there may have been some advantages to this alteration. However, a greater level of innovation and variation would be expected of quern handle fittings from non-military contexts if this were the case, and elbow sockets are dominant across the province (see Chapter 4). This is not to say that iron band handle types do not occur more frequently than has been recorded, as these would not be identifiable on fragmented upper stones. However, evidence appears to suggest that the iron band handle fitting is a typologically different quern to those with the elbow fittings.

Rynd Fittings.

Two upper querns from the assemblage had remains of a rynd chase (CAT 2192, 2179) (figure 156), one which is the complete upper stone previously discussed. Both are of the standardised rynd chase fitting types, being recessed into the top surface of the stone across the central hole in the form of a rectangular iron bar fixed with lead. Remnants of iron and lead remain in the chase for CAT 2192 showing that the rynd was fitted in this way, while CAT 2179 retains only the rectangular shaped slot that would have accommodated the metal fixture. There is nothing on any of the other upper stone fragments to indicate that other forms of rynd fitting were in use at Corbridge, and evidence suggests that the standard types were utilised.

Figure 156- Upper quern stone showing recessed rynd chase in the upper surface. Scale is in cm (photo by the author and used with permission of English Heritage) (CAT 2179).

Surface Dressing.

Dressing for both upper and lower stones typically occurs on the grinding surface and the sides, while for upper stones, the upper surface is also dressed (see Chapter 2). Although much of the Corbridge lava quern assemblage had been subject to weathering, evidence for these types of dressing were apparent on 13 stones:

- well-executed and clear 'harped' dressing on one upper and one lower stone (CAT 2179, 2255),
- poorly executed harps on one lower stone (CAT 2254),
- unidentified grooved patterns on eight upper lower and unidentified stones (CAT 2180-2, 2186, 2188, 2190-1, 2256),

- clear radial dressing on one upper stone (CAT 2192),
- pecking on one lower stone (CAT 2193).

As has been seen at other sites, there does not appear to be any correlation between whether the stone is an upper or lower and the dressing type on the grinding surface; a variety of different dressing types are present. As wear would require redressing of grinding surfaces, these patterns are not associated with the manufacture process unless the stones are little used or unworn. Traditionally, the lava quern is associated with harped style dressing, but they were not always redressed with this design. The variation suggests that people with differing skills in stone working were responsible for redressing the quern stones, and that it may not always have been preferable or possible to replicate the more complex harped design after wear had erased it.

The vertical tooling was present on six of the twenty querns recorded in person and is the most common characteristic of a standardised quern from the archive (CAT 2179, 2181, 2188, 2192, 2255-6). However, edges were missing from many of the stones in the assemblage, and so evidence for this feature is largely absent due to this. Possible reasons for the broken edges will be discussed in the section on reuse/modification. The upper surface dressing was visible on three of the six upper stones (CAT 2179, 2180, 2192), while weathering appears to have removed the evidence for this on the other three.

Distribution

Location data was available for 20 querns. A further 4 querns are known to have been retrieved from the site at Red House, which is not included in the distribution analysis but is worth considering in association with the other site data. Most findspots could be reconciled to specific contexts and their locations. Those from the 1980 excavation season must have been recovered from the location of the current visitor centre, which is where digging took place that year, while those from the 1970 season, though recovered from the spoil heap, must have been from the area to north of the officers' house. Unfortunately, 12 querns could not be allocated a site location, and these have been omitted from the analysis. It must be emphasised that the distribution does not reflect a full dataset and that it is highly probable that evidence for other milling tools was recovered and not recorded. Locations have been plotted onto a site plan that also includes the known phasing for the excavated areas (figure 157). However, it should not be assumed that the objects necessarily follow these dates as these mainly relate to the structural evidence.

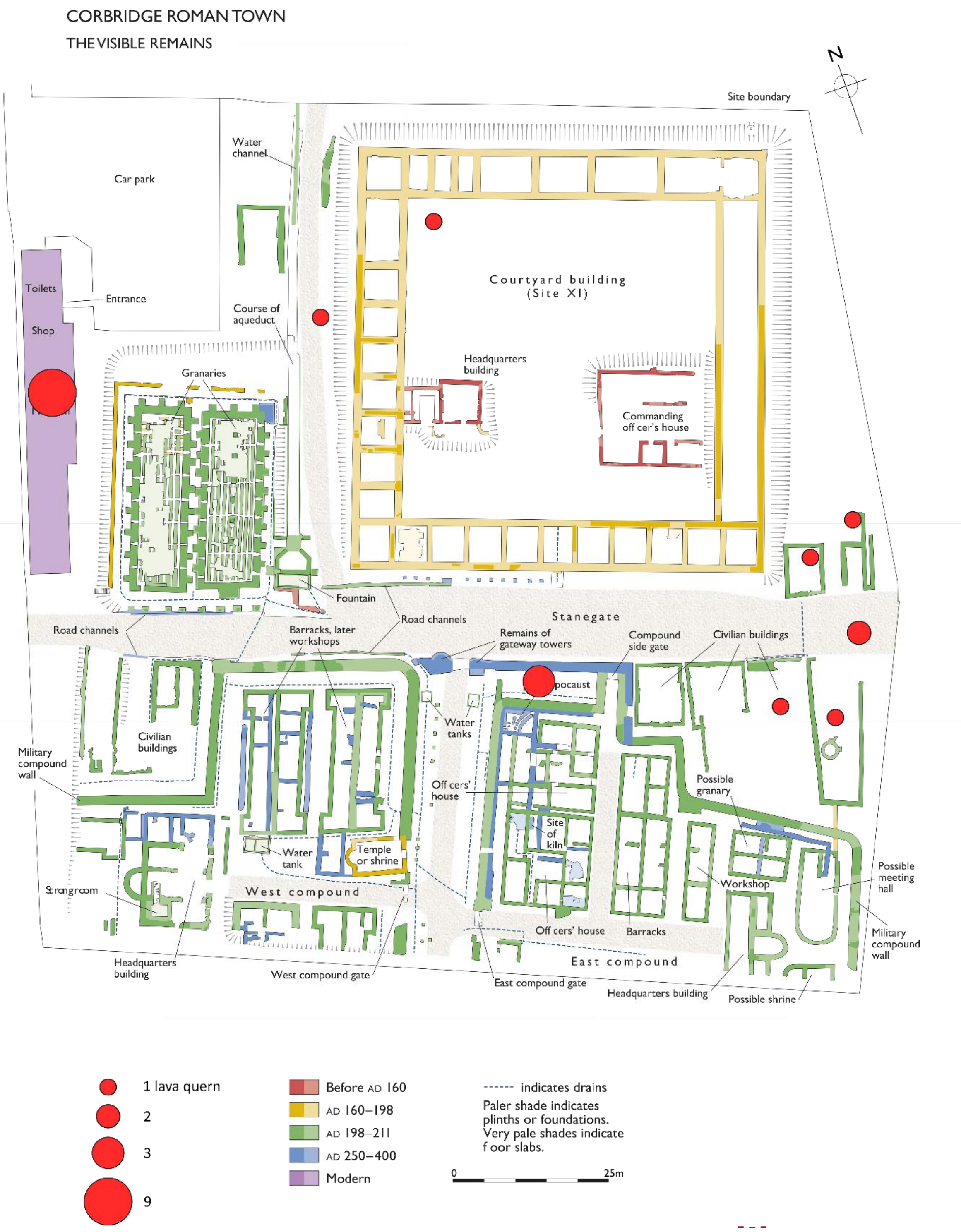


Figure 157- Plan of the site at Corbridge showing the distribution and volumes of lava querns by findspot (original site plan © English Heritage Trust).

The results show a cluster of lava at the area of the east gate and on either side of the road. These are external to the compound walls that are dated to the late second/early first century and close to an area of civilian buildings belonging to the same phase. A small group of three querns were found within the compound wall and near to the officers' house. Two other lava querns were retrieved from the north-western area of the courtyard building, one external and one internal to the structure. The final cluster occurs in the area where the modern-day museum and visitor centre sits and comprises the largest group of the material recovered from the site.

A total of nine querns were found during excavations of the visitor centre area, referred to in the excavation monograph as site 9, and this was the excavated area that showed the greatest amount of post-fort activity. It seems highly probable that the lava was recovered from archaeology of this phase and therefore constitute redeposited material. Evidence at site 9 indicates occupation in timber buildings and the presence of two hearths and an oven. Only one quern had information relating to the archaeological feature it was recovered from; this had been reused within a cobbled surface and cannot be considered as being from a use context. Similarly, the three querns from the 1970s excavation in the area near the officers' house were without context and any association with location of use is impossible to identify. However, this group is close to the main cluster of querns near and at the east gate area. This region is referred to in the excavation monograph as the 'inter-compound' area (Bishop & Dore, 1988, pp. 110-125). Interestingly, this is the area where the earlier phases of the fort were accessible, while the east gate excavations were similarly dated to the earlier military phases (Bishop & Dore, 1988, pp. 88-93). It is not possible to determine whether the lava querns were uncovered from these phases as the third century civilian area overlies it, but it does produce some questions with regards to the concentrated distribution in these areas and the association of lava with early military activity. However, as the region is outside of the third century compound wall, it may simply have been a suitable refuse disposal location external to the main occupation area. Similarly, large areas of road surface were uncovered in this area and the lava may have been reused within this context, creating a greater concentration of deposition.

Primary Use

As has been shown from the analysis of the whole dataset, comparison of the thickness of upper and lower stones presents the best opportunity for exploring primary use of the querns in the assemblage, which mainly comprises fragments that cannot be examined for method of use or rotation. Stone thickness can be easily compared with the stone thickness of querns from the whole dataset, allowing for the identification of especially thick or thin stones that may represent more, or less extensive wear and possible meanings associated with this. Comparison has been completed for the six upper and seven lower stones separately.

Upper Quern Stone Thickness.

The upper lava querns stones from Corbridge are generally thicker than those recovered from elsewhere in the province (figure 158). Of the six upper stones recovered, four were in the upper quartile for thickness when compared with the full provincial dataset. Though this may seem significantly high, it must be remembered that only larger fragments may have been retained on excavation, and that thinner and smaller fragments that may have existed in the site have not been included in the analysis. However, three of the thickest fragments are significantly thick, with two possibly being unworn, or very little used prior to deposition (CAT 2180, 2192). This is also the case for the lower stones (next section).

To emphasise how unusual these thicker querns are, table 16 names the nine sites where upper stones were found to be at least 100mm thick. The majority were from the site at 1 Poultry, London, where their presence has been taken as evidence for London being a centralised distribution hub for imported lava milling tools. The few other examples occur more frequently on military/urban sites, and occasionally on military sites. This may be an indication that lava was redistributed via military/urban sites, as querns that were broken in transit are most likely to have been deposited on arrival. As Corbridge appears to have had an important role in storing goods and supplying the northern frontier, the analysis may suggest that querns were part of this supply chain and were entering northern military circulation at this location, amongst others. This is a theory that is worth investigating further. This could be done by taking the lava quern data from more recent excavations at northern military sites that were also involved in supplying forts along Hadrian's Wall, namely Wallsend, Carlisle, and South Shields. These could be compared with the quern thickness data for Corbridge to see if any similarities in quern stone thickness can be identified and if these differ from lava quern 'consumer' sites on the Wall.

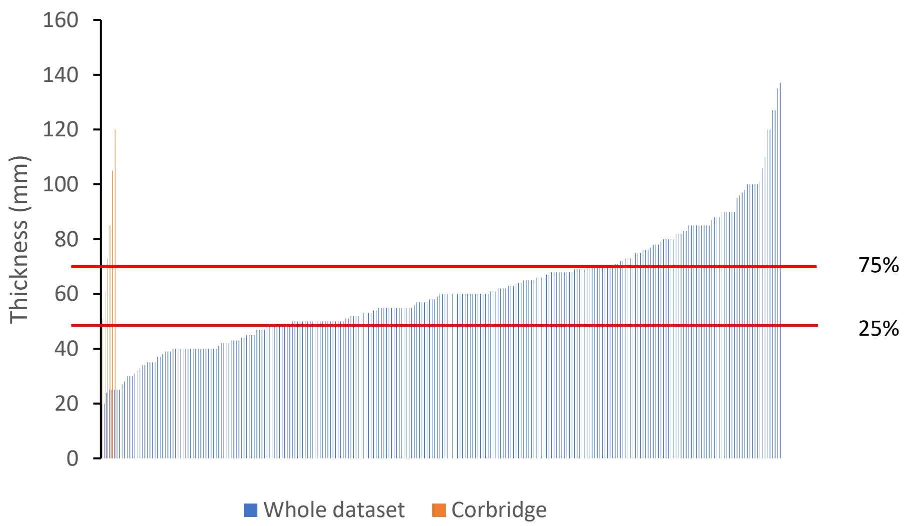


Figure 158- Chart showing the upper stone thickness for lava querns from Corbridge (T= 6) in comparison with those from the rest of Roman Britain (T= 248). The querns from 1 Poultry have been excluded from the analysis.

Table 16- All sites with upper stones thicker than 100mm.

Site Location	Site Type	Number of querns
1 Poultry	Military/Urban	89
Carlisle	Military/Urban	4
Colchester	Military/Urban	3
Corbridge	Military/Urban	2
Segedunum	Military	2
Castleford, North Yorks	Military	2
Chesters	Military	1
Holditch, Staffs	Rural	1
Strageath, Perthshire	Military	1

Lower Quern Stone Thickness.

As with the upper stones, the lower stones from Corbridge show a similar trend in being generally thicker at the point of deposition than querns from the wider province (figure 159). Of the seven lower stones from Corbridge with known thickness measurements, four fall within the upper quartile for thickness when compared with the whole British dataset. The reasons for this are likely to be similar to that seen for the upper stones, and the choices relating to discard or retention at the time of the excavations will provide one possible explanation for this. As with the upper stones, one lower stone also falls into the category of being a possible unused or little used stone (CAT 2190). The remaining three lower stones in the Corbridge dataset fit comfortably into the range that half of the British lava querns do for thickness, showing ordinary extent of wear prior to deposition.

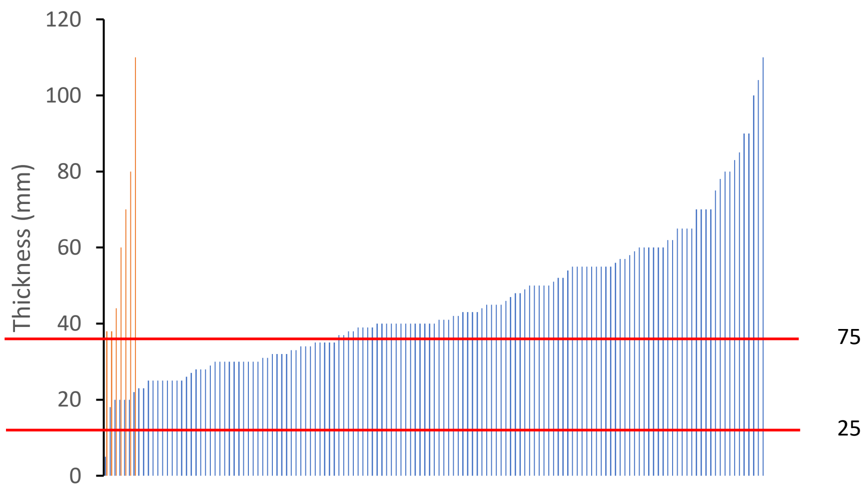


Figure 159- Chart showing the thickness of lower stones (T= 7) compared with the lower stone thickness of data from the whole of Britain (T= 138) excluding the querns from 1 Poultry.

Reuse/Modification

The extent of weathering on the surfaces of many of the quern fragments makes it difficult to determine whether any of the surfaces had been reused for purposes other than for grinding and milling, and in many cases, wear associated with primary use could not be established either. Although perfect preservation cannot be expected, the surface weathering observed could be indicative of lava that has been exposed to frost, suggesting reuse or deposition in an exposed environment, such as for a road surface. Similarly, the extent and way that the lava was broken may give some indication that reuse occurred, or that deposition of lava took place after it had been deliberately broken. Several of the fragments were broken in a way that is unlikely to have occurred accidentally, with thick pieces broken in places that are not usually vulnerable to damage. One example includes CAT 2180, which shows thick areas at the side of the quern stone broken or chipped off (figure 160). Unfortunately, it is not possible to differentiate between reuse or deposition in terms of the treatment of the lava. As lava is often reused in floors, surfaces and roads, the breaking of querns and frost damage could relate to this. Reuse as building material is also possible.

Figure 160- Upper quern stone with broken thick edges that may have been fragmented deliberately for the purposes of reuse (CAT 2180) (photo by author).

The trend seen for modified lower stones by reducing the sides towards the bottom of the stone, such as seen at Verulamium (Chapter 6, CAT 2605 and 2592), is also apparent in the Corbridge assemblage with CAT 2190 (figure 161). The extent to which this had been carried out has changed the profile of the stone, angling the sides inwards where it has been reworked. The sides have been roughly removed, cut irregularly, and show tooling marks associated with this process. The expected standardised vertical tooling is also absent. Meanwhile, the full shape and size of the grinding surface has been retained meaning that there has been no loss to the area of the grinding surface. This shows that the modification was not intended to affect the use of the stone as a milling tool.

Thus far, there has been no evidence for similar modifications associated with upper stones, showing that the alterations probably relate to the functioning of the lower stones only. It can be compared to an indigenous lower quern stone form the Clayton collection at Chesters, which has been fashioned in a very similar way (figure 162). Placement into a floor surface is one interpretation for this form of reworking, and it may have been a common practice that is only identifiable on more complete and less worn stones. What is interesting about this stone is that this example is especially thick at 110mm, and may constitute a new unused quern, or one that has seen little use. Such a situation might be interpreted as a quern roughout, but this is unlikely as the grinding surface has been dressed, a process that would have taken place at the later stages of quern manufacture (see Chapter 2). Why this stone was not used or was little used cannot be explained, but it was broken in half prior to deposition. It is possible that the intended modification failed, that accidental breakage occurred, or the quern was rejected for another reason.

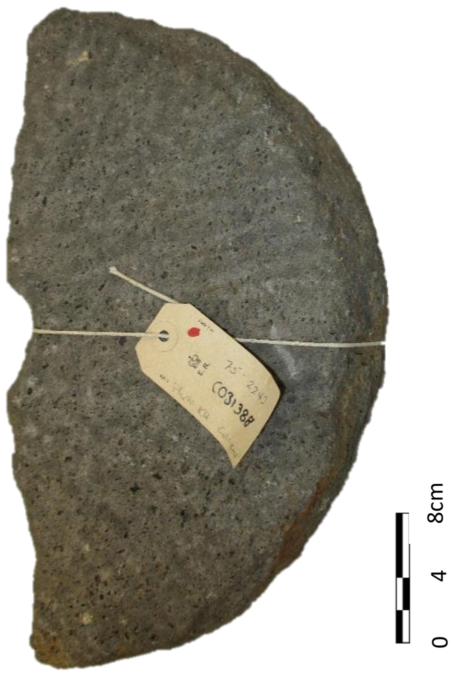


Figure 161- Modified lower stone (above and right) that has had its sides removed near the lower edge (CAT 2190) that is similar to reworked lower stones from Verulamium and Silchester (photos by author).

Figure 162- Lower quern stone of indiginous stone that has been similarly worked to round the lower surface, possibly to fix it into a floor (Acc No CH266) (photo by author).

One other lower stone in the assemblage shows similar features and reworking, though wear has made this more difficult to identify clearly (CAT 2254) (figure 163). This stone is 60mm thick, and so is considerably more worn than the previous example. The sides have been clearly reworked, though these have been smoothed and tooling is not visible on the sides. What is also notable is that the diameter is much smaller than the standardised lava quern at 350mm, and it must have been reduced during the modification process. One possible reason could imply relate to wear, as removal of the sides has caused a gradual decrease in diameter at the lower levels of the quern. This may have impacted the efficiency of the quern, and deposition may have occurred as result. The fact that the lower stone would no longer have fit and paired with the upper stone may also have posed some problems.

Figure 163- Possible modified lower stone that has been more heavily worn and has a decreased diameter (CAT 2254) (photo by author).

Deposition

Unfortunately, specific archaeological features were not identified in relation to the deposition of lava querns in the Corbridge archives, and there is little that can be discerned from the available information. What is known has been presented in figure 164. This includes the four groups of lava fragments from Red House that had context information included in the relevant publication. Of these, three were incorporated into a cobbled floor surface and so the Red House querns have influenced this category significantly. This is a type of deposition that is known for lava at many other sites in Roman Britain and appears to have occurred most often at military sites. However, it is not possible to comment on the prevalence of this deposition type as there is not enough data to make comparison possible.

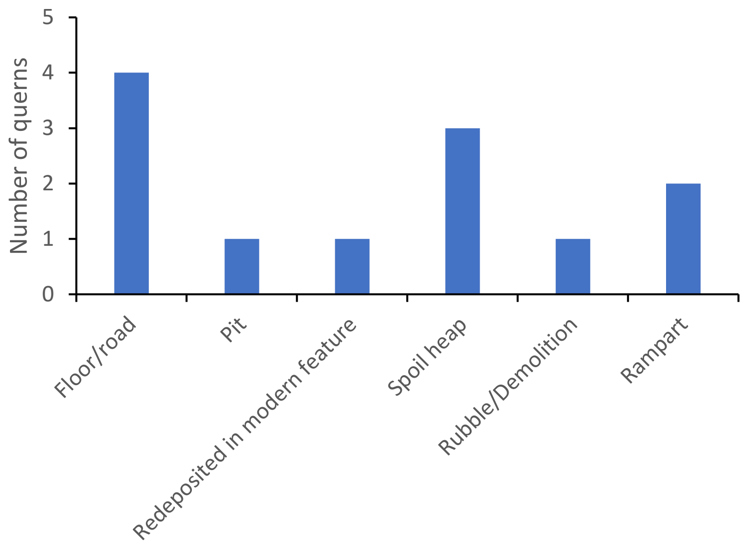


Figure 164- Chart showing the feature type where lava querns were deposited at Corbridge (T= 12).

The treatment of the lava querns prior to deposition has already been commented in the previous sections, but it should also be noted here that the deliberate breaking of querns may have been part of a practice of ritual deposition. In order to establish if this were the case, it would be necessary to complete a detailed examination of context type and associated finds recovered alongside the lava, which is not possible for Corbridge.

Chesters

Introduction and Site Background

The Roman fort at Chesters is in modern day Northumberland on the western bank of the River North Tyne, which is bridged by Hadrian's Wall at this point (figure 165). The fort was one of the earlier constructions established as part of Hadrian's Wall. This required adaptation of the original design of the wall defences, resulting in alterations to the structure itself and associated ditch system (Breeze & Dobson, 1976, p. 45). The fort was garrisoned by a cavalry regiment, evidenced by the barrack stables and inscriptions that identify the troops stationed there (Tomlin, et al., 2009, pp.

467-480; Hodgson & Bidwell, 2004, p. 139). The first of these regiments was the *ala Augusta ob virtutem appellata* – 'the cavalry regiment styled Augusta for its valour', though the date of this initial occupation is not known and can only be estimated to have occurred sometime after the construction of the wall, which commenced in AD 122. The regiment is thought to have been previously stationed at Calunium (Lancaster), and possibly in Germania prior to that (Spaul, 1994, pp. 55-57). Little is known of the use of the fort during the mid-second century when troops were moved to the Antonine Wall, but activity appears to have continued to some extent. Building work and inscriptions have been recovered from the site that date to this period, which suggests that the fort was being maintained and used, even if this was not necessarily on a permanent basis. Permanent occupation by the military continued by AD 178-84 with the arrival of the *ala II Asturum*, 'the Second Asturians', another cavalry unit who remained at the fort until the end of the Roman period. It is thought that they had previously been stationed at Ribchester in Lancashire from a dedicatory inscription (Vanderbilt, 2020). Their arrival initiated large-scale reconstruction and refurbishment works to accommodate the specific needs of the garrison (Hodgson, 1999).

Excavations of the fort were completed by the Clayton family during the nineteenth century and the early nature of these investigations means that the chronological development of the fort is not well recorded due to a lack of stratigraphic data. Further to this, only specific finds were saved and very few of these retain context information (McIntosh, 2019). More recent geophysical survey of areas of the site that remain unexplored have been subject to geophysical survey, which has revealed previously unknown structures, such as a large granary and more barracks (Hodgson, 2009, p. 109). The vicus settlement has not been subject to excavation, meaning that all retained finds were recovered from the main fort area. However, aerial photography and geophysical survey has been used to identify its extent and possible layout (Bidwell, 1999, p. 116; Burnham, et al., 2004, p. 273).

Separate to the main fort area and highly relevant to this study are the remains of a possible mill structure at the eastern abutment of the Roman bridge over the River North Tyne. Excavations of the abutment took place at the same time as those of the fort buildings and are described by Clayton and Bruce (see summary by Simpson, 1976, p. 44). These descriptions in association with the remaining evidence and comparison with the more substantial remains of a Roman mill at Haltwhistle Burn have been used to identify the site as a potential watermill (Simpson, 1976, p. 44). The proximity of the structure to the fort and the sizable population of the garrison makes any possible mill a probable military structure. Further to this, the technological skills, resources, and labour to establish such an innovation would be more easily met by the military community. The mill at Haltwhistle Burn was a third century construction and it might be assumed that any other mills on the Wall were similarly dated. Millstones were recovered in association with the Haltwhistle Burn mill, which still had part of the wooden structure preserved intact. None of these millstones were of lava, though a range of stone sizes were present; probably to cope with the seasonal changes in waterflow and, thus, power to turn them (Simpson, 1976, pp. 36-42). The absence of lava is interesting and might relate to the change in lava consumption seen more generally in the province during the third century (see Chapter 4). The millstones were made from a locally quarried sandstone (Simpson, 1976, p. 36), allowing for the specific dimensions of the mill mechanisms to be factored in at the time of stone extraction and fashioning.

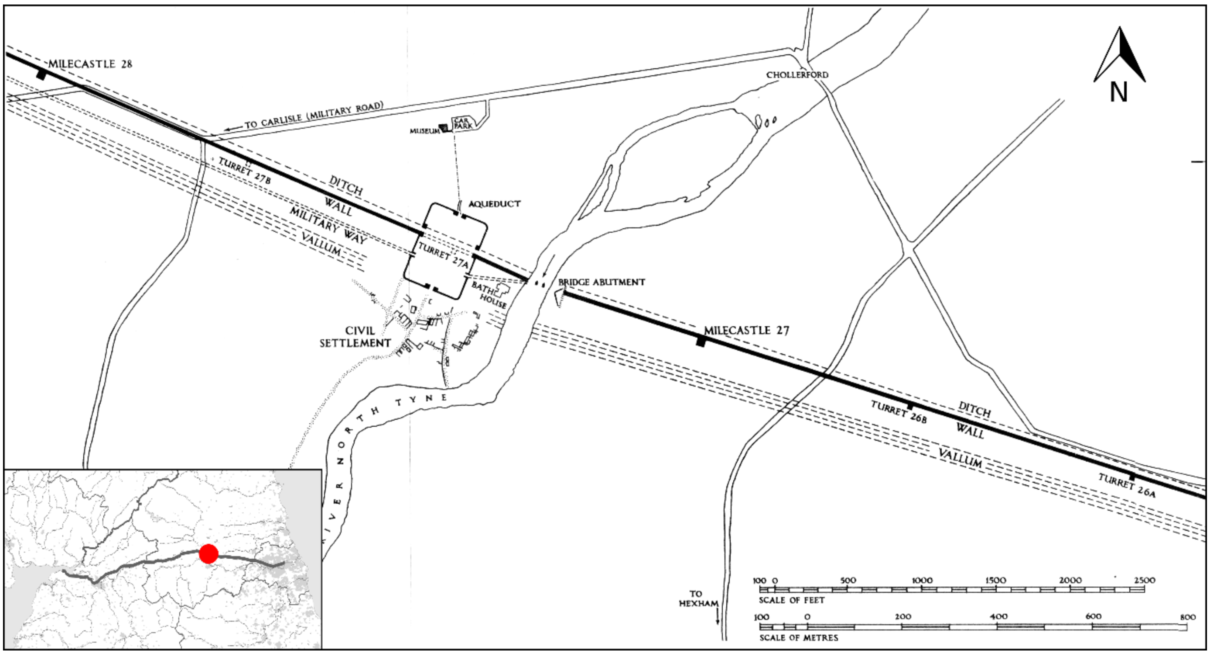


Figure 165- Plan of the location of Chesters Roman fort (map edited using versions available from creative commons).

The Dataset

The dataset for Chesters is the smallest of all the military case studies, comprising only seven stones, four being lower, two upper and one unidentified. As explained in the site introduction, none of these objects has associated context information and the findspots have not been recorded. However, it is certain that they were excavated at Chesters and are of the Roman period, meaning that they can confidently be included in this research. Throughout the analysis, the unknown finds discard policy must be considered alongside the high probability that the stones retained were the best examples recovered from the whole site. It is notable that the lava in the archive at Chesters is well preserved and consists of very large fragments or complete stones. Their condition implies that the retention of querns during the excavation may have been more selective than for other sites and that these objects do not constitute a random sample of what would have been present overall. It is also worth considering the dominance of lower stones in the dataset, as this is highly unusual in the province where upper stones tend to dominate.

Clearly, this does not reflect an ordinary assemblage, and this must be acknowledged in any interpretations relating to it. The gaps in the excavation data somewhat limit the types of investigations that can be carried out on these milling tools in terms of object biography, and data analysis will predominantly focus on what can be learnt from the objects themselves, while making clear any bias that might be inherent in the data. In the absence of context data, distribution and deposition cannot be explored, while only a limited view of primary use can be investigated. This section will, therefore, look at the typological characteristics of the stones relating to manufacture, signs of primary use, and any reuse or modification visible on the objects.

Manufacture

Lower Stones

The features of the lower stones from the assemblage are largely compatible with the standardised lava querns that are known to have been produced in the Mayen region. Weathering or wear has removed signs of dressing for CAT 2173, but this stone retains the convex profile, straight vertical sides and hollowed lower surface, all typical characteristics for Mayen lava lower stones. CAT 2172 presents these features but is a better-preserved example that also has the harped dressing on the grinding surface, which aligns with the vertical striae dressing on the sides (figure 166). CAT 2174

0 4 8cm

Figure 166- CAT 2172, lower quern stone showing all characteristics of a Mayen lava product (photo by author, used with permission from English Heritage).

and 2176 are complete lower stones, the latter being that of a millstone with a diameter of 600mm. The grinding surface for the complete lower quern stone (CAT 2174) does not have any signs of dressing present and has been worn and weathered in a similar way to CAT 2173. There is a possibility that the grinding surface was pecked, but this cannot be identified with any certainty.

The complete lower millstone (CAT 2176) has broken into two pieces and is of the same style as that of the lower quern stones, only larger (figure 167). As there is no evidence present on lower stones that would be indicative of methods of rotation as they are not active in the millstone mechanism, the stone has been identified as a millstone based on its size alone. The profile is of a convex grinding surface with a hollowed out lower surface. The sides are vertical and straight, and it has a circular central hole that fully perforates the stone. The grinding surface is dressed in harps that are clearly visible, but there are no vertical striae present on the sides. It has been surmised by Moritz (1958) that bigger querns/mills of this type were used by larger units of men, such as 'centuria' or 'turma' to process greater volumes of grain to accommodate their needs. The suggestion is that these needed to be operated by groups of soldiers or turned using animal power, though operation using a turning crank has also been proposed by Jacobi (1914).

However, the association between specific unit sizes is largely based on the presence of a limited number of inscriptions found on millstones in Germany and this theory has not been tested using a larger dataset with consideration of chronological change. Nonetheless, the millstone does demonstrate that larger scale food processing was occurring at Chesters and that lava was utilised in this activity. Whether this was in association with the potential water mill at Chesters is also a matter for consideration, though the absence of lava in the millstone assemblage at Haltwhistle Burn dating to the third century indicates that watermill technology at Hadrian's Wall may have been introduced at a time when lava imports decreased in Roman Britain.

Figure 167- Part of the complete lower millstone showing top and bottom view (CAT 2176).

Upper Stones.

The two upper stones were similarly less fragmented, comprising one half stone and one complete example, both of which were weathered. The complete stone (CAT 2175) is heavily abraded from weathering, and it is not possible to identify any surface features, such as dressing or a kerb, except for a small trace of vertical tooling on the sides. The central hole is very heavily worn, showing the probable reason for deposition, but a small amount of a rectangular rynd chase remains (figure 168). Although the standardised features are minimal, those present suggest that this was manufactured to the same specifications as other Mayen quern stones. There is, however, no handle slot and can be compared with CAT 2179 from Corbridge where it is likely that an iron band handle fitting was employed. As another example of the use of such a fitting, evidence indicates that this type may have been more prevalent than first thought, at least in the context of military sites.

The second example (CAT 2177) has retained more of the characteristic features of a standardised upper stone, with a well-pronounced kerb, part of the rynd chase and dressing on the upper and grinding surfaces. The dressing on the grinding surface appears to be harped and has worn almost through to one of the holes for the mechanism fitting. This stone appears to have been modified, distinguishing it from the other upper stone and this will be examined in more detail in the section on reuse/modification.

Figure 168- Complete upper stone that has been weathered and heavily worn at around the central hole. A small part of the rynd chase remains on right side of the central hole. No handle fitting exists on the stone (CAT 2177) (photo by author, used with permission from English Heritage).

Unidentified Stone.

The unidentified stone is the smallest lava fragment in the Chesters assemblage and does not retain any features that allow for it to be determined as an upper or lower stone (CAT 2178). Some faint dressing marks on the non-grinding surface could suggest that it is an upper, but these are not clear enough to confirm that this is the case. What is interesting about this stone is the dressing on the grinding surface itself, which has been clearly pecked (figure 169). The wear of the stone suggests that this is not associated with the manufacture process, and it may have been redressed in this style. Its presence in the assemblage suggests that this may have been considered as an unusual example at the time of excavation or may have been the best sample of this type of dressing style.

Figure 169- Small fragment of unidentified lava stone that has been pecked on the grinding surface (CAT 2178) (photo by author, used with permission from English Heritage).

Stone Diameters.

Diameters were measurable for six out of the seven stones in the assemblage, and the five querns show a smaller range to the standardised range of diameters when compared with the whole British dataset (table 17). However, the dataset is very small and more susceptible to distortions as the result of unusually large or small stones. The one example measuring 360mm is likely to have been the cause of this and as a single exception of an unusually small stone, cannot be considered as representative of the dataset. Overall, the diameters agree with the standardised sizes for lava querns. Similarly, the lava millstone is of a diameter that occurs regularly elsewhere and is not unusually large or small.

Table 17- Left, Diameters of the lava milling tools in the assemblage with their associate catalogue numbers. Right, values of the upper and lower quartiles for lava quern diameter at Chesters and for the complete British dataset.

Cat No	Diameter (mm)
2172	360
2173	390
2174	400
2175	400
2176	400
2177	600

	Lower quartile (25%)	Upper quartile (75%)
Chesters	375	400
British data	400	425

Primary Use

As has been noted in the discussion on the dataset, the lava milling tools from Chesters are likely to have been retained at the time of excavation because they were well-preserved and more complete. A comparison of the thickness of the lava querns with the rest of the British dataset will, therefore, not be representative in terms of showing the range of thicknesses present and the degree of wear that was normal at the site prior to deposition (table 18). It will, however, show the probable upper range of thicknesses that are likely to have been present. The results show that there is one significantly thick upper stone, with the second being within the normal range for thickness as that of 50% of the British lava data. Similarly, the lower stones were all within this normal range. The outcome is unexpected but could signify that at Chesters the querns experienced a greater degree of wear prior to deposition when compared to other military sites in Britain. The reasons for this are not clear, but it is possible that Chesters was continually occupied, as shown by dated inscriptions during the period when troops were stationed at the Antonine Wall. Continuous occupation would enable prolonged use of milling tools and more extensive wear prior to deposition. Another possibility is a lack of or changing supply of lava to the site, possibly relating to the function or chronology of the fort.

Table 18- Upper and lower stone thickness for the querns from Chesters (left), and the upper and lower quartiles for the lava querns from the whole British dataset (right).

Cat No	***Upper stone thickness (mm)***
2175	100
2177	50
	Lower stone thickness (mm)
2172	50
2173	45
2174	40

	Lower quartile (25%)	***Upper Quartile (75%)***
British dataset upper	48	73
British dataset lower	31	55

Reuse/Modification

Reuse was not visible on any of the stones in the assemblage, mainly due to the extent of surface weathering on most of the milling tools, but modification was present on one. This is the previously mentioned upper stone, CAT 2177. This has many of the standardised features of a Mayen lava upper stone, with the addition of two parallel holes adjacent to the central hole (figure 170). These are located at a right angle to the remains of the rynd chase a few centimetres away from the central hole. A more complete parallel to this quern exists at Housesteads that retains the iron fittings that match the holes in the Chesters upper stone. In this example, an iron bar braces the central hole and is fixed into one side of the upper surface of the quern via an iron loop fitted into two holes using lead. On the other side, the iron bar is fed into the upper surface and fixed with lead (figure 171). Part of the kerb has been removed, indicating that this addition was an adjustment to the original design and not related to the manufacture process. The function for this bar is not clear, but possible interpretations could relate to its use as a handle to lift the stone, or as a tentering mechanism to adjust the gap between the upper and lower stones. This will be discussed in more detail for the quern from Housesteads.

Figure 170- Upper quern stone from Chesters (CAT 2177) that shows evidence for modification in the form of holes that would have accommodated iron fittings not associated with manufacture (photo by author, used with permission from English Heritage).

Figure 171- Upper quern stone from Housesteads (CAT 2284) that retains the iron fittings and provides a parallel for the incomplete stone from Chesters above (photo by author, used with permission from English Heritage).

Housesteads

Introduction and Site Background.

Housesteads Roman fort, also referred to as *Vercovicium*, is in modern day Northumberland and located in the central region of Hadrian's Wall on the Whin Sill escarpment (figure 172). The site has produced some of the best-preserved Roman military archaeology along Hadrian's Wall, much of which has been excavated using modern excavation methodologies, which has yielded detailed insight into the lives of those who were stationed at the fort and who lived in the associated *vicus* settlement (Birley, 1961, pp. 178-184; Rushworth, 2009, p. 1). Excavations at the site have been carried out since 1922, though records of the presence of the fort exist as early as the sixteenth century. These preliminary investigations predominantly focused on the curtain wall and Hadrian's Wall, with some work also done to uncover the granary structures. At the turn of the century, excavations were carried out on the *principia*, while a fuller plan of the structures on the site was also 'traced', with little consideration of the chronology of the buildings. Further explorations followed with several small-scale targeted excavation to examine specific areas of the fort interior. As excavation methodology improved during the mid-to-late twentieth century, greater focus was given to identifying chronological development of structural evidence, and to investigate the *vicus*

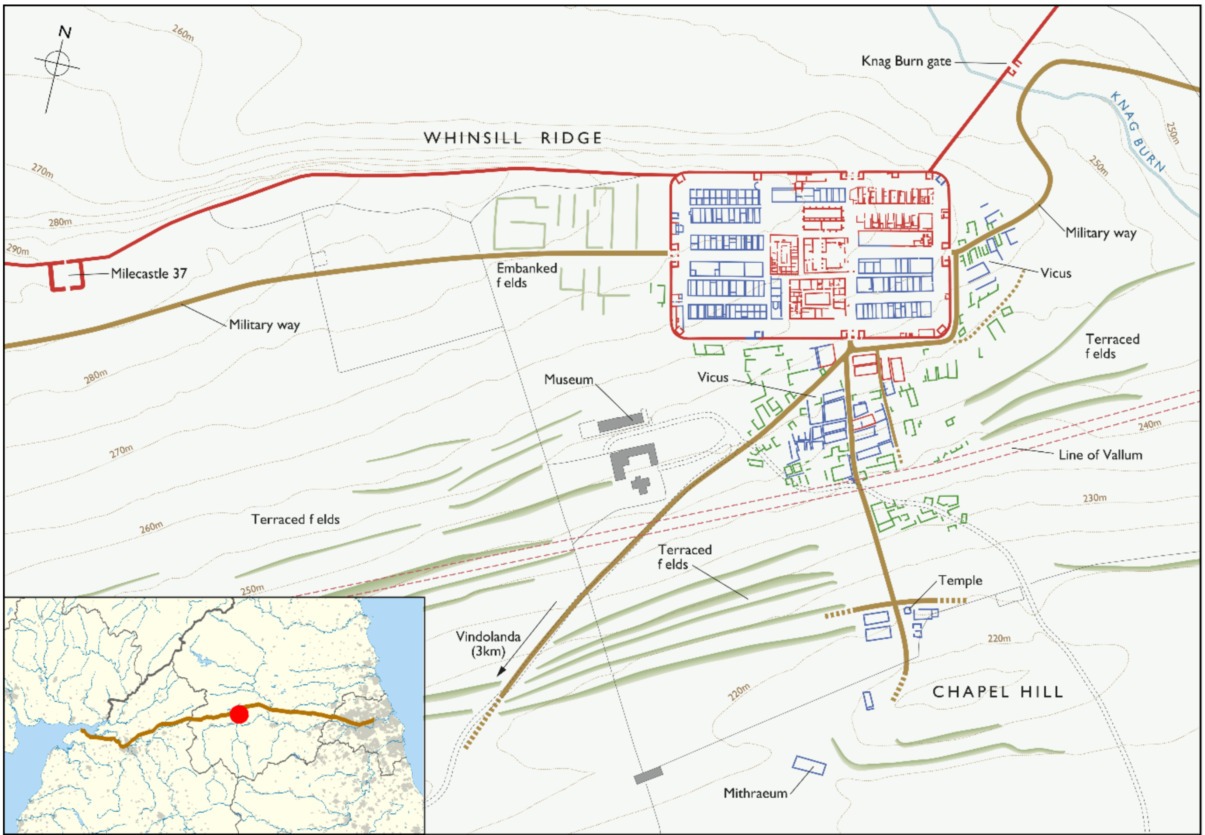


Figure 172- Location map of Housesteads Roman fort (plan of Housesteads fort © English Heritage, location map Wikicommons licence).

settlement. These more recent excavations, alongside with what can be pieced together from earlier site reports have been consolidated and presented in one report by Rushworth (2009) to present a fuller picture of life at Housesteads during the Roman era (Rushworth, 2009, pp. 1-8).

The fort was built within a decade of the initial construction stages of the wall, after AD 122, and evidence suggests that this occurred during a phase roughly contemporary with the building of the surrounding segments of Hadrian's Wall (Crow, 1995, pp. 17-21). Unlike Chesters, the fort lies parallel to the wall and does not project beyond it into the north. It was home to a large regiment of infantry soldiers, comprising auxiliary troops and numbering approximately 800-1000 men (Crow, 1995, p. 27). The first garrison may have consisted of the first cohort of Tungrians, as recorded by inscriptions dating to around AD 200, but this is not certain (Crow, 1995, pp. 57-59). They were a cohort initially from Belgic Gaul (Birley, et al., 2013, pp. 291-293). On the movement of troops to the Antonine Wall, continued occupation at Housesteads is evident, though probably by a caretaker garrison instead of a full regiment. The full complement of the first cohort of Tungrians had returned to Housesteads by the early third century, presenting an unusual continuity of the cohort's occupation at the fort. Supplementary units were stationed alongside the main garrison on occasion, but the Tungrians remained the core of the population (Crow, 1995, p. 59; Rushworth, 2009, p. xiii).

Most buildings of the fort were initially constructed in stone within the stone curtain wall defences. The layout of the central range included the *praetorium*, *principia*, and the granary, alongside a storage building of unknown function. Further to this was a hospital and possible baths for the commandant, while to the east and west of the central range lay the barracks (Crow, 1995, p. 44; Rushworth, 2009, p. 271). As water supply was an issue at the site, the bathhouse was situated away from the main fort structures at nearby Knag Burn, where fresh water was readily available. Due to excessive robbing of the bathhouse structure, little is known of the chronology of its development (Crow, 1995, p. 43; Rushworth, 2009, pp. 241-242). A programme of rebuilding and refurbishment occurred on the return of the full garrison after the return to Hadrian's Wall around AD 162, with more extensive changes occurring around AD 300, when the barrack blocks were converted into individual 'chalets', reflecting a change in the way that soldiers were accommodated within the fort complex (Rushworth, 2009, pp. 119-127; 134). Though suggestions have been made that this was to allow soldiers to live with spouses and children, finds evidence does not prove the presence of women or children in these areas of the fort and difficulties remain in interpreting the evidence this way (Hodgson, 2014). The other main change that took place at this time was the addition of a large storehouse of unknown function (Rushworth, 2009, pp. 133-135). The final identified phase involved modifications to the 'chalets', ramparts, and other fort structures, alongside road resurfacing that occurred around the fourth to early fifth centuries (Rushworth, 2009, pp. 136-177).

Connectivity with other military sites in the north was possible initially via a road that linked up with the Stanegate, which was the first stone-built road to serve the fort when it was under construction and ran east to Vindolanda. This was followed by the Military Way running east-west in the later second century, which provided a more direct route to the other forts along Hadrian's Wall. Communication and the movement of supplies was, therefore, conducted using the road system, with the Stanegate remaining a significant route throughout the military occupation of Housesteads (Crow, 1995, pp. 25-26).

In terms of structural evidence relating to the preparation and consumption of grain, the granaries and bakehouses have provided interesting details. The west gate, known as the *porta decumana* was the main vehicular access to the large granaries for the fort (Crow, 1995, pp. 34-35). These were within the central range of the fort. The earliest granary built during the Hadrianic period consisted of a single structure with two aisles, a raised floor, and stone piers that supported a double span broad roof with eaves, reinforced with buttresses. The entire structure was designed to keep the grain within cool, dry and vermin free (Crow, 1995, p. 51), and would have been one of the more important buildings within the complex due to grain being a staple part of the military diet and representing the bulk of the rationed allowance of foodstuffs provided by the state (Groenman-van Waateringe, 1997). By the Severan period, adjustments had been made to the granary with the addition of two internal walls to replace the pillars, effectively splitting the building in two. The changes reduced the storage space significantly and could signify a contemporaneous change in the garrison size. It has been suggested by Crow (1995, p. 52) that the structural changes may have occurred in two phases, with the addition of the walls as separate occurrences that reflect a decrease and subsequent increase in garrison size. The first wall being designed to decrease the size of the granary initially, and a second added to enable use of the other half of the building later with the return of the fort to full force (Rushworth, 2009, p. 271).

Bakehouses have been uncovered in the area of the east (figure 173) and west ramparts and in the angle towers of the fort, which were in use in the early occupation phases of the fort (Rushworth, 2009, pp. 38-39; 42). The way that these have been spread out and the frequency at which they occur seem to suggest that use of ovens was divided between the military population and individual ovens may have been allotted for the use of set groups of soldiers. This correlates with the evidence that we have for quern use, in that inscribed querns from military sites indicate that food preparation was undertaken as a communal activity within units of soldiers (see section on Vindolanda, this chapter). The oven in the commandant's kitchen is of a similar style to that of the commercial ovens in bakeries at Pompeii (Crow, 1995, pp. 36-37). The provision of specialist equipment of this type possibly indicates that a professional baker was employed to prepare delicacies for the military elite and their guests when stationed at the fort.

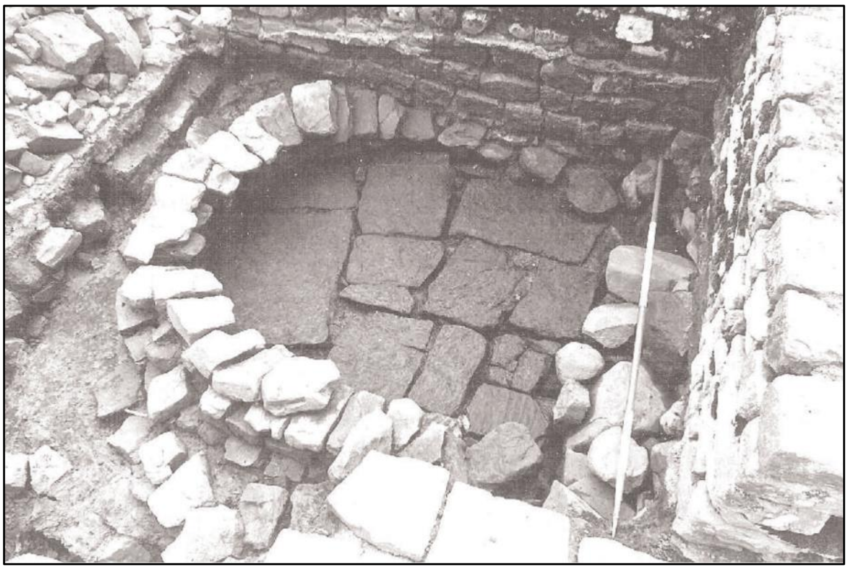


Figure 173- Oven at Housesteads in the bakehouse in the eastern rampart area of the primary fort. The layout and structure changes considerably over subsequent phases (Rushworth, 2009, p. 39).

The Dataset

The dataset from Housesteads is somewhat complicated by the long chronology of excavations that have taken place at the site. It has resulted in inconsistent data standards due to varying levels of detail in the recording process, and different finds retention and reporting policies across the multiple projects undertaken over the years. It would appear the earlier excavations only retained the larger lava quern fragments, or those that had peculiar or distinctive diagnostic features. Disappointingly, these probably represent only a small number of those uncovered from the site, as comments made by Bosanquet (1904, p. 285) refer to a large number of querns excavated during the 1898 excavation season. It is probable that some of these have been retained and archived at the stores in Helmsley, which was not accessible at the time of data collection due to Covid restrictions. As these are not identified by specific stone types in the archive database, they could not be added to the dataset at this time. The lava milling tools recorded from these early excavations lack any context information or findspot data and may only be examined as objects known to have been recovered from the fort site, and highly likely to have been retrieved from Roman contexts. These comprise 8 recorded lava milling tools.

The bulk of the dataset are of lava objects recovered during the more recent archaeological investigations at Housesteads, most being found in the north-east area of the site where detailed recording was undertaken and comprise 17 objects. These have location data relating to the findspot of each quern, though some of these are more general areas of the excavation zone and do not relate to specific contexts or archaeological features. There were 10 querns that had associated

Table 19- Breakdown of the data in terms of stone part and milling tool type.

	Upper stone	***Lower stone***	***Unidentified***
Quern	5	5	1
Millstone	2	1	0
Unidentified	0	0	11

context data, 6 with general location information, and one unprovenanced object. Many of the querns from this data group were heavily fragmented and non-diagnostic showing that most material must have been retained, while also providing a picture of the volumes that may have been discarded and not recorded in earlier excavations. They also allow for a general view of lava quern distribution of a sample of the site area to be examined. Of these, 12 were recorded in person at the archive, while a further 5 were taken from the published excavation monograph for the site compiled by Welsby (2009), which provides detailed descriptions for the lava querns recorded in the catalogue. These were cross-referenced with the lava recorded in person to ensure that none were duplicated.

Overall, the data includes 6 lower stones, 7 upper stones and 12 unidentifiable groups of fragments, totalling 25 (table 19). Of these, 3 might be identified as millstones/large querns, 11 as querns, with a further 11 that could not be identified as either due to an inability to accurately measure or estimate the diameter of the stone.

Manufacture

Diameter of Stone

Stone diameter could be measured or estimated for 13 stones in the dataset, 3 of which could be identified as either small millstones or large sized querns due to their diameters, with 10 clear examples of querns. The possible millstones did not retain any features that might be related to the method of their use. However, as the three milling tools all have a diameter of 500mm or more, they will be treated separately. For analysis purposes, they will be assessed alongside the millstone data for Britain. The Housesteads quern diameters can be seen in figure 174, which also shows the diameters for all British lava querns with the upper and lower quartiles for this dataset.

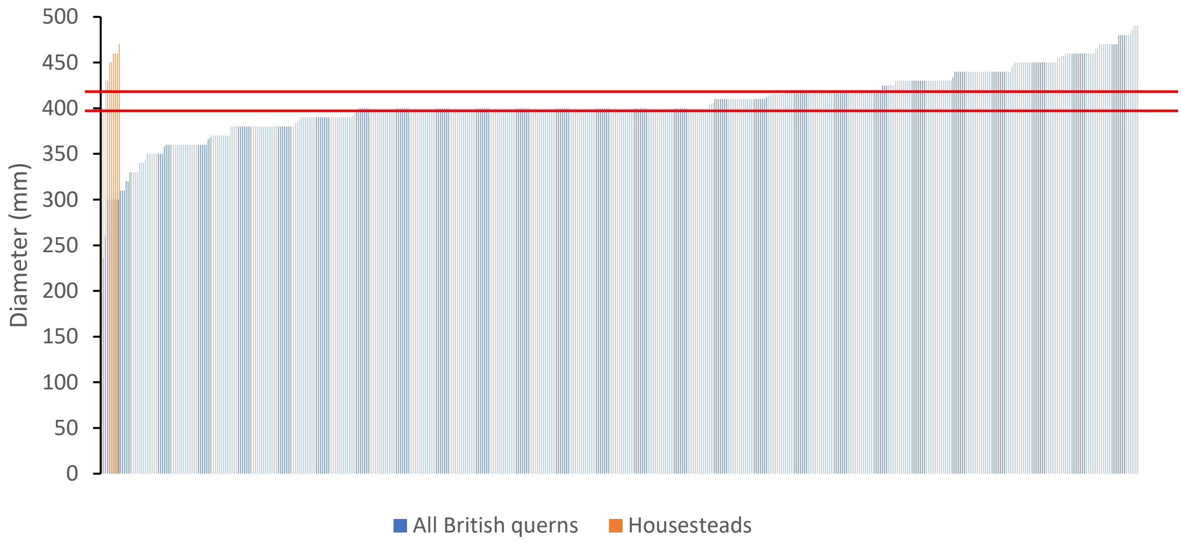


Figure 174- Chart showing the diameters for lava querns from Housesteads (T=10) compared with those from the whole of Roman Britain (T=553). The upper red line indicates the upper quartile, the lower indicates the lower quartile for diameters in the British dataset.

As has been discussed in Chapter 4, there is a high level of standardisation in the size of lava querns imported into Roman Britain and this is visible in the proximity of the lines that show the upper and lower quartiles for the British dataset. The Housesteads data presents a clear deviation from this, being larger than the normal range. The extent of this deviation is shown in table 20 which examines the differences in the upper and lower quartiles for the two datasets. It shows that for the British dataset, 50% of querns are sized within the range of 400-420mm, while at Housesteads the figure is for 423-460mm. Some consideration needs to be given to the size of the dataset from Housesteads, as occasional large values are more likely to skew the results upwards. However, there are no unusually large diameters represented. Only two of the querns fit into the normal range for British quern diameters, with the majority larger than 420mm.

Quern Diameter (mm)
400
400
430
430
450
450
460
460
460
470

	British dataset	***Housesteads***
Lower quartile	400	423
Upper quartile	420	460

Table 20- Upper and lower quartiles for quern diameter at Housesteads compared with the full British dataset.

Though the sample size is relatively small, the results need to be reconciled with the pattern of diameter size seen at other northern military sites. There are practical reasons as to why querns may have been larger at military sites in general, and at Housesteads specifically. As communal objects that are likely to have been shared within a unit of soldiers, they were required to process large volumes of grain. This differs from the assumed traditional role of the household quern, used for everyday domestic food preparation. A larger surface area would increase the rate of flour production, and the large garrison size at Housesteads in the earliest phase of occupation may have secured the largest querns for its troops. Whether the larger diameters observed here would have made a significant difference when compared with those 30-70mm smaller is a question worth addressing using experimental archaeology, yet the clear variability across site types suggests that there was a reason why this occurred.

The two smaller millstones in the assemblage are only 30mm larger in diameter than the largest quern in the assemblage. This means that the clear differentiation between millstones and quern stones that exists within the wider British dataset is more difficult to identify at Housesteads. This is like the pattern seen at Silchester (Chapter 6), where it is possible that larger lava querns, or smaller animal powered mills were in use to enable large scale processing without the use of watermills. This research has defined lava millstones as predominantly being 500mm in diameter or larger (see Chapter 4). Therefore, the 'millstones' at Housesteads are some of the smallest in the whole British dataset, being 500mm, 500mm and 510 mm. Considering the relatively restricted space inside the fort at Housesteads due to topography, and the difficulties associated with water sources at the fort, small human or animal powered millstones may have provided a solution the problem generated by a large population and limited centralised processing capabilities. One would imagine that the military community had privileged access to forced labour or beasts of burden, if these were necessary to keep the garrison functioning smoothly. However, as there is no current evidence to suggest that these were operated as millstones, either on the stones themselves or in terms of structures associated with mills, an interpretation that these were larger sized querns should be considered most likely. In depth analysis of lava milling tools at other northern military sites needs to be carried out to see if similarly larger sized stones present handle fittings, as these would prove that these were hand operated. This would suggest a different standard of quern existed at northern military sites when compared to southern (non-military) sites.

Kerbs and Handle Fittings

Kerbs and handle fittings only occurred once each across the assemblage and as these features occur together on one example, it is best to discuss them together. Both a kerb and handle fitting are present on CAT 2284, which is the best-preserved upper stone recovered from Housesteads. The kerb is wide at 70mm and is also very shallow standing only approximately 1mm proud of the upper surface. Although the stone has been considerably weathered, the upper surface dressing is still clearly visible meaning that the shallow kerb is unlikely to be the result of post depositional damage and was part of the original design of the stone. There is no elbow handle socket, and so the combination of a shallow and wide kerb with the absence of the elbow handle appears to coincide with what has been observed previously, specifically that the kerb may not have been required on this style of quern due to the absence of the elbow handle fitting that required extra reinforcement of the edges (see Corbridge, this chapter). The kerb lacks the properties needed to make it a functional characteristic, and its continued addition may have been a reference to previous styles, or other quern types that were in contemporary use.

The handle fitting is instead formed from an iron band wrapped around the circumference of the stone near to the upper edge (figure 175), which is still clearly visible as corrosion product. The handle itself is not distinct, but a concentrated area of corrosion product could indicate where this may have been and analysis using x-ray would have the potential to further identify the feature. This example of an upper quern stone with an iron band handle fitting and no evidence for an elbow handle socket provides further evidence for a previously unidentified lava quern type that is archaeologically less visible than the types previously recognised. There can be no question that when CAT 2284 was finished, that the intention was to fit it with an iron band handle. The continued addition of a non-functional kerb and the upper surface dressing on CAT 2284 suggest that these querns were still produced at a centralised location, probably at Mayen. Therefore, questions remain as to whether this type of quern can be identified at the quern finishing sites that have been examined in Germany and whether a chronological development can be seen to occur. This could have implications for how we date lava querns from Romano-British contexts and how we understand the lava quern manufacturing process; as a continuous centralised practice, or one that became devolved over time, allowing for alternate types to be produced.

Figure 175- CAT 2284 showing the faint shallow and wide kerb on the upper surface with upper surface dressing (left), and iron corrosion product where the iron band would have been fitted around the circumference of the stone. This can be seen as a wide band above the scale, culminating in a cluster of corrosion product where the handle itself is likely to have been located (right) (photo by author, used with permission from English Heritage).

Dressing.

Surface dressing on the grinding surface was present on 8 stones: 4 upper, 3 lower and 1 unidentified. Of these, all were of the harped style, except for one upper millstone, which was pecked. There is, therefore, some relative consistency in the dressing style for the grinding surfaces of the lava milling tools from Housesteads, perhaps showing that a high level of stone working skill was present at the fort and that there was a uniform understanding of how querns should be dressed. The pecked millstone is an exception, which could relate to its method of operation as both other identified millstones had no visible dressing present despite being well-preserved. However, pecking is much harder to identify on lava due to its vesicular nature, especially on an assemblage that has experienced any surface weathering, as is apparent at Housesteads.

Vertical striae on the quern sides were present on 7 stones, including one upper stone that has been identified as a small millstone. These tooling marks are typical of lava querns manufactured in the Mayen region and could suggest that this example was also produced there, as opposed to the separate millstone finishing area at Andernach (see Chapter 2). The other upper millstone lacks these striae and has well-shaped but rough sides, markedly different to the other example, but has upper surface dressing; another feature of a milling tool finished at Mayen. The reason why different combinations of features are visible on each stone might relate to post-depositional effects of weathering or soil conditions, or the way that they were operated or modified during their use lives. The upper surface dressing is visible on 4 of the upper stones in the assemblage in total.

Distribution

The distribution of lava milling tools at Housesteads could not be established for any objects that had been excavated prior to the 1974 excavations due to an absence of location data. For the 1974-81 excavations in the north-east area of the fort, site zones had been allocated for 12 lava milling tools, while a further 3 had general zones that still allowed for some form of mapping to be carried out. Those without specific zones have been marked differently on the plan. Therefore, 15 lava milling tools have been mapped, which constitutes all objects in the dataset that were recorded for Housesteads and from the 1974-81 excavation years (Crow, 1995). This presents a good sample of data for investigation within a focal area of the site. It should be noted that each object mapped presents the central point within the excavation zone from which the milling tools were recovered and does not relate directly to findspot data. The results allow for a general view of distribution to be visualised (figure 176). Locations of the bakehouses, ovens and granaries have also been added to this plan, as these are structures and archaeological features that relate directly to the preparation and storage of grain and may help with interpretations relating to the distribution of milling tools.

As has been previously discussed, the bakehouses and ovens for the fort were located in the area of the ramparts and close to the curtain wall. It is assumed that the strategy was to avoid the possibility of setting fire to buildings within the fort by minimising burning in built up areas and is a common arrangement seen at other forts across the empire (Hajnalová & Rajtár, 2009, p. 204; Hatherley, 2020, pp. 29-30). From evidence elsewhere at Housesteads, the pattern seen in the north-east corner of the fort with bakehouses and ovens on either side of the angle tower is repeated at the other corners of the curtain wall, showing that the layout was designed and probably related to policy. Though the precise arrangement and number of ovens and bakehouses did not remain static throughout the period of the fort's occupation, each renewed layout was relatively similar to the one that preceded it. The area of the ramparts must have been an area where food preparation occurred daily, and the role of this area apparently continued throughout the life of the fort.

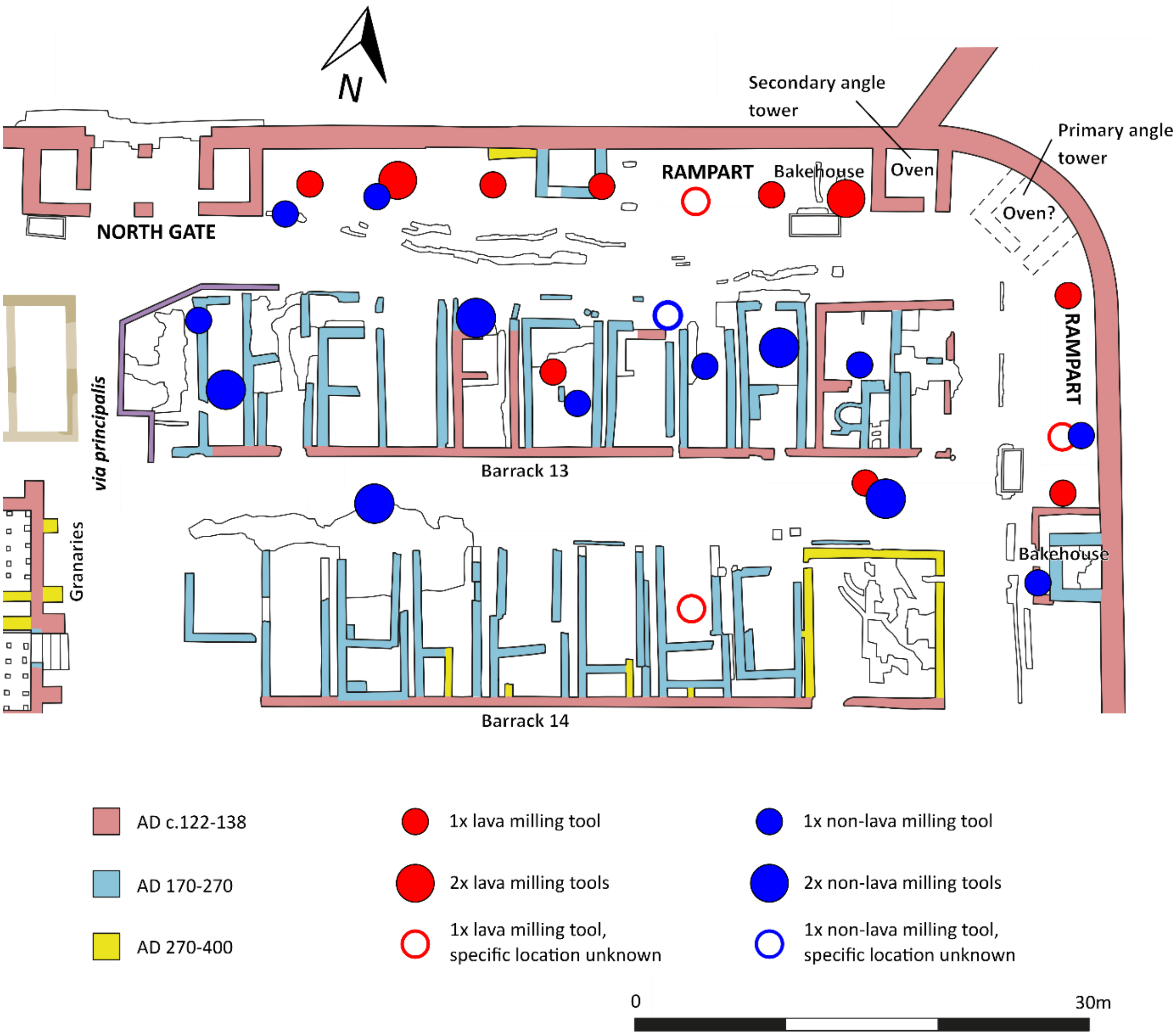


Figure 176- Phased plan of the north-east area of Housesteads Roman fort showing the placement of bakehouses, ovens, and granaries. The general locations where lava milling tools were recovered are shown in red, with non-lava milling tools in blue (plan after ©English Heritage).

Using this information, the distribution of lava milling tools at the site suggest a correlation with these food preparation areas. Care must be taken when interpreting findspot information, as milling tools may simply have been deposited in this area as it provided a convenient location at the outskirts of the occupation area. Secondary deposition is also highly probable. However, the distribution analysis suggests a strong association between quern deposition and the locations where grain products would have been cooked. Of course, querns need not have been used so close to ovens as flour can easily be moved. Nonetheless, the possibility that food preparation, including grain processing, took place in the area of the ramparts should be considered. This possibility has been noted at other fort sites in Britain, for example at Doune, Scotland, where high numbers of amphorae and mortaria were found in the rampart areas compared with other parts of the site, which also indicate that this was an area for food processing (Hatherley, 2020, pp. 19-20). The fort at Housesteads had restricted occupation space due to the topography of the site, despite having a large population of troops when fully garrisoned. It is likely that grain was being ground almost continuously to accommodate the needs of the troops that probably worked in shifts and relied on grain as a large part of their diet. Everyday domestic activities, such as grain processing, may have required designated areas to maintain discipline and manage the limited space available. Being away from the main routes through the fort and the central range, the ramparts may have been the best place for such activities and conveniently close to the ovens and domestic areas to similarly reduce traffic and movement across the fort.

As a further way to explore the deposition observed for lava, the 19 published non-lava milling tools were also plotted on the same plan to see if a similar pattern existed. Interestingly, the non-lava show a very different distribution, being mainly clustered in and around barrack 13 where very few lava querns were recovered. Several of these were found consolidated into floor surfaces, one was reused in a wall, and one in a threshold. Interestingly, very few milling tools of any type were recovered from barrack 14, and this absence provides a second feature of the data that requires some thought. Initially the matter of chronological change in quern types should be considered. If lava is assumed to be the earlier choice of milling tool, the non-lava querns are indicative of querns that were in sole use during the later periods of occupation, but may also have been used simulataneously alongside the lava in earlier periods. Table 21 shows the chronological distribution of the lava and non-lava querns. To visualise the data better, the chronology of deposition for different stone types is presented in figure 177. This suggests an earlier start date for the depoistion of lava, but a peak in all querns being deposited in phases III and IV, these being the chalet phases of the fort. The evidence suggests that this may have been the result of redeposition, causing the mass movement of broken querns to suitable reuse or disposal locations at a time when major refurbishment works were being undertaken. This helps to explain the reuse of non-lava querns within structures and floors in barrack 13, but does not help interpretations relating to the different way that lava and non-lava milling tools were treated in terms of the location of their deposition.

Table 21- Chronological distribution of milling tools of lava and non-lava types.

Site phase	**No. lava milling tools**	**No. non-lava milling tools**
I	0	0
II	1	0
III	3	6
IV	4	6
Post-Roman	1	5
Undated	1	5

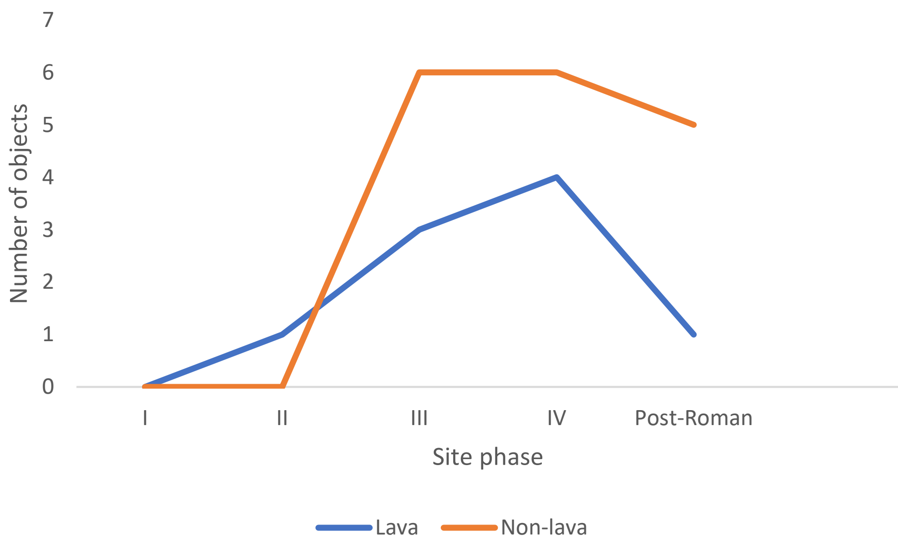


Figure 177- Chart showing the chronological change in lava and non-lava milling tool deposition in the north-east area of Housesteads fort (T=26).

Possible explanations for the difference in the distribution between the lava and non-lava milling tools vary. For example, at the time when the barracks were remodelled into the chalet format all rubbish from the inside of the buildings, including broken and discarded lava querns, could have been removed and dumped onto the nearby rampart area. If lava was not considered as a suitable building material due to its physical properties, it may not have been reintroduced into the areas of habitation as recycled stone. This may also reflect different or changing deposition practices and meaning attached to different stone types, or to milling tools in general if indigenous stone types overtook the use of lava in later periods. It is also possible that the chalet phase of the barracks is indicative of the introduction of greater privacy and separated living conditions for soldiers to that provided by the preceding barracks. Previously communal activities, such as grain processing and food preparation, may also have become more of an indiviudal affair, occurring in the privacy of individual chalets instead of the rampart areas. This would result in different use locations for the lava and non-lava milling tools and possibly result in different deposition sites as a result. However, none of these possible interpretations explains the prevalence of milling tools deposited in and around barrack 13 and their absence at barrack 14.

Primary Use

Thickness of Upper Stones

The thickness of only 4 upper stones could be measured, providing a very small sample for analysis (figure 178). Two of these were from the earlier excavations and were probably selected for retention due to their larger size. The other two were from the 1974-81 excavations, and although this might make them more representative of quern wear at the fort, they were the only upper stones that had survived as more than tiny fragments. It is likely that the most heavily worn quern stones deposited at the site have not survived, leaving only the larger and thicker examples that may not be characteristic of typical wear. Overall, the analysis does not produce any conclusive results because of the small sample size, but it is interesting to note that two of the querns are thicker than that of 50% of the upper lava querns from the whole British dataset. As the other two examples fall in with the normal range for quern thickness, it is not possible to state that the assemblage is particularly unusual. However, there has been a continuing pattern of thicker lava querns recovered from military sites, and this is also visible in the data for the upper stones from Housesteads.

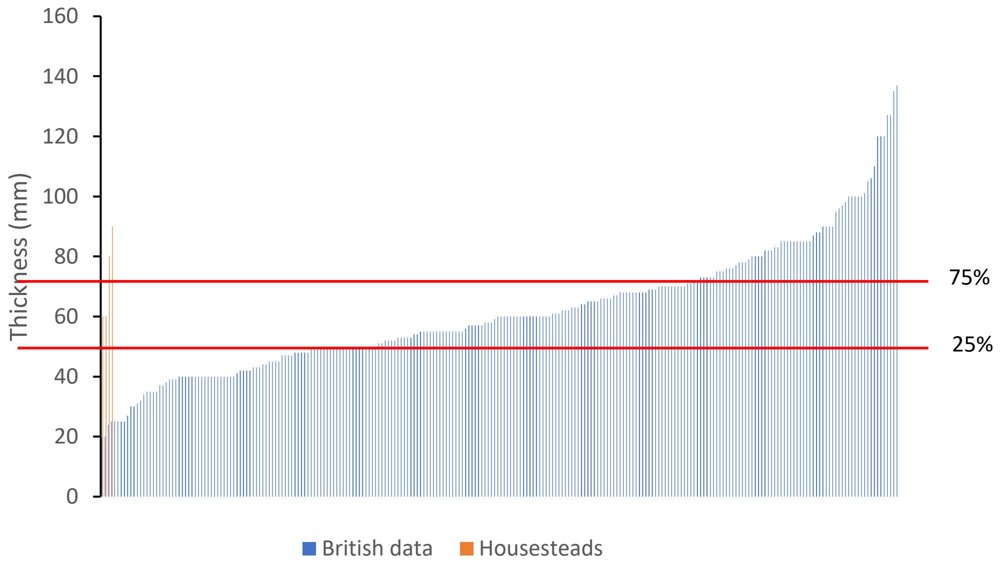


Figure 178- Chart showing the thickness for upper lava querns from Housesteads compared with those from the whole of the British dataset excluding those from the site at 1 Poultry. The 25th and 75th percentiles for the British data are marked with red lines.

Lower Stone Thickness.

There were 4 lower stones from the Housesteads assemblage that had measurable thicknesses, one of which was from the 1974-81 excavations and 3 from the earlier projects. A similar issue to that with the upper stones is, therefore, also present in this dataset. The results of the analysis can be viewed in figure 179. The outcome of the analysis presents similar issues and results to that seen with the upper stones, with two of the stones being thicker than 50% of the lower lava stones in the British dataset, and two that are within the 'normal' range for thickness. Similar conclusions can, therefore, be drawn and there is some indication that Housesteads follows the same pattern for stone thickness as seen at other military sites.

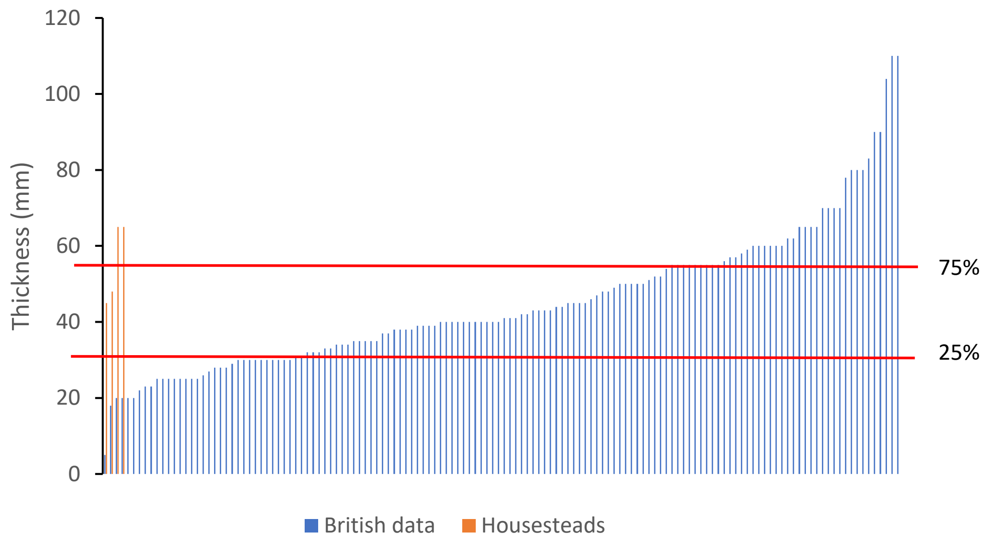


Figure 179- Chart showing the thickness for lower lava quern stones from Housesteads compared with those from the whole British dataset excluding those recovered from the site at 1 Poultry. The 25th and 75th percentiles are shown with the red lines.

Secondary Use/modification

Reuse of lava querns, other than that associated with deposition, can only be speculated on for one example, CAT 2269, and this interpretation has been drawn from its context. This was a complete upper stone that was found next to a tipped-over stone mortar and may have been used as a lid (Welsby, 2009, p. 356; p. 355, fig 12.9D) (figure 180). This stone was not available for examination at the time of data collection and was included in the dataset using information taken from the site monograph. Unfortunately, no description of the object has been published as it was not seen by the author, Welsby (2009), at the time that the quern catalogue was complied. This means that if any modifications had been made to the stone to facilitate its reuse, they have not been identified. Such observations might support the evidence for possible reuse; large mortars often had a wooden lid with a hole, which would secure the position of the large wooden pestle. Reuse of a quern in this format would work well as a replacement lid and serve a similar purpose (Shaffrey, pers. comm.).

Figure 180- Site photo of mortar, with a glimpse of the upper lava quern CAT 2269 that has been interpreted as reused as a possible lid (Rushworth, 2009, p. 355).

In terms of querns that had been modified, one lower stone (CAT 2288) may have been altered at the sides and lower surface in a similar way to that of lower stones seen at Corbridge (this chapter) and Verulamium (Chapter 6). The edges on this stone were rough and irregular with no sign of vertical striae, showing that they may have been reworked. However, this is less convincing than some of the other examples identified. There were two upper stones that may have been modified from the original manufactured specifications, CAT 2284 and 2267. The first of these is the best-preserved upper stone in the assemblage and has been discussed in the previous section on manufacture. It retains an iron bar that has been fitted into the upper surface bracing the central hole; one side of the bar has been bedded into the stone, while the other side is fixed into position using an iron loop that is fitted into the surface with lead (figure 181). Addition of the bar has interfered with the kerb, indicating that this is a later addition to the stone and occurred post-manufacture. The central hole itself has been widened and this has not occurred through wear suggesting that it was also adjusted deliberately. This process has removed the rynd chase, suggesting that the iron bar was added to replace the rynd component of the mechanism. The bar must, therefore, have functioned as the rynd and provided the pivot for the spindle. As the bar is moveable on one side within the iron loop, this may have been designed to alter the angle of the grinding surface as a method of tentering the stone. Although this provides one possible explanation, experimental work and further examination of the upper stone may produce alternate interpretations. After seeing a complete upper stone with the iron bar fitting *in-situ*, it makes it easier to identify other stones that may have been similarly modified. One example includes CAT

2267, a small fragment of upper stone that has a ‘shallow oval depression’ in the upper surface that may have accommodated one side of an iron loop like that seen on CAT 2284.

Figure 181- Upper stone CAT 2284 that has an iron bar fitted into the upper surface as a possible modification of the original manufacture design. The upper image shows the widened central hole that may have removed the original rynd chase. The end of the iron bar that is fully bedded into the stone has interfered with the kerb. The opposite end is held in place with an iron loop that allows for the bar to be adjusted and may have altered the angle of the upper grinding surface. The iron loop is fixed into the stone via two holes in the surface which have then been filled with lead (photo by author, used with permission from English Heritage.

Deposition

Context of deposition was recorded for 7 of the lava querns recorded from the 1974-81 excavations in the north-east area of the fort. Of these 3 were recovered from rampart deposits and had been incorporated into the feature. A further 2 were in deposits of rubble, while the last 2 were incorporated into road surfaces near the eastern rampart. The querns included in rampart deposits may have been redeposited and been discarded at the outskirts of the occupation area or relate to activity areas where food processing took place. The number of lava querns recovered from the area of the ramparts suggests that they had been deposited in this part of the site deliberately, but any meaning is difficult to extrapolate from such evidence. The querns were not subject to any specific treatment that would suggest ritual practice. Lava querns have been frequently associated with deposition in road surfaces at military sites and the two occasions of this at Housesteads correlates with the wider dataset of Roman Britain.

Vindolanda

Introduction and Site Background

The fort of Vindolanda is one of the most famous Roman forts in the country, with some of the best preservation conditions known from within the empire (Bidwell, 1983; Birley, 2009; Bowman & Thomas, 1994). The fort is, in fact, probably nine different forts, each constructed in the same location with slightly different layouts and seemingly to suit slightly different purposes. Associated with this is an extramural settlement that is thought to have had official *vicus* status from the third century AD (Birley, 2009, p. 153; Birley, 2016, pp. 225-226). Initial construction pre-dates Hadrian's Wall and is estimated to have occurred *c.*AD 85. The site is slightly south of the later Hadrianic frontier, though it probably formed part of the first defended frontier in the region as delineated by the Stanegate. Troops stationed at Vindolanda may have been involved in the construction of the Stanegate road and its associated series of structures, separated by distances easily covered in half a day's march (Historic England, 2019; Breeze & Dobson, 1987; Edwards & Breeze, 2000).

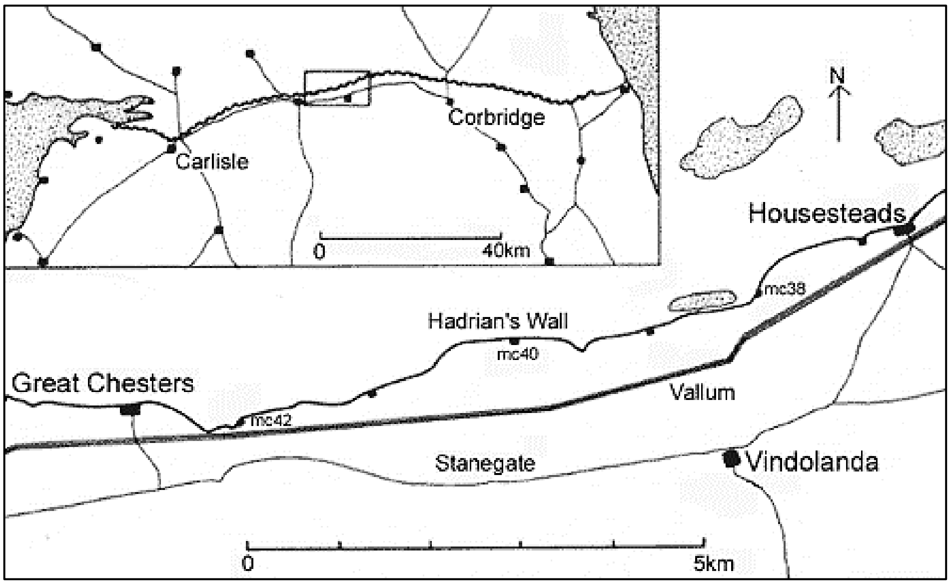


Figure 182- Map showing geographical location of Vindolanda and its relative position to other Roman period frontier fortifications (image used with permission from the Vindolanda Trust).

The location of Vindolanda highlights why the site had continued significance throughout the Roman period, even after the movement of the frontier to Hadrian's Wall; situated almost halfway between Newcastle and the North Sea to the east, and Carlisle and the Irish Sea to the West (figure 182) (Birley, 2009, p. 13), the fort was probably a strategic midpoint for the centralised distribution of people and goods. The administrative writing tablets recovered from the site that record such movements appear to confirm that this may have been the case; at least in some periods of the fort's occupation (CSAD, 2019). Food and supplies may have been transported more easily by sea, but these would then have to make their way inland by river and road to ensure continuous supply to those stationed away from the main navigable waterways. Vindolanda was relatively well-connected by water and road, and was centrally located to serve eastern, western, and northern supply routes. That the site was located away from the frontier in later periods would also have provided greater security; there would be less chance of supplies or back-up troops being compromised by incursions of 'barbarians.'

Although current interpretations identify the earliest phase of occupation at Vindolanda to date from *c.*AD 85, the possibility of an earlier Flavian fort has been speculated on from aerial photographs that show a possible fort structure to the northwest of the later forts. Yet unconfirmed, the site may have provided a temporary camp for troops undertaking construction work in the area (Birley, 2009, pp. 42-45). The first confirmed fort, dating from *c*.AD 85-92 was constructed in timber and was primarily occupied by troops from the *Cohors I Tungrorum* during this period, though 337 of the 752 strong cohort were away at Corbridge (Birley, et al., 1993, pp. 4-9). Demolition of the early fort and reconstruction work on a second timber fort occurred *c.*AD 92-100/103, which coincided with the backfilling of pre-existing ditches to allow for expansion of the fort's site (figure 183). The military bathhouse may also have been built in this phase. Expansion was to the west of the preceding fort and the extent of the western defences in this period are yet to be established. This period probably saw continued occupation by the first cohort of Tungrians, who were followed by the ninth cohort of Batavians (Birley, 2009, pp. 45-62), who were originally from regions in and around Belgic Gaul and Germania.

The third timber fort dates to *c.*AD 97-105 and was probably a reconstruction of the previous fort through refurbishment and modification. This was completed using better quality materials and building methods and was built directly above the period 2 structures. The end of the period saw the reassignment of the entire cohort to Dacia with the subsequent demolition and destruction of the site and its contents. Large volumes of equipment, administrative and personal writing tablets, tools, and other items were dumped or burnt when the occupants of the fort departed. There is, therefore, a wealth of finds relating to this period, with written evidence to further enhance interpretations of these finds (Birley, 2009, pp. 63-90). It is from the tablets that we know that the part- mounted ninth cohort of Batavians were stationed at Vindolanda during this period, comprising over 1000 men (Birley, et al., 1993, pp. 7-9). We also know that their prefect was Flavius Cerialis, and that his wife, Sulpicia Lepidina, also lived at the fort (Birley, et al., 1993, pp. 38-39); it is these details that have enhanced our knowledge of the social and administrative lives of those who

Figure 183- Plan of the excavated area of Vindolanda showing the locations of the different period forts. The period 1 fort is outlined in red, period 2 and 3 in green, and the probable locations of period 4 and 5 are shown in blue. The third century stone fort and associated buildings is outlined in black (after Birley, 2009, Plate 6).

occupied the fort at this time. The seemingly hurried departure of the cohort has preserved many finds *in-situ*, and it has, therefore, been possible to determine the probable functions of buildings and rooms using the objects recovered from them. For example, small room VIII was likely a kitchen; it had two small bread ovens and tablets discovered in a rubbish pit contained recipes and crockery inventories (Birley, 2009, p. 77). This provides a unique opportunity to potentially explore the socio-economic roles of objects within their context of use. However, it must not be assumed that all finds were deposited in use locations, as many were intentionally gathered together and relocated to be dumped or burnt (Birley, 2009, pp. 72-73).

The *praetorium*, and possibly the whole site was deserted for a few months after the departure of the Batavians. The first cohort of Tungrians returned to Vindolanda later in AD 105, though other detachments of auxiliaries and legionaries appear to have been also stationed there at different times after this until AD 120. A new timber fort was constructed to a different plan to the last layout and may have been considerably larger. Unfortunately, areas beyond the fort have not yet been explored for this period, but it should be assumed that its reach was extensive and accommodated a large population of non-military persons. The fifth timber fort was likely to have still housed the first cohort of Tungrians with construction commencing after *c.*AD 120, though it is very probable that there were also legionaries and other wall builders stationed there. Most of the features and structures from this period have been destroyed by the subsequent stone fort developments, though the remaining evidence demonstrates that the period 5 fort was well-built with a heavy stone flag floor. Industrial activity is evident within the fort, and this may be linked to the probable vital role of Vindolanda in supplying the Wall construction teams with building supplies, food, and clothing. After AD 128, the Tungrian cohort were likely moved to the newly built Housesteads fort, and Vindolanda was empty for a few years (Birley, 2009, pp. 64-91).

A primary stone fort, stone fort 1, that saw the return of troops to Vindolanda can be dated to *c.*AD 130-213. The precise size of the fort is not yet known, though both the western and eastern walls lie under, or were incorporated into those of the subsequent construction of stone fort 2. A military bathhouse and the western temples have also been assigned to this period, along with an elaborately designed and ornate *principia* with similarly elaborate extramural stone buildings. Most of these major changes are thought to have occurred around AD 184. Nearer the end of the period, stone-built circular huts were constructed. These were clustered in groups of 10, and though their precise function remains unknown, they may have had domestic functions from the hearths discovered within them (Birley, 2009, pp. 135-140). These have been interpreted by Bidwell (1985, pp. 28-31) as being self-built structures by forced labour, a suggestion that has been supported in a discussion of the evidence by Webster (2005, pp. 171-172).

Stone Fort 2, which forms the most visible remains at Vindolanda, must have taken several years to complete and was in use from *c.*AD 213-300. The change from a southern-facing headquarters, to one that faced northwards also indicates an alteration in the role of Vindolanda as a frontier outpost, instead of overseeing the Tyne Valley below. The end of this period may have seen a few years of disuse for the fort. Reconstruction works occurred around AD 300, when the size of the garrison may have declined, while the extramural settlement seems to have been abandoned by the fourth century. Reconstruction occurred again in the last quarter of the fourth century, with the granaries converted to living quarters after AD 400. Parts of the *principia* were also converted into accommodation. However, less detail is known about this period, mainly due to disturbed deposits and a lack of suitable datable material (Birley, 2009, pp. 141-168).

The Dataset

There are 174 querns from Vindolanda, of which 59 are of lava. Of these, 48 were examined and recorded in-person, while the remaining 11 were added using publications; two from Collingwood & Wright's (1992) section on worked stone in the 'Roman Inscriptions of Britain', with the remainder extracted from the Bidwell (1983) excavation report. Of the 115 non-lava querns, 80 were recorded in person by Ruth Shaffrey, one was taken from Collingwood & Wright and 34 from Bidwell. It should, therefore, be noted that there will be some disparity in the detail of recording, as the published accounts had a different focus from the research questions addressed here. It is also acknowledged that there are probably many querns that were unavailable during the recording stages; it is likely that these were stored elsewhere or had not been retained. However, the sample size is large enough to produce significant results. Of the 59 lava querns from Vindolanda, 31 are upper stones or probably upper stones, 24 are lower or probably lower stones and 4 are unidentified.

There were some issues regarding the quality of the data available for some of the recorded querns; some were stored outside without context information and there were several in the stores that were no longer labelled. This highlights more general issues that are faced by researchers in terms of how larger finds are retained and archived as these are not uncommon problems relating to querns or other bulk finds, such as building material (Shaffrey, 2006, pp. 3-4). However, these particular examples will not have been recovered from any other site and have been included on this basis. Althought there will be many details that will be impossible to extract from these objects due to the lack of findspot or data, they can be used to demonstrate presence or absence of particular quern types. The missing context information does also mean that there may be non-Roman querns within the dataset. As the extent of occupation at the site after the Roman period cannot be precisely determined, there is a possibility of later objects being present within the finds assemblages. Although many finds recovered from post-Roman contexts are likely to be residual, the absence of context information for some querns makes it difficult to assess each individual example to decide if this could be the case. Although this issue is not expected to be extensive at a predominantly Roman site such as this, it must be considered when interpreting the results.

As part of this study, the non-lava data will not be examined in great detail and its inclusion is to summarily provide a wider context for a more nunaced examination of lava querns at this site. As the main focus, there will be some aspects of data analysis that will only involve lava; though if relevant and practicable, other querns will be considered and added to the dataset. As querns of all stone types are equally important when considering food production, stone supply and demand, socio-economic change and cultural practice, it is possible in a small-scale study such as this to widen the investigation slightly. Lava querns did not exist in a vacuum and the interplay between types is of significant consideration, though this must be done strategically.

Manufacture

Kerbs

Of the 31 upper stone or probable upper stone examples, 24 had kerbs present in the form of an annular raised band around the top surface circumference (figure 184). Two upper stones without kerbs were recorded using information from 'The Roman Inscriptions of Britain'. Detailed descriptions of these objects were not provided, and so the presence of this feature cannot be ruled out. A further five were heavily weathered and degraded, making more subtle features difficult to identify with any certainty. Therefore, it is entirely possible that all querns in the dataset may once have had kerbs, though this cannot be proven. The observations indicate that a high level of standardisation existed across the lava quern assemblage at Vindolanda.

Figure 184- Upper lava quern stone showing annular raised kerb on the top surface (CAT 0014) (photo by author, used with permission by Vindolanda Trust).

Diameter of Stone- Quern vs Millstone.

To investigate whether lava querns could be distinguished from lava millstones at Vindolanda by examining diameters of the stones, the diameters for both upper and lower stones were plotted on a graph (figure 185). This included 20 stones from the assemblage for which this measurement was possible. The results show a clear differentiation between querns and millstones, with querns measuring between 380-470mm, and two millstones measuring 590-600mm. A separate group of slightly smaller querns exists, measuring 350-360mm, though both these diameters were estimated from fragments of querns, which may have produced inaccuracies. The most common diameter for a lava quern at Vindolanda is 430mm, and all other querns (excluding the two small anomalies) were within 50mm of this measurement. A high level of standardisation existed at the fort. The millstones are very clearly separate from the querns in terms of their size, which presents a different view to that seen at Housesteads where this division is more subtle. Perhaps the milling technology was different at Vindolanda, especially considering that it had a more suitable local water supply that could exploited to power a water mill. This would have allowed for larger stones to be turned and less need for the smaller millstones that may have been driven using animal power. Chronology must also be considered, as Vindolanda was occupied before Housesteads and may have been initially using querns manufactured in earlier periods that were more highly standardised and smaller than their successors.

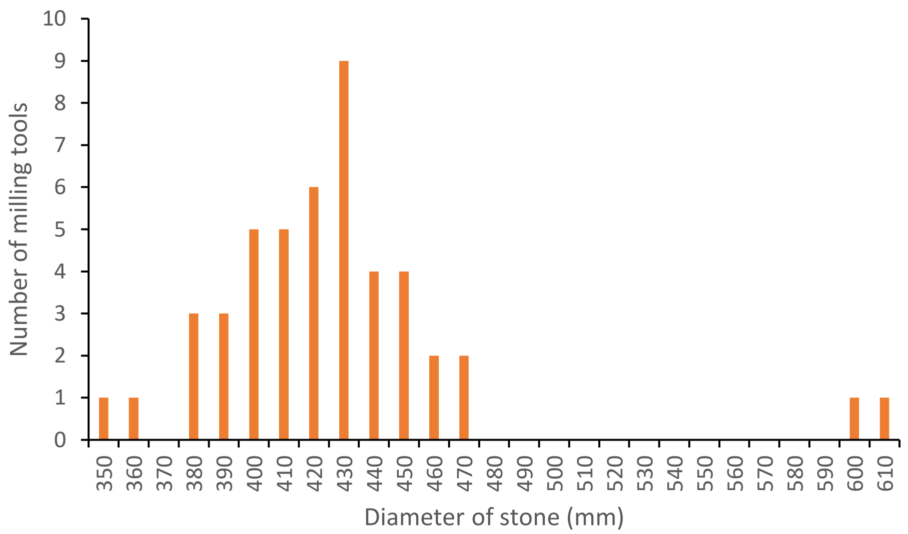


Figure 185- Distribution of all upper and lower stone diameters for Vindolanda lava milling tools, T=20.

Quern Diameter.

As has been identified from the distribution of quern diameters at Vindolanda, a high level of standardisation appears to have existed within the fort. However, it is worth exploring how well this compares with the standardised lava querns from elsewhere in the province. The diameters for the querns from Vindolanda have been plotted on a chart with those from the wider British dataset (figure 186), with the inclusion of lines to illustrate where the upper and lower quartiles for the lava querns from the whole British dataset exist. The upper and lower quartiles for the Vindolanda and British querns have also been presented in table 22. The results show that, in comparison, the Vindolanda querns are fairly representative of those from elsewhere in Roman Britain. They do, however, have a wider range of sizes that are slightly larger than those from elsewhere in the province. The larger size has been found to occur also at Housesteads, though this difference is less exaggerated at Vindolanda.

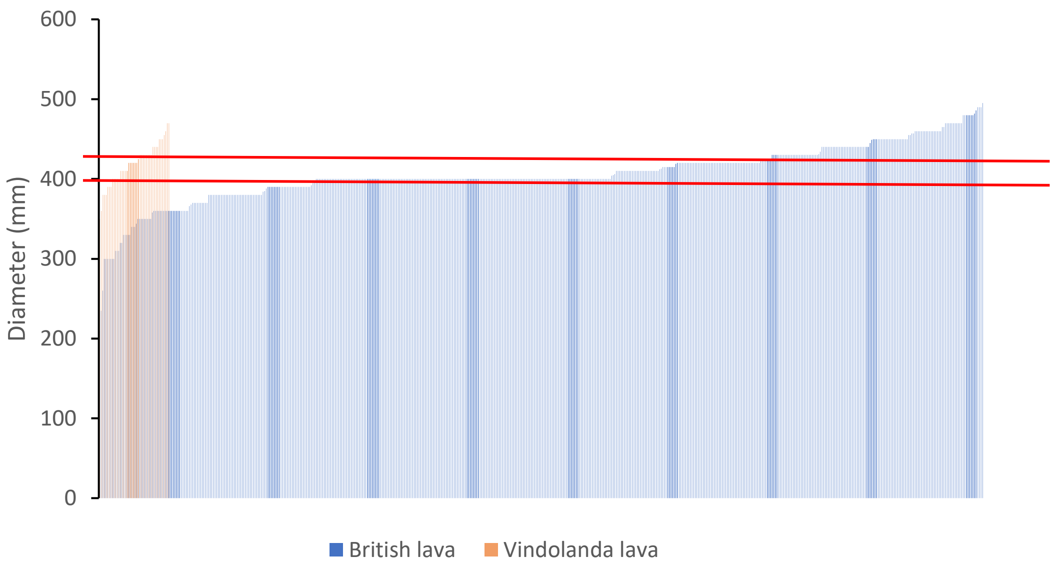


Figure 186- Chart showing the diameters of querns from Vindolanda (T=44) compared with those from the wider British dataset. The 25th and 75th percentiles have been indicated with red lines.

Table 22- Upper and lower quartiles for quern diameter for stones from Vindolanda compared with the wider British dataset.

	Vindolanda	***British dataset***
25%	400	400
75%	430	420

Rynd.

To identify whether there were any features of the Vindolanda querns that do not conform to the standardised types, the shapes of rynd chases were also examined to determine whether the rynd had been fitted to the upper stones in a consistent way. These had to be recorded carefully as wear of the stones can change how the rynd chase appears (figure 187). The most common form of rynd chase is that of a rectangular slot bedded into the upper surface of the upper quern stone that bridges the central eye perforation, which would have housed a flat rectangular bar to provide the pivot for rotation (see Chapter 2). From the 31 upper stones in the assemblage, all 11 that had evidence for a rynd chase were of the same form; that of a rectangular slot recessed into the top surface of the stone (CAT 0001, 0002, 0014, 0017, 0018, 0027, 0029, 0043, 0045, 0048 and 2317). It is possible that modification of this may have occurred on other examples to prolong the use-life of the stone, but this will be discussed in the section on reuse/modification.

Figure 187- Three lava quern upper stones from Vindolanda showing differing levels of preservation and wear. Intact iron rynd in-situ within rynd chase (left, CAT 0002), intact rynd chase with iron rynd removed (centre, CAT 0045) and fully worn rynd chase with absent rynd (right, CAT 0001).

Handle Fittings

Although the wider British dataset has shown that the most common handle fitting was the elbow type, other types of handle fitting may have been in use that are less archaeologically visible, such as the iron band type that has been observed on a quern from Housesteads (CAT 2284) and is likely to have been present on an example from Chesters (CAT 2175), and a further one from Corbridge (CAT 2179). The well-preserved assemblage from Vindolanda provides an opportunity to understand how prevalent these different types may have been across a large sample of lava querns from a military site. Overall, there were 15 upper querns with identifiable handle fittings. Of these, 13 were elbow types (CAT 0001, 0014, 0020, 0025, 0029, 0030, 0042, 0043, 0045, 0046, 0048, 2317 and 2319), with one clear iron band fitting (CAT 0032) and one probable iron band (CAT 0002). CAT 0032 presents a highly fragmented quern that has the remains of an iron band adhered to the outer circumference (figure 188). Fortunately, all parts of the upper stone had been preserved together, allowing for these to be reconstructed. However, it does show how less ideal preservation conditions would make this handle fitting type very difficult to identify on fragmented lava. The other example, CAT 0002 is a complete upper stone that shows signs of wear but has no evidence for the presence of a handle (figure 189). Though an iron band cannot be proven, it is highly probable. This evidence suggests that elbow fittings were the most prevalent type, but that iron band fittings may have been more common than first thought and might be missed due to the difficulties involved in identifying them when querns are in fragmentary form.

Figure 188- Fragmented upper stone with iron band handle fitting (CAT 0032) (photo by author, used with permission by Vindolanda Trust).

Figure 189- Upper quern with signs of wear but no evidence for a handle fitting (CAT 0002) (photo by author, used with permission by Vindolanda Trust).

The other observation relating to handle fittings involves the elbow type, which as described, were present on 13 upper stones. Of these, multiple elbow fittings were present on 6 stones (CAT 0001, 0029, 0030, 0032, 0043, 0048), with a further two where a second handle fitting had been started but not completed (CAT 0014, 0042). As these are later additions to the stones and do not relate to the manufacture process, they will be dealt with in the section on reuse/modification.

Distribution

Spatial Distribution

Unfortunately, due to the type of context information provided for the findspot of the querns, it is difficult to attribute specific locations to many of the objects. However, for 73 of the lava and non-lava querns, it has been possible to determine whether they were recovered from within the fort or from the *vicus.* Of these, 65 were recovered from the fort (89%), with the remaining 8 from the *vicus* (11%). It must be understood, however, that most excavation work has taken place within the area of the fort, with very large areas of the *vicus* still unexplored. This does, unfortunately, make it difficult draw significant conclusions from a comparison of distribution between the fort and the *vicus*. Of the 65 querns from the fort area, 18 were of lava (28%) and 47 (72%) were of other stone types. Within the vicus, two querns were of lava (25%) and the rest of other stone types (75%) (table 23). There is, therefore, little to separate the two areas from each other in terms of the distribution of lava for querns.

Table 23- Number of querns recovered from the fort compared to the vicus, with a further breakdown of the lava and non-lava examples.

	Lava	***Non-lava***	***Total***
Fort	18 (28%)	47 (72%)	65 (89%)
Vicus	2 (25%)	6 (75%)	8 (11%)

Chronological Distribution

In terms of chronological distribution, there were 85 querns with context data that allowed for them to be allocated a site period. The number of querns from each site period was plotted (figure 190) to obtain an overview of the distribution of all querns over time. In total, there were very few in the earlier periods, increasing slightly in period five and peaking in period seven, to fall away again in period nine. Although it might seem reasonable to assume that this relates directly to the level of food production and grain processing activities taking place at the site, it must be remembered that period six saw the construction of the first stone fort, with a second built-in period seven. The querns recovered from Vindolanda often occur within construction contexts; incorporated into foundations, flag floors or road surfaces (see analysis for re-use). Therefore, the querns assigned to these periods were not necessarily in use during that particular date range; they may simply have a higher chance of recovery as these periods and locations have been heavily researched and excavated and because the querns were deposited in areas and at periods when stone was more extensively used in construction. It seems unlikely that grain was not processed in the earlier periods. The high level of period six or seven querns could also be due to the recycling of stone for building projects, incorporating querns disposed of in previous periods.

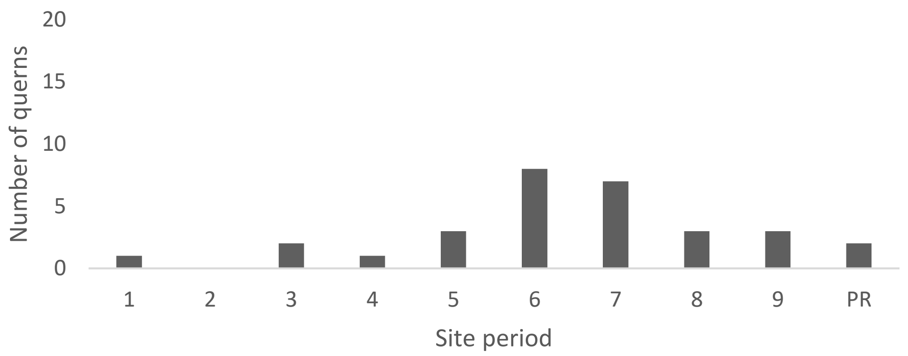


Figure 190- Chronological distribution of lava querns, T=30, by site period at Vindolanda.

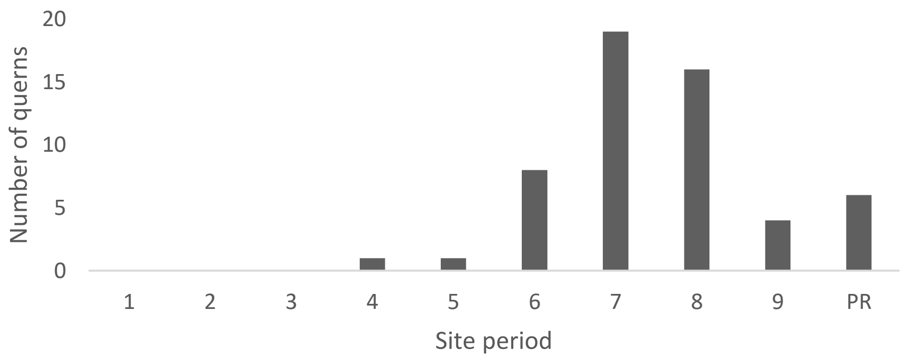


Figure 191- Chronological distribution of non-lava querns, T=55, by site period.

Interestingly, when examining the difference between lava and non-lava types by chronological site period (figure 191), there are differences visible. Although the quantities are very small, there is a presence of lava querns at Vindolanda from the earliest period onwards. This gradually increases in period five, peaking in periods six and seven to fall away again in the later phases. There are no non-lava querns present until period four and five, increasing in period six to peak in period seven and eight before falling away. The overall number of lava querns is much smaller than that of other stone types, though the trend in numbers indicates a much earlier commencement and peak in use when compared to the non-lava querns. Interestingly, the non-lava querns peak as the lava begins to drop away, indicating that indigenous stone types may have begun to replace the imported querns. Unfortunately, due to the nature of the context information for the site and the difficulties involved in defining social context, there is very little data that can be used to explore more detailed social distributions.

Primary use

Wear Traces

There are many ways that use-wear analysis can be applied to the assemblage, but these predominantly rely on access to complete upper and lower stones, preferably as working pairs. Although there is one possible pair (CAT 0047 & 0048, figure 192), there are no others to compare them to. Furthermore, the extent of mending that has been completed on this quern, in the form of new handles being added will have resulted in changing movements in the use of the quern. Consequently, earlier wear traces will have become obscured by those that followed after each phase of mending. The lower stone does have differential wear, and this can be interpreted as being a quern that was used in a fixed position. The heaviest area of wear on the upper stone is between the original and second handle-hole, though heavy wear continues after the original handle. This shows that it was mainly rotated in the anticlockwise direction, probably using the right hand (figure 193), and the range of movement appears to have been the same when either handle was in operation. Similar observations can be made of two other upper stones (CAT 0045 & 0001), both of which are also complete examples.

Figure 192- Possible pair of lava quern stones (CAT 0047 & 0048). A higher degree of wear can be observed on the top stone (photo by author, used with permission by Vindolanda Trust).

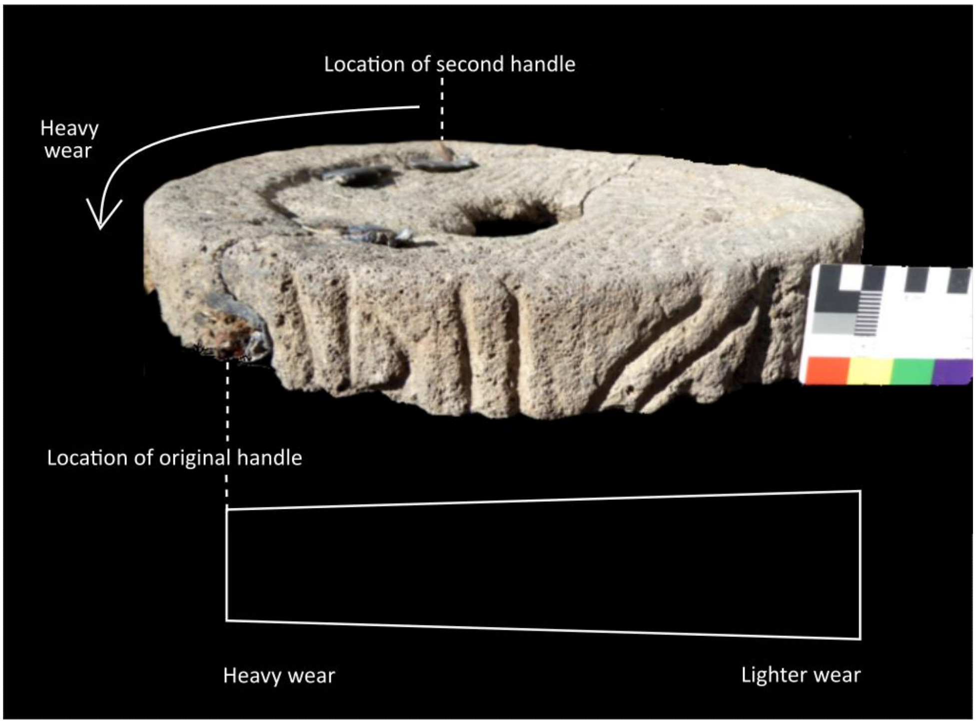


Figure 193- Upper quern stone (CAT 0048) showing heaviest wear after the original handle, showing it was probably rotated in a clockwise direction (photo by author, used with permission by Vindolanda Trust).

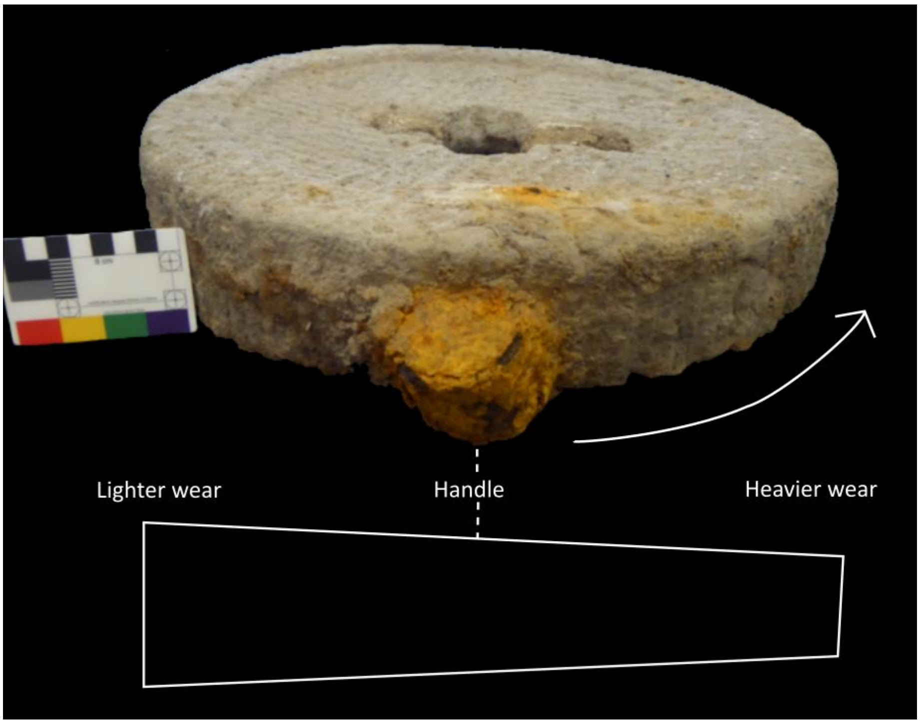


Figure 194- Quern upper stone with wear traces showing the direction of movement when in use (CAT 0045) (photo by author, used with permission by Vindolanda Trust).

There was one complete upper stone that showed even wear and a similar thickness of stone for the whole circumference (CAT 0002, figure 194). The maximum thickness of this stone was 61mm, and only deviated from this by 4mm the whole way around despite a moderate level of degradation. This quern did not have a handle slot, though it had clearly been used and had worn down from an original thickness that would have been approximately 100mm. This stone is the example that is likely to have been fitted with an iron band handle. How this addition may have affected the operation of the quern is not fully known, but the even wear suggests that this occurred differently to querns with an elbow handle.

With regard to lower stones there were more complete examples within the assemblage compared to upper; seven showed signs of uneven wear, while two were evenly worn. This indicates that querns were often used in fixed positions at Vindolanda, and less often moved. There is one example of a lower non-lava quern recovered from the site that was fixed into a bench to maintain its position while in use (Bidwell, 1983, fig 29). Roman period querns from other sites have been found set into the floor, and this appears to have been a common occurrence (Cool, 2006, p. 74). The prevalence of complete examples in the dataset could be related to this method of fixing the stone into the floor and a higher chance of their recovery as a result. These may have been more likely to have remained in place once they ceased to be used, as was seen in the previously mentioned example that was set into a bench. Lower stones that were not fixed are more likely to have been disposed of in areas away from the main buildings of the fort complex, and are less likely, therefore, to have been found in excavations targeted at the fort itself.

Quern Thickness

Upper Stones

A total of 13 upper stones from the assemblage could be measured for thickness, and these are shown in figure 195, which also presents the thickness for upper stones from all lava querns recorded in Roman Britain, excluding those from the site at 1 Poultry. The upper and lower quartiles for the British data are also indicated using red lines as a further means for comparison. The results show that many of the Vindolanda querns fall within the same range for thickness as 50% of those from the rest of Roman Britain; only one falls below, and eight are in the upper quartile for thickness. This shows that the quern stones from Vindolanda are typically thicker than those from elsewhere in Roman Britain, emphasised further in the data table for figure 195, which shows the upper and lower quartiles for the upper quern stone from Vindolanda compared with that of the British dataset. This follows the pattern seen at other military sites and probably relates to the better access to replacement querns that the military had, alongside the premature dumping of material during fort abandonment phases, such as the one that occurred at Vindolanda around AD 105.

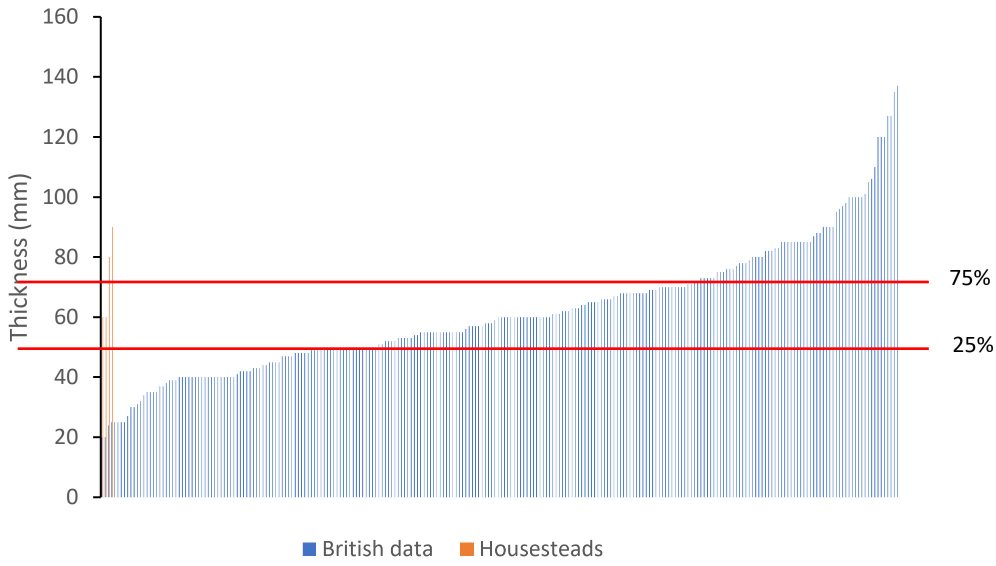


Figure 195- Chart showing the thickness of upper quern stones from Vindolanda compared with those from all Roman Britain, excluding the querns from the site at 1 Poultry (T=13) and table (below) showing how the upper and lower quartiles for Vindolanda and Britain compare.

	Britain	***Vindolanda***
25%	48	61
75%	73	83

Lower Stones

There were 14 lower stones in the Vindolanda dataset that could be measured for thickness, and these are presented in figure 196, which also shows the thickness for lower querns from the whole British dataset. Upper and lower quartiles for the British data are also shown for comparison. A similar outcome is seen in the data that was observed for the upper stones. One lower stone from Vindolanda occurs in the lower quartile for stone thickness, 5 in the upper quartile, while 7 occur within the same range as 50% of the querns from the wider dataset. The lower stones are, therefore, slightly thicker than those from elsewhere in Roman Britain. However, this difference is less pronounced than that for upper stones, as seen in the data table for figure 196, which shows the upper and lower quartiles for Vindolanda lower stone thickness compared with that for the larger dataset. This is an interesting discrepancy, as it suggests that lower stones were worn to a similar extent to that seen at most other sites in Roman Britain, but the upper stones were deposited much sooner. How and why this trend exists is worth considering. It could possibly relate to the use of fixed position lower stones, as suggested by the wear patterns on complete examples, or pairing old lower stones with new uppers once the more vulnerable original upper stones ceased to function.

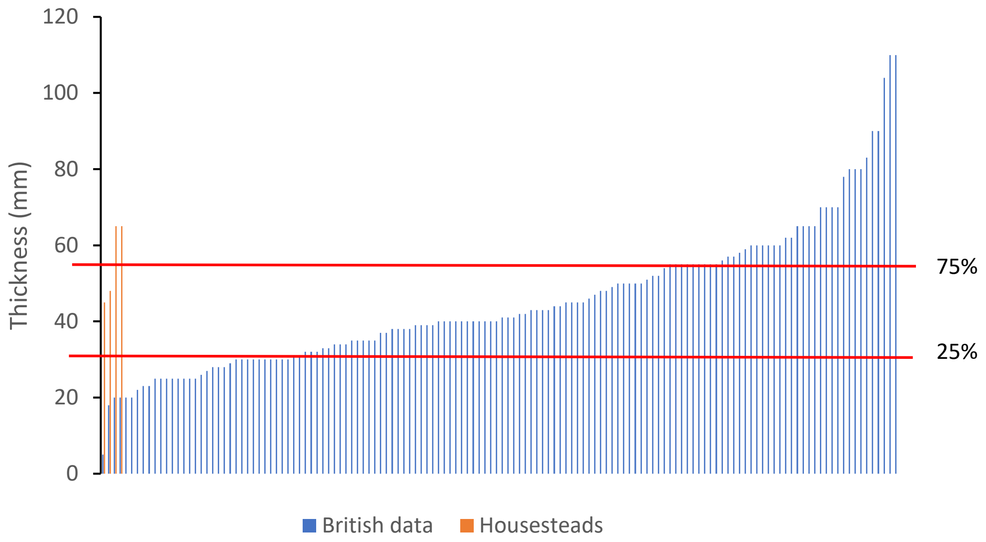


Figure 196- Thickness for lower stones from Vindolanda (T=14) compared with those from the wider British dataset, excluding those from the site at 1 Poultry. The upper and lower quartiles are indicated with red lines. Data table below showing the comparison between upper and lower quartiles for Britain and Vindolanda

	Britain	***Vindolanda***
25%	31	39
75%	55	56

Inscriptions

Inscriptions on lava querns are rare in Britain but occurred on three examples from Vindolanda that were recorded in person, with a further two added from published sources. It should be noted that this may not be representative of the extent to which inscriptions occur on lava querns, as there were many fragmented and degraded pieces in the assemblage that may also have been enhanced in such a way. However, as this was the only military site case study that had such inscriptions, Vindolanda should be considered as an exceptional site for this type of evidence; as a northern frontier site with an unusually large number of inscriptions, this might be expected. The two published examples were taken from Collingwood & Wright (1992, pp. 94-98, RIB. 2449.2), the first of which is a small fragment, with the following incised on the top surface of the upper stone,

Ↄ Λ D

This has been interpreted as either meaning (centuria) Ad(…), to translate as ‘century of Ad…’, with Auditor being the most likely name (CAT 1190). The second example (CAT 1191), consists of another fragment which has, instead, been inscribed on the outside edge of the upper stone, around the circumference (figure 197). The letters inscribed are:

[…]ICTOR[..]

This could be [(centuria) V]ictor[is], to be translated as, [century of] Victor; or […V]ictor[is], to be interpreted as [property of] Victor (RIB 2449.14).

Figure 197- Inscription on side of lava quern from Vindolanda (CAT1191) (Collingwood & Wright, 1992, pp. 98, RIB. 2449.14)

The three querns recorded in-person were taken from two complete and one fragment of upper stone. Although a specialist interpretation of these inscriptions is not achievable at this time, it is still possible to describe them and attempt to understand potential meaning and context. The first example (CAT 0021) is the fragmented piece, and this does not present any clear letters or symbols. Although it is clear that this piece has been inscribed, the level of degradation of the object has made it difficult to ascertain precisely what the figures could be (figure 198). What is identifiable is a possible 'V' and 'I', though whether this is part of a number or word cannot be established.

Figure 198- Fragment of lava upper stone with inscription on outer circumference. A possible 'VI' is visible, though any other figures are indistinguishable (CAT 0021) (photo by author, used with permission by Vindolanda Trust).

The next example (CAT 0045) can most certainly be defined as the inscription of a number (figure 199). Though there is nothing to indicate what this may be in reference to, it would be safe to assume that this would relate to some form of military unit. The inscription is clearly visible, and wear has not been so heavy as to remove too much of text at the bottom, as is often seen on other querns.

Figure 199- Inscribed complete upper lava quern stone from Vindolanda (CAT 0045). Text appears to read 'XXV' (photo by author, used with permission by Vindolanda Trust).

The final inscribed quern (CAT 0048), although also a complete upper stone, was broken, mended in several places and heavily worn; it had clearly come to the end of its use-life. The inscription was located around the outer circumference of the stone and had been damaged at the bottom as the quern was used and grinding surface worn down. The exact letters are hard to identify and are partly obscured by the broken handle socket that has been repaired with lead (figure 200). Behind this is a curved character, possibly an 'S' or 'C' followed what could be an 'A'. There is clearly 'DII', though the inscribed figure after this is unclear in terms of lettering. This consists of two parallel angled lines and one connected vertical line (//I). This could, once again, be partly numerical in its content.

Figure 200- Inscribed upper lava quern stone from Vindolanda (CAT 0048) (photo by author, used with permission by Vindolanda Trust).

Overall, all the lava quern inscriptions appear to communicate the names and numbers of particular units and individuals. Those that are currently unpublished will require further research. It should be noted that non-lava querns at Vindolanda were treated in a very similar way to those of lava in terms of inscriptions and were also found to have been inscribed to identify ownership by an individual or a group (see examples in Collingwood & Wright (1992)). That all inscriptions were placed on upper stones is significant; this would have been the most visible location and was also the moving part of the quern, meaning that these aspects may have been important. That people went to the time and effort to add labels in this way reveals that these were personal objects, valued and to be taken care of. They were clearly not communal objects to be shared with everybody, but for the restricted use of those identified in the inscription; the quern was a physical manifestation of comradery and shared group identity, and it was important to be able to identify one group's property from another. That the lettering and labels are not standardised or always present shows that the addition of an inscription may also have been a matter of individual or group choice.

Re-use/modification

Reuse aside from that related to deposition context was difficult to identify, and there were no surfaces on the stones that indicate that they may have been used for other grinding, sharpening, or processing activities. All wear appeared to correlate with use as a grinding tool only. There were a significant number of lava querns that were very well preserved, and so the absence of any evidence relating to this form of reuse likely reflects that this was not regular practice at the fort. There were, however, multiple examples of modification from the standardised form of a lava quern, which was mainly visible on upper stones; these being the part of the quern that houses most of the mechanical features of the device. Many of these modifications can be classed as repairs and were probably completed to prolong the use-life of the stone, the most common of these being the addition of new handle fittings.

This occurred on six stones (CAT 0001, 0029, 0030, 0032, 0043, 0048), with a further two where a second handle fitting had been started but not completed (CAT 0014, 0042). New handle fittings were of the elbow form and were added once the grinding surface had worn down to the extent that it interfered with the original handle (figure 201). As wear tends to be most extensive around the handle area, new handles appear to have been added on the opposite side of the stone or at right angles to it, where the stone was thicker due to this differential wear (figure 202). Multiple handles are not common for lava querns and have only been recorded on two other occasions: one from Carlisle (CAT 0381) and another from Usk (CAT 2347). However, complete upper querns are rare, and the handle slot is the most vulnerable part of the stone where breakages are likely to occur. This means that this phenomenon is unlikely to be identifiable on upper querns that are fragmented, which describes 99% of the total lava quern assemblage (2696 out of 2723 querns). The excellent preservation of the material from Vindolanda highlights the extent to which mending may have occurred and is unlikely to be a site-specific practice, especially when considering the extreme levels of wear seen at some rural and southern sites.

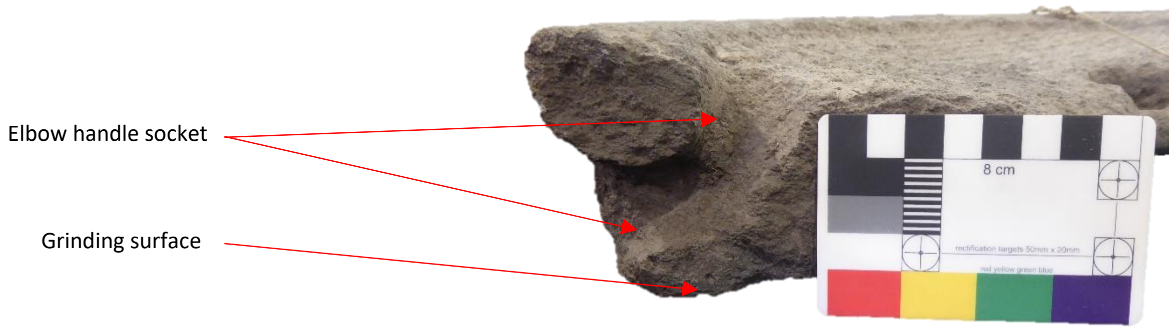


Figure 201- Upper quern showing wear at the grinding surface, which is worn down to the elbow handle fitting, making it unusable (CAT 0014) (photo by author, used with permission by Vindolanda Trust).

Figure 202- Upper quern stone showing two elbow handle fittings, almost opposite each other. On the left, the grinding surface has been almost worn to the handle fitting and the one on the right may have been added to allow for continued use (CAT 0043) (photo by author, used with permission by Vindolanda Trust).

Modification by adding extra handle fittings appears to have taken place by people with mixed stone working skill levels. This is especially apparent on stones where modification work had been abandoned due to a failed attempt, when compared to those where such fixes were successful. One of the best examples of a less skilled quern mend is that of CAT 0048, which has two handles and failed attempt at a handle (figure 203 and 204). The first handle (1) has been worn through at the bottom, prompting a new one to be fitted at right angles to the original (2). For some reason, this was abandoned, which may have been due to it being placed too high on the side of the stone. The third handle (3) was then added close by and still retains its iron fitting. Similarly, an abandoned attempt at a handle fitting has occurred on CAT 0042, but this has occurred at an angle that had little chance of success and the hole at the side never joined the one on the top surface.

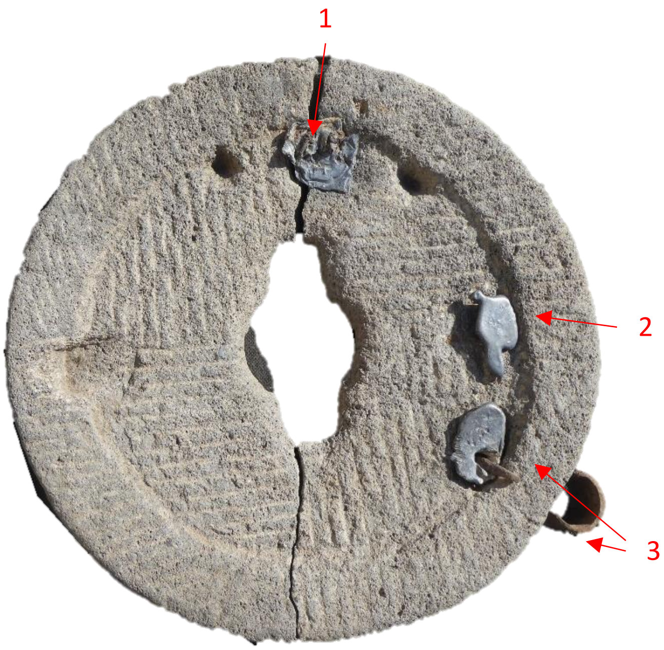


Figure 203- Upper stone CAT 0048 that has 2 handle fittings and one abandoned attempt at adding a handle (photo by author, used with permission by Vindolanda Trust).

Figure 204- Side view of handle fittings,1 and 3, and attempted fitting 2 on CAT 0048.

Other evidence for modification has also been observed within the assemblage which, again, appears to have been completed to compensate for wear and extend the use-life of the object. Referring again to CAT 0048, it would appear that a fix was attempted to reinforce a weak point in the stone where the original handle was positioned. Shallow holes on either side of the vulnerable handle have been added, perhaps with the aim of bridging the area with an iron fitting or equivalent material to bond the stone back together. Elsewhere on the stone, deliberate damage to the kerb is similar to that seen for the upper quern from Housesteads with the iron bar fitting (CAT 2284). As the rynd chase has been worn away, the idea may have been to add an iron bar to house the spindle as a replacement for the original rynd. However, these interepretations are speculative and based on modified querns that still retain their metal fittings.

Other possible identifications for the presence of an iron bar fitting exist for CAT 0025, 0030, 0032 and 0041. Evidence for each varies, as thse are fragmentary upper stones that do not present the complete set-up as seen at Housesteads. CAT 0025 has a recessed rectangular slot in the upper surface that is position adjacent to the kerb (figure 205). This is much further out than an ordinary rynd chase, and may have instead accomodated an iron bar fitting. Similarly, CAT 0030 has two shallow adjacent holes in the upper surface that may have held the two ends of an iron loop for this type of fitting. One of these holes still contains iron and lead (figure 206). CAT 0032 has the remains of an iron bar adhered to the upper surface (figure 207). This stone had lead 'plugs' that would have fixed part of an iron mechanism to the stone. As this stone had an iron band handle fitting, the lead may have been used to fix the iron bar. Finally, CAT 0041 has a plug of lead with iron projecting from it, in a way that resembles the fitting of the iron loop for an iron bar fitting (figure 208). It seems probable that this type of modification may have been more prevalent than first thought. Evidence for this has not been observed at other sites thus far, and could be limited to military sites. However, now that a near-complete parallel exists for comparison, further examples might be identified in the future.

Figure 205- CAT 0025 that has a recessed rectangular slot that may have accommodated an iron bar fitting like that at Housesteads (2284) (photo by author, used with permission by Vindolanda Trust).

Figure 206- CAT 0030 showing shallow holes in the upper surface of the stone that may have housed the ends of an iron loop as part of an iron bar fitting (photo by author, used with permission by Vindolanda Trust).

Figure 207- CAT 0032 showing possible iron bar adhered to the upper surface of the stone. A lead plug is visible under the iron on the stone as a white/grey shape to the left of the iron corrosion product. A further two lead plugs may have fitted the iron loop ends (above) (photo by author, used with permission by Vindolanda Trust).

Figure 208- CAT 0041 showing end of possible iron loop for an iron bar fitting (photo by author, used with permission by Vindolanda Trust).

Deposition

There are some very clear instances of quern reuse and the scale of this can be presented by examining the types of feature from which querns are recovered (figure 209). The prevalence of querns incorporated into floors or roads and within structures, including ovens and corn dryers, demonstrates the extent to which these objects were recycled. In terms of the distinction between re-use of lava compared with non-lava, there does not appear to be much of a difference in the relative numbers of querns reused in particular ways. This indicates a lack of preference for stone type, but also shows that the military had access to a variety of types. Whether or not there was a socio-cultural dimension to reuse in this way is difficult to determine with any certainty and it would be simple to describe this as being a purely functional activity relating to the continued use of good quality stone.

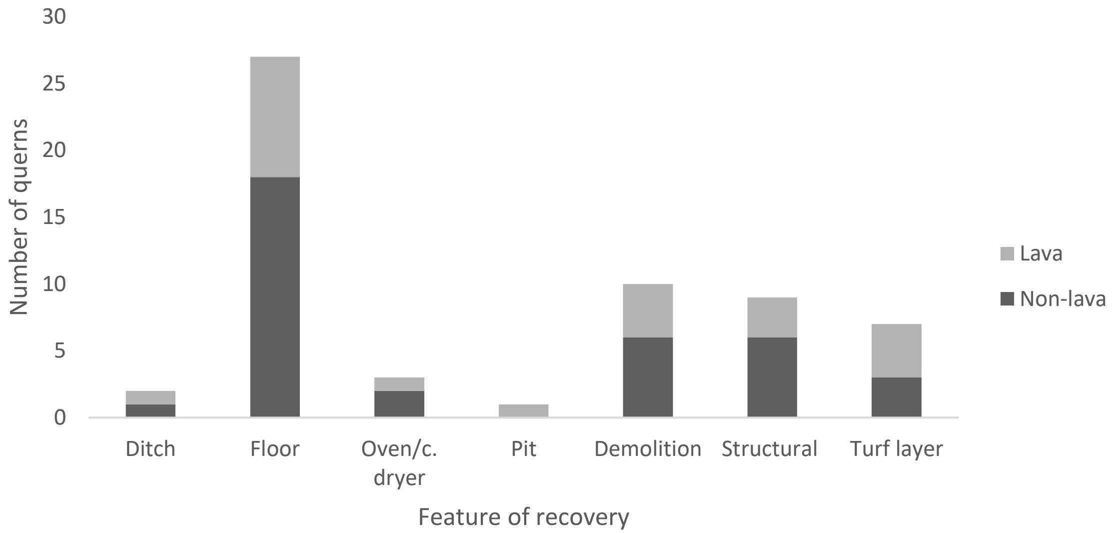
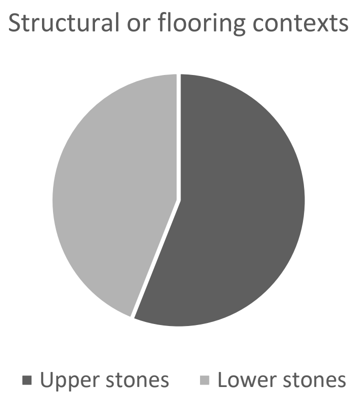


Figure 209- Number of querns recovered from different types of feature and split into lava or non-lava types, T=59.

In terms of when these querns became recycled building material, of the thirteen lava querns reused in this way, all were small fragments consisting of a quarter or less of a whole quern stone; except one, which was a half. Although this may partly be due to post-depositional processes, such as weathering, it appears that the pieces of quern selected had come to the end of their primary use-lives by the time they were incorporated into structures and floors. Most of the pieces were no more than a few centimetres thick and the majority were upper stones that were more susceptible to damage and wear. Of the 39 identifiable quern stones in the dataset, 22 incorporated into floors or structures were upper stones. Lower stones seem to have had a longer use life and are less likely to be recovered (figure 210); these may have been re-paired with new upper stones to allow for continued use. If stones were specially selected for this kind of disposal, it would be expected that there would be a greater disparity, but the ratio of upper to lower stones within this context is not dissimilar to the ratio within the whole dataset. It seems logical to deduce that those recycled and disposed of in this way must have been from those available from the normal 'pool' of broken querns.



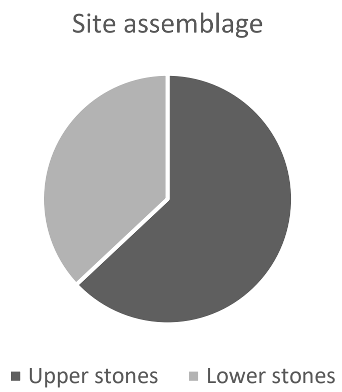


Figure 210- Percentage of upper to lower stones found in structural or flooring contexts, (T=13), compared to that of the whole assemblage (T=55).

Conclusion

To summarise, this chapter has examined four military site case studies: Corbridge and Chesters that were predominantly excavated as part of older projects, yielding fewer querns and millstones due to probable limited retention of stone artefacts; Housesteads and Vindolanda that were subject to long durations of archaeological investigation and have produced data and finds to modern standards for recent excavations. Vindolanda has produced the largest dataset and best-preserved finds from across the four sites. This high level of preservation has allowed for detailed analysis to be carried out on typology, use-wear, and quern stone modification. Furthermore, the observations made in relation to the assemblage from Vindolanda enables better identification of similar features on fragmentary stones from other sites.

As grain was a vital part of the military (and civilian) diet (Davies, 1971, pp. 122-132), the ability to process grain into edible food products would have formed an essential part of day-to-day activities. The capacity of grain stores at both legionary and auxiliary forts, both in Britain and elsewhere in the Empire illustrate this importance (Haverfield, 1920; Rickman & Rickman, 1971; Richardson, 2004). In some periods, it seems that a certain level of respect was associated with the frugality of the military diet. This is suggested by Herodian (IV, vii) in his description of the Emperor Caracalla, who is described as having led the life of an ordinary soldier, both processing his grain ration and baking his own bread. The solidarity Caracalla shared with his troops with such behaviour may not be a true reflection of reality but does highlight the culture of military food consumption and the way that troops were expected to conduct themselves.

This sense of solidarity can be seen in the assemblage of querns recovered from Vindolanda in the inscriptions found on some of the upper quern stones, which have also been noted on those of non-lava. These tend to relate to unit names or numbers (perhaps a *centuria, turma* or *contubernium*), indicating group ownership and use. These were not communal objects but were designated for the use of specific groups of people and labelled accordingly. It was clearly of some importance to ensure that the group were able to identify their own quern, and personalisation of the object would have allowed each group to claim joint ownership and use of the tool. If they did grind their own grain by hand, this would have been an object that a group of soldiers would have had regular contact with, and it may have held significant meanings associated with camaraderie, group identity and shared experience. The coming together of people to prepare, cook and consume food is a way that strong social bonds are formed, reinforcing a sense of cohesion and shared aims (Fischler, 1988; Carroll, 2005); something that must have been a desirable outcome for soldiers that were required to live, fight, and potentially die side-by-side. This concept is amplified by the evidence of quern mending that appears to have been a common occurrence at Vindolanda and is likely to have been the case at other sites, though evidence is less apparent. These were clearly valued objects and worth repairing, sometimes being fixed multiple times before being disposed of. The need to repair could suggest that the supply of querns to the fort was not stable, but this seems unlikely when considering the evidence that we have for the large-scale movement of goods in and out of Vindolanda (Bowman & Thomas, 1983), and military supply in general. It may be possible, instead, to consider whether lava querns were preferred over other stone types, or that the shared ownership of a significant and meaningful object may have been an experience that was worth preserving.

Small-scale food processing on a group level may not have been the only means by which this activity was undertaken. The presence of two lava millstones at Vindolanda, the evidence for a possible watermill at Chesters, coupled with the small lava millstone/large quern from the site of the fort, and the unusually large lava querns at Housesteads suggest otherwise. Moritz (1958, pp. 124-130) states that larger sized milling stones, of between 65-80cm in diameter, were operated by several people or by animals as part of grain processing on a large scale, as evidenced by inscriptions on the millstones that refer to *centuria* or *turma*. By the same measure, Jacobi (1914) has suggested that querns of approximately 40cm in diameter were for the use of each *contubernium*, also based on quern inscriptions eividence. That differently sized milling tools existed is not in question, but care must be taken when determining that these were used in such a specific way. The inscriptions found on lava milling tools at Vindolanda need to be examined in more detail, and meanings of these correlated with the diameter of the object. This research provides the possibility for such a study to be completed, which would need to be widened further to include more examples to understand how food processing may have been organised between and within units of soldiers.

Furthermore, the distribution analysis of the querns at Housesteads has provided a glimpse into how such activities may have been spatially organised within a fort setting. Although querns are unlikely to be recovered from their context of use, the clustering of lava milling tools in the area around the ramparts raises some important questions, especially when correlated with the structural evidence for ovens in these areas of the fort. Other fort locations have similarly provided finds evidence for food preparation activities being carried out in fort periphery areas, such as amphorae and mortaria. This emphasises the need to carry out more in-depth analysis of finds evidence, including environmental samples, within such fort areas in the future.

Analysis of quern stone thickness has also produced some interesting outcomes. Overall, the results correlate with the conclusions relating to quern thickness for all Romano-British military sites, in that lava querns appear to have sometimes been deposited well before full use had been made of them, and that they are generally thicker at the point of deposition than at rural and urban sites (see Chapter 4). The possible reasons for this are varied and may relate to the types of sites where lava querns were entering circulation, and where supplies of lava querns were abundant enough for them to be replaced easily. As the Roman military had good access to imported goods, earlier disposal of lava querns does seem more likely in these contexts. However, the periodical abandonment of fortifications along the frontier, and the redeployment of troops may also provide a reason for patterns seen. Such mass movement of troops often coincided with the dumping of military equipment, and this may have resulted in thicker or less used objects being deposited prior to full use being made of them. If attacks on forts and subsequent destruction of occupation areas also occurred, a similar pattern of deposition might be expected.

From the four case study sites, both Chesters and Corbridge yielded unusually thick stones measuring over 100mm: two upper and one lower stone from Corbridge, and one upper stone from Chesters. There were only 9 sites across Britain that yielded 106 upper stones measuring 100mm or more, and 4 sites with 14 lower stones of this thickness or greater. Of these, 90 of the upper stones and 11 of the lower stones were recovered from the site at 1 Poultry. It is likely that these represent stones that were either unused, or little used prior to deposition. Therefore, due to the high density of such stones, 1 Poultry, or its immediate vicinity, has been interpreted as a location where the centralised distribution of lava querns may have occurred. Breakage on arrival into London may have resulted in a high volume of unused querns being deposited, which is supported by the fact that the bulk of those deposited were upper stones that are more vulnerable to breakage. This pattern is consistent with the ratio of upper to lower stone of equal thickness recovered at other sites across Roman Britain, with there being 16 upper stones and 3 lower.

Consequently, serious consideration should be given as to whether Corbridge was a centralised distribution location for lava milling tools at the northern frontier. Although a small number of thick quern stones were recovered from the site, the rarity of them elsewhere in Roman Britain suggests that these are exceptional. Other sites receiving lava imports may have broken down and reused such querns, which would remove them from the archaeological record. This must not be discounted as it would have implications for how findspots for thicker querns are interpreted. However, the central position of Corbridge within the Stanegate system, its clear role as a distribution centre for military supply and the fact that it was accessible via river and road all support the theory that it may have held an important role in lava quern distribution across the military sites at or near Hadrian's Wall.

The differences seen in quern diameter between sites is another result that is worth considering. Looking at the upper and lower quartiles for quern diameter across the four sites compared with the figures for the wider British dataset (table 24), the querns from Vindolanda most closely resemble those from elsewhere in the province. Corbridge and Chesters have yielded querns with slightly smaller diameters to those from the wider dataset, while the querns from Housesteads are significantly larger. For Housesteads, Chesters and Corbridge, the datasets are small, and this means that anomalies in the data are more likely to skew the upper and lower percentiles. However, the quern diameters from Housesteads were relatively consistent in being large and were, therefore, different to those seen at the other three sites. Possible reasons for this might relate to the size of the garrison stationed there and the need for larger milling tools to accommodate the needs of a large population. It might also be a result of different chronologies of manufacture and lava quern supply if lava quern size were a feature that changed over time, or different manufacture quarries/ supply networks.

Interpreting different supply networks for lava between the sites is a complex undertaking, and one that is hampered by small dataset sizes and the differential discard and retention policies for finds that existed during the various excavation projects across the four sites. It is interesting to note that all of the initial occupiers of these military sites had strong connections to Belgic Gaul or Germania prior to being stationed in Britannia, either due to the origins of the unit or from prior postings in the

Table 24- Comparison of upper and lower quartiles for quern diameter across the four sites compared with that of the wider British dataset.

	25%	*75%*	*No querns*
Corbridge	385	408	8
Chesters	375	400	6
Housesteads	423	460	10
Vindolanda	400	438	44
British dataset	400	420	553

region: At Corbridge, the *ala Petriana* were probably at *Mogontiacum* (Mainz) previously (Clauss, et al., 2022; Spaul, 1994, pp. 180-182); the *ala Augusta ob virtutem* at Chesters are likely to have been in Germania in the first century, before being moved to *Calunium* (Lancaster) and then to Chesters (Spaul, 1994, pp. 55-57); Vindolanda was initially occupied by the first cohort of Tungrians from Belgic Gaul, who had been at Mons Graupius before being garrisoned at the fort (Birley, 2009, pp. 45-62); while Housesteads probably received the first cohort of Tungrians at some stage after they departed Vindolanda (Crow, 1995, pp. 57-59; Birley, et al., 2013, pp. 291-293). These troops and their quartermasters would, therefore, have been very familiar with the use of Mayen lava in milling tools prior to being posted to Britannia, as these were already distributed at military sites in Germania and Gallia Belgica (Gluhak & Hofmeister, 2011, p. 1616). It is probable that the initial movement of troops into Britain during AD 43 saw the introduction of lava, which would have been carried into the province by the troops themselves. Although the military case study sites are dated much later, continued use of lava may have been part of military culture- a familiar tool and material in an unfamiliar landscape. Furthermore, it negated the immediate need to discover and exploit suitable indigenous stone supplies for vital equipment, which could be tackled at a later time once the province was fully secure and integrated into the Roman empire.

Chapter 8. Conclusion

This research presents the first holistic study of imported lava milling tools in Roman Britain. This has been achieved by compiling a database of a substantial corpus of Romano-British material, including 2,707 lava milling tools from 564 sites in Roman Britain and data from a further 601 sites where lava was absent but milling tools of other lithologies were present. In-person data that involved examining the querns and millstones first-hand was conducted for the bulk of the case studies, including 18 sites: Chichester and 11 sites in its hinterland, Verulamium, Vindolanda, Corbridge, Housesteads, Binchester and Chesters. The querns recorded for these sites comprise 301 lava and 127 non-lava examples. The rest of the dataset was compiled using information taken from Ruth Shaffrey's personal database, and from a systematic sweep of 'grey literature' reports from developer led excavations and published excavation monographs, reports, and county journals. Good use has been made of the Rural Settlement of Roman Britain Project database as a means of identifying reports containing quern data. Repeated Covid lockdowns prevented me from accessing more museums and archives for in-person data collection and have limited the choice of case study sites. This is most notable for London and Colchester, both of which were significant sites in terms of lava milling tool introduction, distribution, and consumption. Nonetheless, I strongly believe that the issues have been mitigated as much as possible with the volume of data collated and that the analyses incorporate a representative sample of lava milling tools data. The survey has established key patterns of distribution, consumption, and chronology, and provides a basis for further milling tool data to be added in the future.

My work contributes data relating to previously unknown aspects of lava milling tool use such as distribution and deposition in the province, whilst also examining the physical characteristics and functional elements of this significant group of material culture. Context has been provided for this study in the form of a critical discussion of the Roman economy, the stone trade, and North Sea trade, while the extensive work completed on Mayen quarries in Germany has been summarised to provide a view of the manufacture stages of lava milling tools (Chapter 2).

Analysis of the full dataset has allowed for a thorough comparison of the Röder typology created at Mayen with the British lava querns. Results have shown that a high degree of standardisation exists within Romano-British assemblages and that almost all identifiable lava querns can be classified as a Röder type 4 (Chapter 2). However, two more complete examples were found to exhibit alternative handle fittings of an 'iron band' type, with a probable four other examples within the dataset. These appear to have been manufactured to different specifications (Chapter 4) and, when the iron band has not been preserved, are almost identical to Röder type 4 querns. The only difference is the absence of the elbow handle socket. This feature is not always present if querns are fragmented, meaning that identification of missing handle sockets is not possible at most sites where poor preservation or breakage is common. The iron band fitting is also rarely preserved, creating a high chance that this type has been missed or misidentified, both in Germany and Britain. This type should be considered in correlation with unrecorded and newly excavated material to see if further examples exist. Further analysis of the functional elements of the Romano-British assemblage of lava milling tools has examined common functional features, and those which are different to that of the standardised type. Such use wear analysis has shown how people engaged with these objects, how they were operated, and how they were sometimes modified to fulfil differing functions or accommodate specific requirements.

Distribution analysis has been used to examine the role of lava milling tools in the broader provincial economy and patterns of consumption (Chapter 3 and 4). As an imported product, lava milling tools have shown some similarities with that of other imported goods and commodities, such as writing equipment, appearing in the greatest numbers at military and urban sites. However, lava also fulfilled a need for milling tools in regions where suitable natural stone sources were less available, specifically the east and parts of the south-east close to the main distribution centres of Colchester and London. In these areas, the much wider distribution of lava also incorporate rural sites. The significance of lava querns in rural Roman Britain has often been overlooked because they are so prevalent in military contexts and are well-preserved at the northern frontier sites. Though rural distributions of lava are geographically restricted, results of the distribution analysis have challenged this view. In the east, all types of rural sites consumed lava, but elsewhere people of villas and roadside settlements were more likely to have access to this stone type than those inhabiting lower status rural sites.

An important distinction not always appreciated in site reports is that between querns (for small scale flour grain processing) and millstones (centralised flour production); the definition rests on size, which is not always well preserved or recorded. Data analysis of stone diameter has shown that the division between hand operated querns and mechanically driven mills is most clear at 500mm, but that care needs to be taken to examine individual examples for evidence for mode of operation. This has allowed for renewed mapping of lava and non-lava millstones alongside the location of known mill structures (figure 211). Lava millstones show similar restricted distributions to that of lava querns, being most prevalent at urban and military sites. This may relate to centralised processing occurring in areas with higher populations, or the possibility that lava millstones were the preserve of elite consumers who had privileged access to imported goods and specialist equipment.

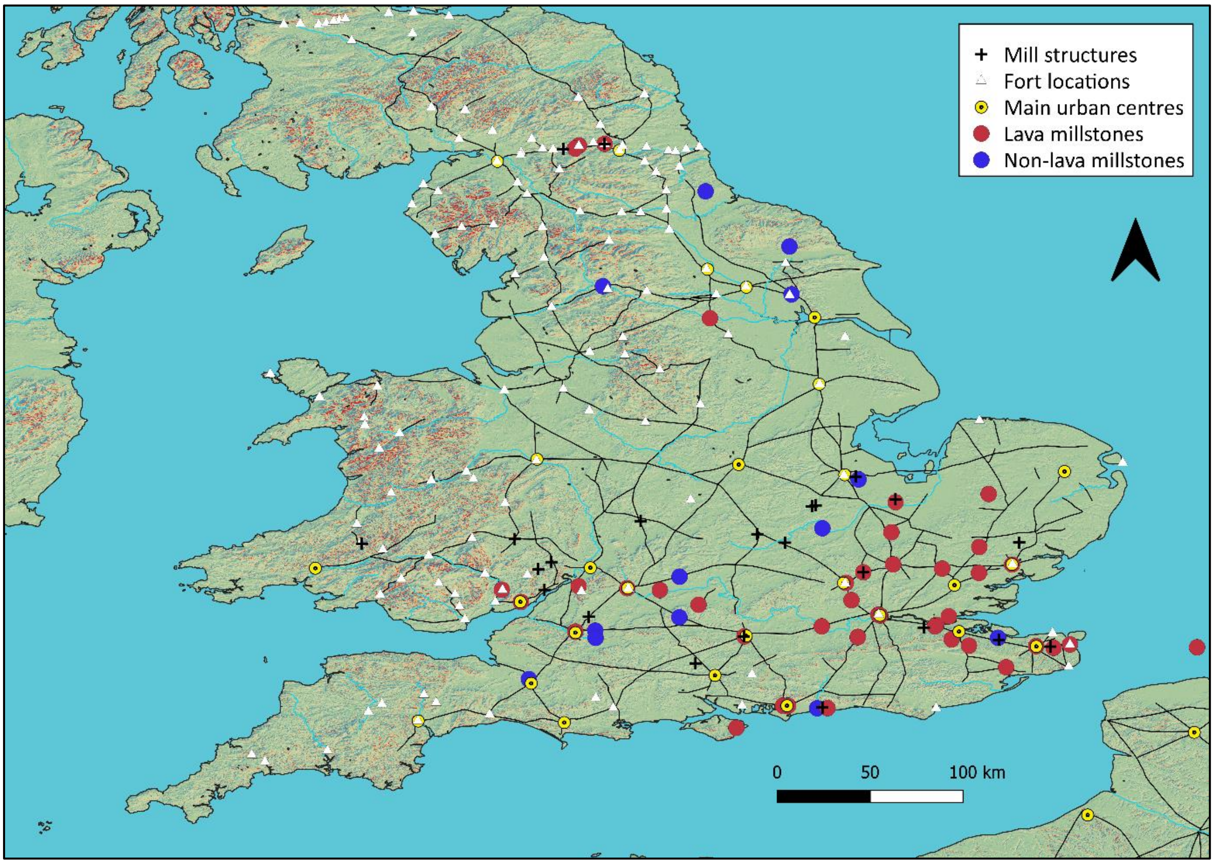


Figure 211- Map showing the location of lava and non-lava millstones alongside the location of known mill structures (backdrop map Ancient World Mapping Centre).

Chronological change in lava milling tool use has shown that these objects were introduced in the first century AD and that a peak in deposition occurred from the second to third centuries (Chapter 4). It is possible that reduced use of lava continued into the fourth century, but the high incidence of redeposition and reuse of the material makes it difficult to pinpoint when imports into Britain ceased. Absence of lava at sites that originated in the late Roman period suggest that imports may have reduced or stopped by the mid-third century. The co-occurrence of a lava quern with Mayenware and Eifelkeramik pottery at the late Roman site of Summerton Way suggests that imports of lava may have continued alongside other goods from the Rhineland at some sites, and further work on this pottery and its potential association with imported stone is desirable (Chapter 5). Geographically, early lava introductions occurred primarily in the south-east, spreading north and westwards by the second century, when lava was the most widespread. A contraction occurs by the third and fourth centuries, which continues into the fifth century. The change in distribution over time correlates well with what is known of military movements in the regions where forts or camps were present, emphasising the connection between the military and lava milling tool consumption.

The focus of this study on systematic measurement of functional features and human interaction with lava milling tools has yielded some interesting results. For example, the thickness of an upper or lower lava quern stone is a good way of quantifying the extent of use of that particular object. Comparison of this measurement between military, rural and urban sites has shown that querns were worn significantly thinner at rural sites than at urban and military sites. This is likely to correspond with a need to preserve use for as long as possible in rural areas with unequal access to supply to new lava milling tools. This method of analysis has also shown that examination of lava quern thickness at an individual site level can show the extent to which a specific site had access to exchange systems operating from the east coast areas of Britain, which was most closely linked to North Sea trade networks.

Identifying patterns of deposition relating to lava querns has been complicated by the extent to which lava tends to be redeposited, reused and recycled as building material. Similarly, preservation has been a recurrent issue in terms of recording lava presence and is particularly affected by geology, exposure and soil conditions.

There is some suggestion that lava may have been incorporated into ritual pit deposits at Silchester and Verulamium, but it is very hard to establish whether lava was deliberately deposited, and that the intention was for ritual purposes. Querns have been known to have held important ritual and social meaning throughout prehistory, and it seems highly likely that this was the case in the Roman era also. However, the huge volume of material that archaeologists deal with on Roman sites is so much greater than in preceding periods, while urban sites especially saw long chronologies of occupation that resulted in high levels of redeposition. These factors, though not unique to the Roman era, do make interpretation of ritual deposition more complicated. Some deposition patterns are observable in the form of querns reused as building material and road surfacing on military sites, and deposition in ditches and enclosures at rural sites. The extent to which this relates to the prevalence of these types of archaeological feature at these sites, as opposed to deposition, provides a possible reason for these patterns. What is most notable, however, is the extent to which lava querns were not recovered from use contexts and were typically deposited away from these places.

One possible exception is that presented in the distribution analysis of the querns from Housesteads. Here, it would appear that lava querns were deposited in the rampart area of the fort, where ovens and bakehouses were situated, and other evidence of food preparation occurs (Chapter 7). Small-scale distribution analysis of this kind has not been possible or accurate for the other case study sites in this thesis, mainly due to missing data, poor recording, or an absence of location information. Older excavations are especially challenging to analyse in this regard, but disappointingly, even modern excavations sometimes fail to record the most basic and fundamental aspects of quern deposition and location; namely findspot and context of recovery. Nonetheless, the results from Housesteads show the potential that site-based distribution analysis of quern deposition has for our understanding of the culture of food preparation and consumption on an intra-site scale. It would be interesting to see whether these results are replicated at other military sites.

Case study sites were selected to investigate different consumer groups: urban, military and rural. Small-scale analysis on an intra-site level has provided more specific examples of the relationships that people had with lava querns and millstones in the past and the physical evidence that can be identified on the objects as a result of human-object interactions. The focus has been less on typological analysis and has instead demonstrated the usefulness of viewing material culture as existing within a complex web of interactions, using object biography to understand and interpret the lived experiences of those using lava milling tools. This method has shown that systematic use of measurements to explore specific life stages, such as quern stone thickness for primary use, has the potential to produce interesting patterns that have real world meaning.

Results have shown the archaeological potential that lava querns and millstones have if time is invested in their recording and analysis. Unfortunately, a current lack of consistency exists in finds reports for lava milling tools, and this extends to those of indigenous stone types also. One of the most important recommendations for future recording would be, as a minimum, to distinguish lava from other quern stone types when cataloguing milling tools, as there are many clear differences in terms of economic and social considerations that would apply to imported vs indigenous material culture groupings. It is concerning how many times during data collection this basic distinction had not been made and a total number of milling tools is provided with no attempt at identification on this most basic scale. It is understandable that geological determinations are not always possible, but lava is easily distinguishable from sandstone and conglomerate and should be recorded independently. Quantification has been another issue and is especially complicated at sites where high levels of fragmentation is apparent. It is recommended that, where possible, attempts should be made to refit lava quern fragments to gain an estimate of the number of individual objects and to identify and count how many separate objects there are using typological features, size and material as a way of differentiating between them. Where this is not possible, all fragments recovered from a single archaeological feature should be counted as one object, with the provision of a total number of fragments/fragment groups and the total weight. Though this is not a perfect system, it does at least create consistency in recording methodology and the ability to fully scrutinise the data on an individual site level.

Initial identifications should include whether the stone is an upper or lower, which can be determined by the curvature of the grinding surface or the presence of features that are typical of either stone. This should be followed by a brief description of any features, such as handle slots, kerbs, central holes, iron fittings or dressing patterns. Correct terminology for identification is provided in Chapter 2. Where an object differs from the standardised type, more attention should be placed on describing the stone and understanding how and why it differs. Where possible, measurements should be taken of the measured or estimated diameter of the milling tool, which can be completed using the same method and tools that are utilised for estimating diameters of pot rim sherds. Whether the measurements were measured or estimated should always be indicated. Diameters are vitally important for identifying millstones from hand operated querns. This distinction is important to make as it allows us to identify locations where intensive centralised milling practices were occurring, a fundamental identifier of economic activity, population size and organisation of labour. Measurement of stone thickness should also be recorded where a clear edge exists, and this should be taken at the edge of the stone regardless of whether it is an upper or lower stone. If there is no edge, if a diameter cannot be measured, or if features are not identifiable, this should be indicated in the report.

Building on the work of this thesis, a number of suggestions for potential future work can be made. One of these would be a systematic campaign of thin section and geochemical analysis on lava querns from Romano-British contexts. Though this research originally aimed to complete these investigations, restrictions imposed due to Covid over the past few years has made such work impossible. The work would form a substantial future project and should utilise the previous work completed by Gluhak and Hofmeister (2009;2010) as a guide. The results of such a study would provide more detail pertaining to the specific exchange networks that were in place between the Rhineland and Britain during the Roman era, how these changed over time and how different parts of the province may have been supplied from different quarries and lava sources. Other future work should also aim to tackle some of the larger missing datasets, including London and Colchester, though published data from these areas have been included in the dataset. These locations could be highly significant in understanding the initial introduction of lava milling tools into the province. Their absence in this thesis is regrettable but was caused by the lack of access to these collections due to Covid restrictions at the time of data collection.

Overall, this study has shown that the distribution and consumption of lava milling tools was predominantly an early Roman period phenomenon, and that the main consumers of imported lava products resided in the urban and rural areas of the south-east and the east of Britain, and the military sites of the north. The dataset produced as part of this project can be further interrogated to answer different research questions and, it is hoped, added to. As with any research, the outcomes here provide a base of knowledge from which new theories and interpretations can be developed to challenge or support those presented here. I personally welcome others to continue to explore this fascinating body of material culture, as I believe that there is much more to be learnt.

Appendix 1. Review of the Rural Settlement of Roman Britain Project

To ensure that full use of the data provided as part of the RSRB project, it is necessary first to provide a summary of the interpretations and conclusions that have been presented as part of the original analysis. A detailed critique of the approaches used should be generated prior to the development of a new methodology for the analysis of querns and millstones as part of this research. In doing so, the aim is to highlight how aspects of the RSRB data can be extracted, added to, analysed, and presented to illustrate new information that relates specifically to lava querns and millstones in Roman Britain. This section will therefore:

- draw out data analysis that included food processing tools as carried out by the RSRB project,
- provide a summary of the results as presented in the published volumes,
- assess the usefulness of the analyses in terms of developing narratives relating to the socio-economic role of lava querns and millstones in rural Roman Britain.

Querns and millstones in relation to region and settlement type

The first volume, titled, The Rural Settlement of Roman Britain (2016), focuses on settlement morphology and classification, buildings, landscape context and infrastructure, and settlement hierarchies using site evidence in conjunction with specifically selected finds categories. The analysis completed in relation to settlement hierarchies is highly relevant to this examination of querns and millstones, as these are included within the major artefact categories under the definition of 'food processing tools' and are examined in relation to other finds. There is already, therefore, some quantitative and comparative analysis within the entire corpus of rural settlement data, though these have not been differentiated by stone type or chronological period. This material has been structured and presented regionally, allowing it to be analysed and interpreted in terms of geographical variation.

Previous studies have used a range of classification methods to determine regionality that have little relevance to the Roman period, such as adopting modern political and administrative boundaries (for example, Taylor (2007)). Other examples of different approaches used to determine regions have been outlined and critiqued by Fulford & Brindle (2016, p. 15), and include the following: Haverfield (1912); Fox (1947); Jones & Mattingly (1991, p. 154); Millett (1990, p. 67). To address the issues associated with such approaches, in the RSRB project regions were determined using the rationale that the physical natural environment and Roman settlement patterns are more indicative of ancient regionality. Settlement evidence was the first factor to be referenced and mapped, with more precise division between regions delineated using 'Natural Areas', as defined by a scheme produced by Natural England. These follow physical and topographical lines in the landscape, features that would have remained relatively unchanged throughout history, and thus provide a much better guide with regards to how regionality may have functioned in the past. Consequently, eight regions were identified: south, central belt, east, north-east, central west, north, south-west and upland Wales and the Marches (Fulford & Brindle, 2016, pp. 15-16) (figure 212).

In the southern region, food processing tools constituted the second most prolific of the major artefact groups after coins, being present at 40% of the 897 sites recorded (figure 213). When this is broken-down into subregions, food processing tools are relatively consistent in their prominence and presence across different areas when compared to other artefact groups. However, there is some variation, and this can be seen more clearly through more detailed sub-regional analysis of specific artefact groups; for example, the South Wessex Downs produced 55% of sites with querns or millstones present, while the Wessex Vales has less than 20%. Interestingly, when compared to subregional variation in the presence of agricultural tools, there is no clear direct correlation between these and the incidence of food processing tools. It appears that though querns and millstones consistently occur, the numbers of agricultural tools are more geographically varied. For example, in the London basin, agricultural tools are not frequently found on rural sites (11%), though food processing tools are relatively consistent with the numbers found on other sites in the region (43%) (Allen, 2016b, pp. 122-123). This may be related to taphonomy, as agricultural tools of iron and wood may not survive as well as stone tools, especially in certain soil conditions, meaning that regional variation according to geology would be expected.

In terms of site type, food processing tools were more likely to be found at villages and roadside settlements than at villa sites and farmsteads in the southern region. This is discussed as possibly being an unintended consequence of sampling during archaeological investigations, and a focus on specific areas of particular sites. For example, at villa sites, excavation work tends to be centred on the residential areas with clear structural evidence, as opposed to less easily identified auxiliary buildings that may have served more utilitarian purposes, such as to house grain processing activities (Allen, 2016b, p. 124). If this is the case, it is expected that this pattern will be replicated in the lava quern data, though a more in-depth breakdown of the difference between querns and millstones alongside lava and non-lava materials may reveal alternate explanations for the patterns seen.

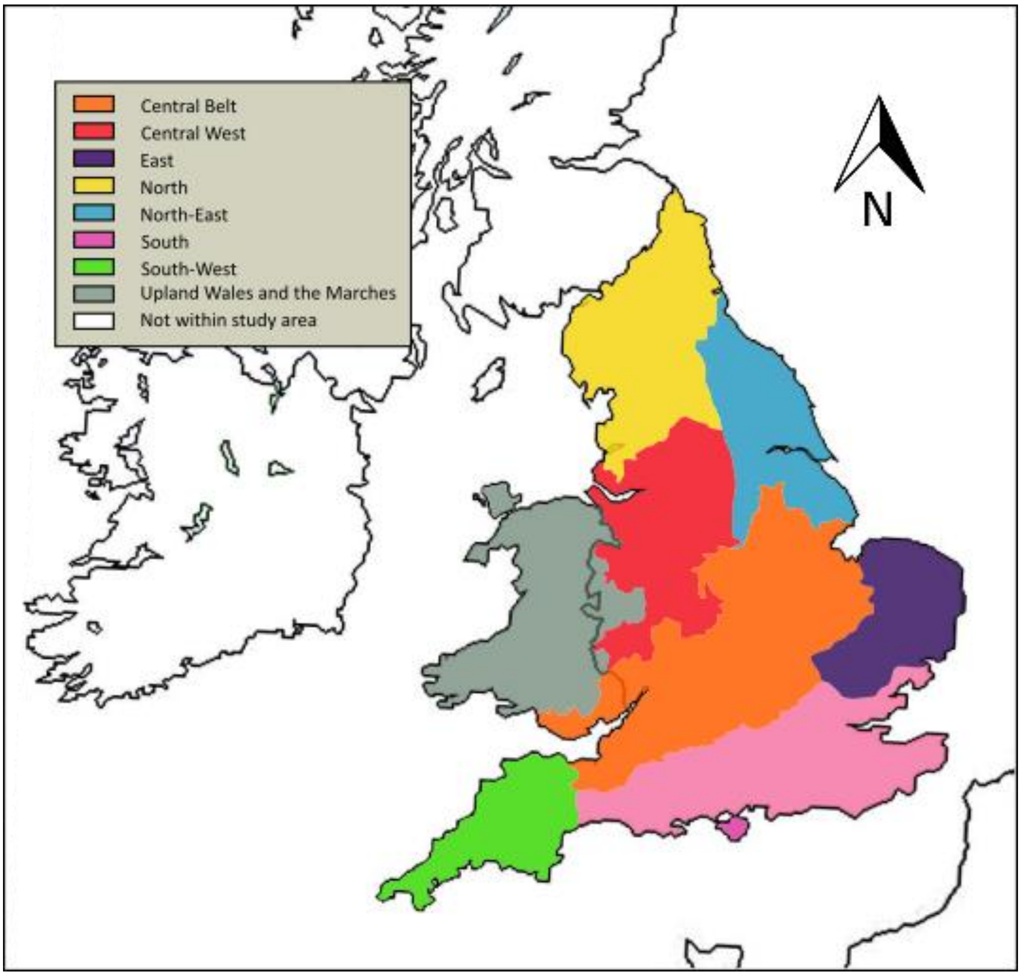


Figure 212- Map showing the regions as used by the Rural Settlement of Roman Britain Project (after Fulford & Brindle, 2016, Fig. 1.5, p. 16).

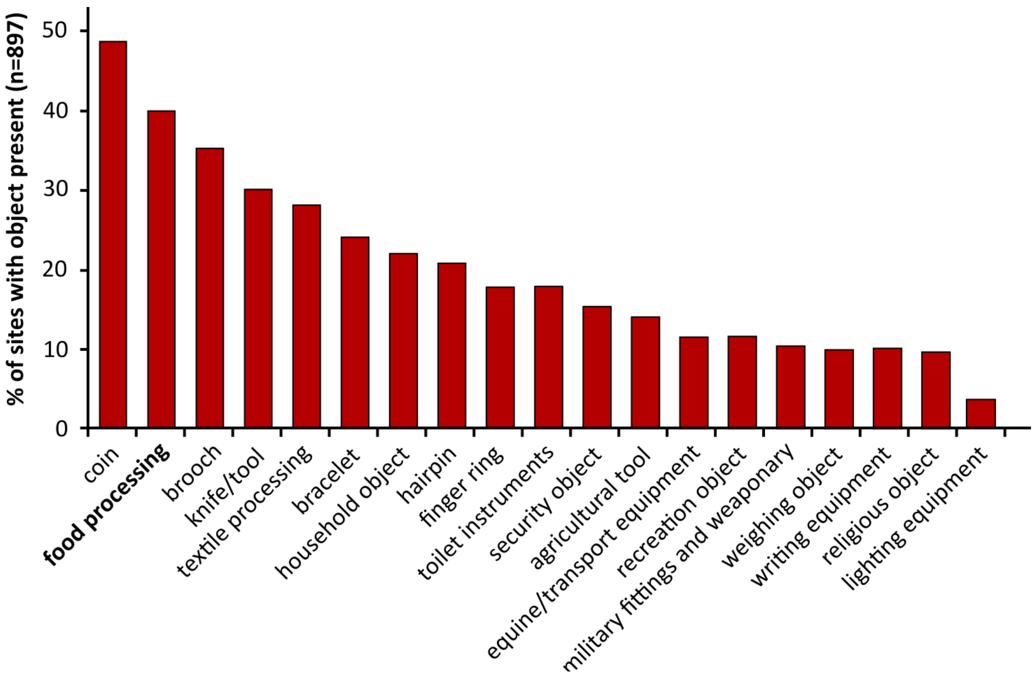


Figure 213- Main artefact groups in the south region showing percentage of sites with object present (after Allen, 2016b, Fig. 4.56, p. 122)

Prevalence of querns in the eastern region is like that seen in the south and the central belt, being second most prolific after coins. Querns and mills are present at over 50% of sites in the region, and this is significantly higher than seen in the other regions (figure 214) (Smith , 2016a, p. 235). When assessed on a subregional basis, the East Anglian Plain claimed 62.83% of the total number of food processing tools for the region, while Breckland and East Anglian Chalk areas had 16.6% and 17.44% respectively. The three other areas presented very few examples, and this appears to demonstrate a very clear subregional variation in the organisation of food processing activities. Interestingly, the percentage prevalence of agricultural tools in these areas correspond very well with the data for food processing objects and could demonstrate very clear differences in subregional food production and processing areas in terms of arable farming and cereal consumption. In the Breckland and East Anglian Chalk areas, the high number of millstones, storage buildings and corn dryers imply more centralised production and processing of grain, and so percentage volume may not entirely represent the true scale of activity on an individual site level. In terms of differences between site type, querns and millstones were more likely to be present at roadside settlements and less likely at farmsteads and villas, in a similar way to that seen in the south and central belt (Smith , 2016a, pp. 235-236).

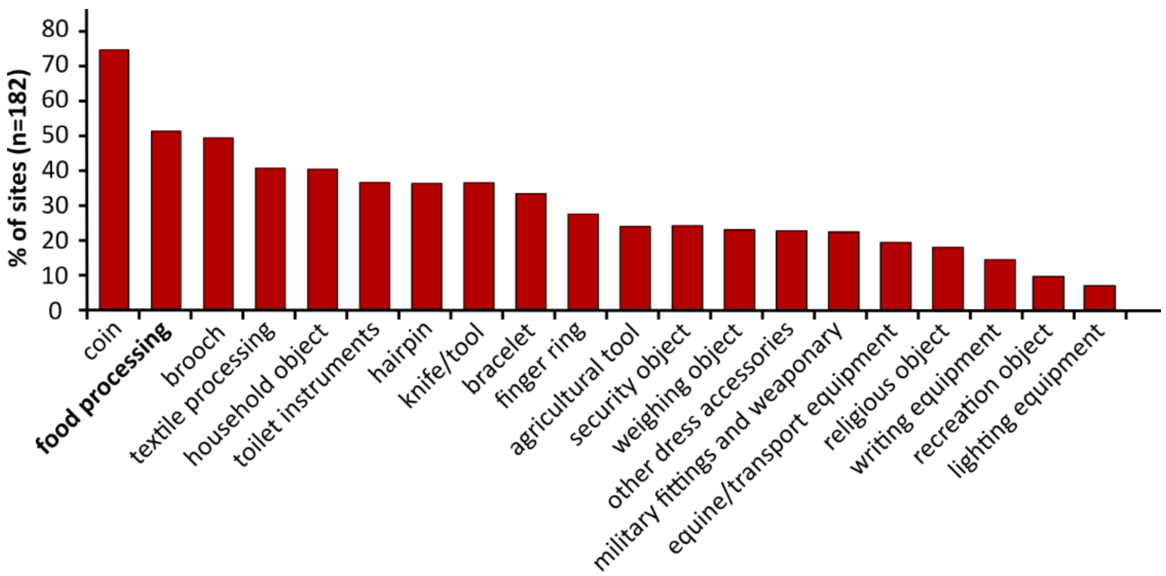


Figure 214- Presence of main artefact groups at sites in eastern region (after Smith, 2016b, Fig. 6.30, p. 235).

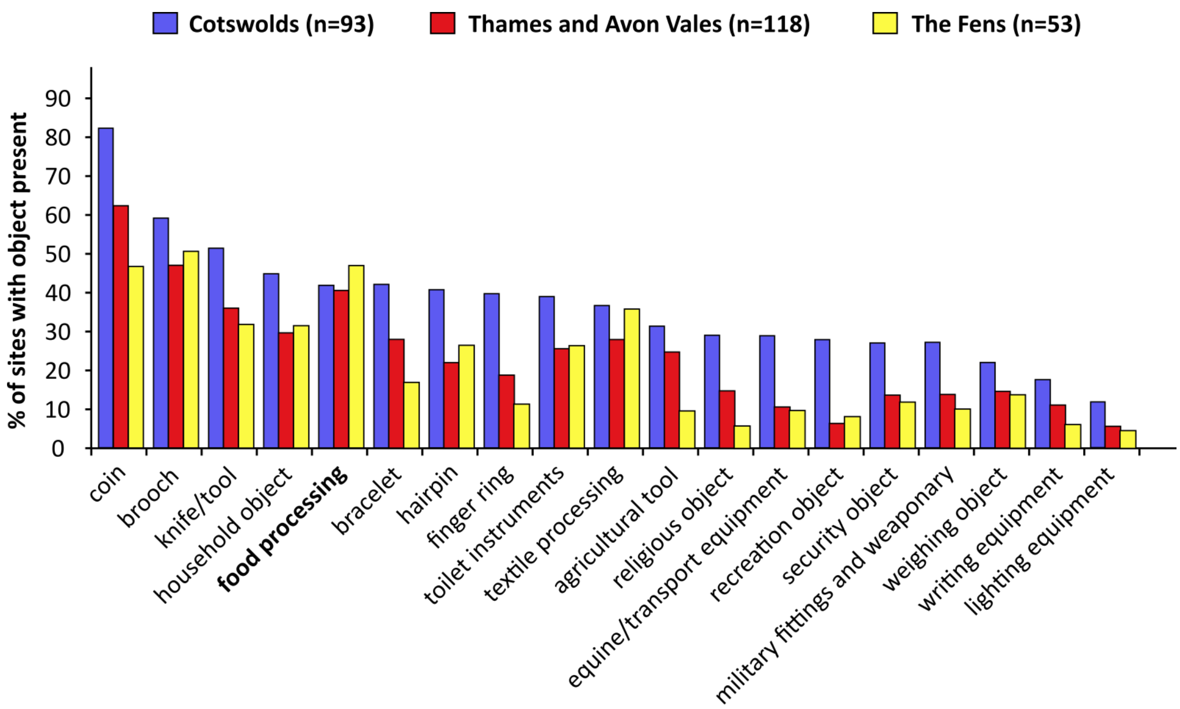


Figure 215- Presence of main artefact groups in the central belt region by subregion (after Smith, 2016a, Fig. 5.44, p. 184).

As with the southern region, food processing tools were some of the most common finds at rural sites in the Central Belt, being third most prolific after coins and brooches. The percentage of sites with food processing tools is consistent with that seen in the south, with 40% of sites recording the presence of querns or millstones. Similarly, variation between the presence of querns and millstones at sites in the central belt are not significantly different when analysed from a subregional perspective (figure 215), remaining at around 40% regardless of the area within the region. When looking at the difference between site types, villas, and farmsteads, again, are the sites significantly less likely to have food processing tools present (Smith, 2016b, pp. 183-185). To consider these differences in more detail, the numbers of food processing tools recovered from each site type were also presented in comparison with the other main artefact groups. To compensate for different excavation strategies and varied extents of excavation at each site, these have been shown as the mean number of objects recovered per hectare of excavation. Interestingly, the volumes of querns and millstones recovered from each site type appear to coincide well with the data for the presence or absence of these objects. Villas and farmsteads show a significantly lower number of processing tools when compared to roadside settlements (Smith, 2016b, pp. 187-186).

Querns, coins, and other tools are frequent finds at sites in the north-east and though there is still a clear difference between the presence of querns at roadside settlements compared to villas and farmsteads (figure 216), this is less pronounced than that seen in the south and in the central belt regions. The changing settlement types between southern and northern regions and a difference in the density of settlement is likely to be reflected in these figures, making them not directly comparable with data from the south. However, on a subregional scale variation is also

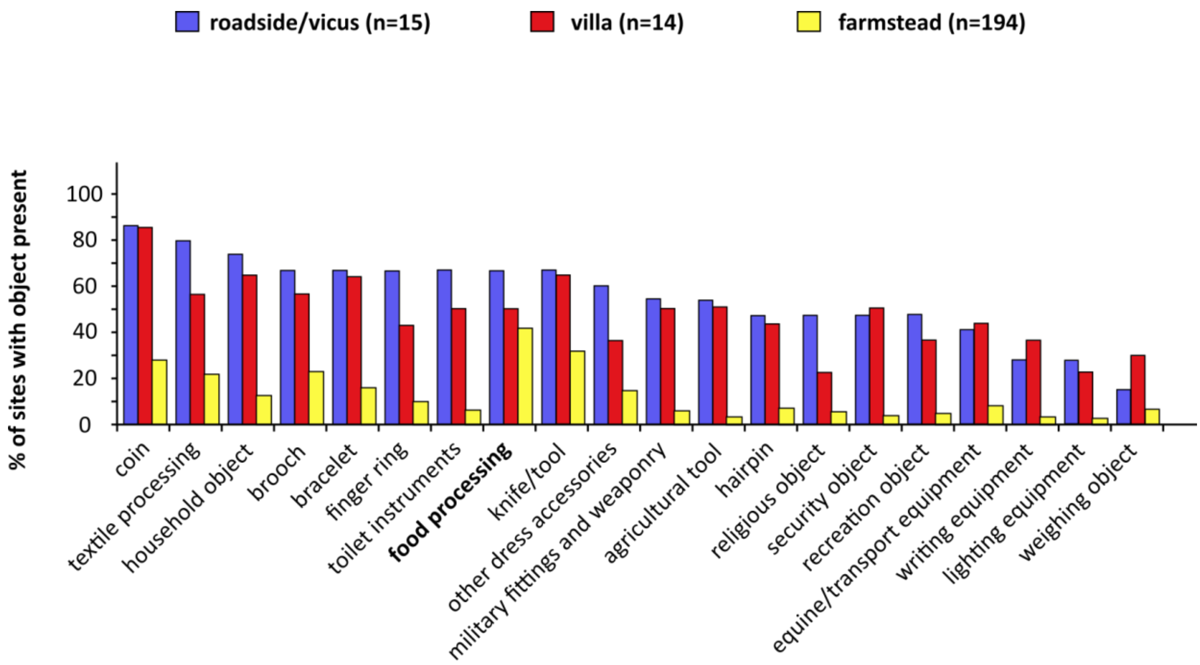


Figure 216- Presence of major finds categories by site type in the north-eastern region (after Allen, 2016a, Fig. 7.40, p. 275).

visible; there is a more significant presence of quern stones in the areas of the Tees Lowlands and Magnesium Limestone Belt, and these are more prolific than coins or brooches within these districts. Again, we must consider underlying patterns in artefact distribution, in this case the relative rarity of metal finds on northern sites (when compared to southern Britain). Millstones are recognised at 18 sites in relatively high numbers, and these have been interpreted as subregional centralised food processing locations (Allen, 2016a, p. 275).

Rural northern sites show a general lack of finds across all main finds categories, though querns are common, being less frequent than pottery only. Querns have been recorded at over 50% of farmsteads, a notably high proportion in comparison with other regions, and this is interpreted as evidence for accessibility to grain as a foodstuff for those living within these settlements. Arable farming is thought to have taken place in the lowland areas, the Eden Valley and Solway Plain in Cumbria, while livestock farming is more evident in parts of the Northumberland uplands.

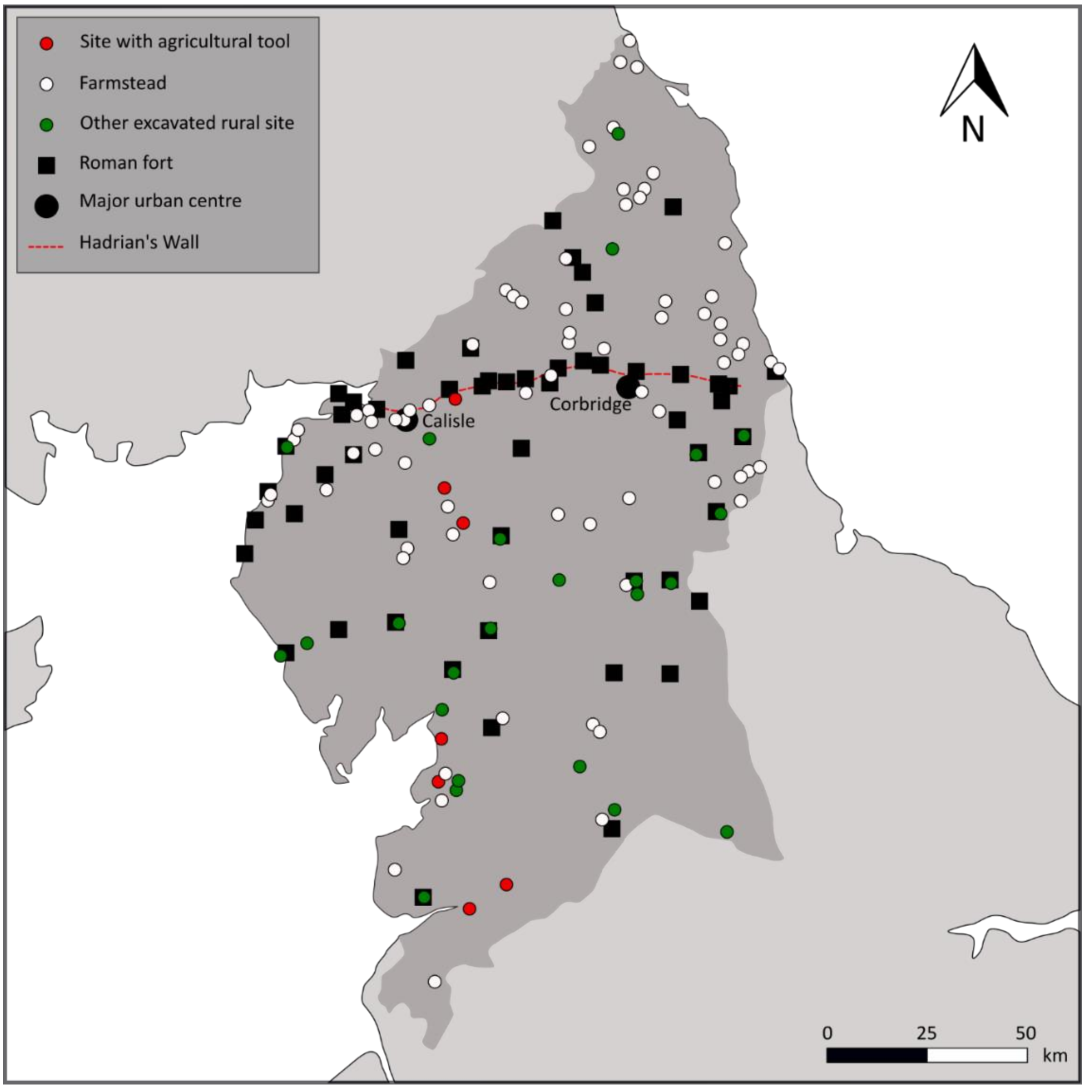


Figure 217- Distribution of sites with agricultural tools in the north region (after Brindle, 2016b, Fig. 9.21, p. 327).

Agricultural tools are mostly found at sites limited to the western lowland areas (figure 217) which, combined with other evidence, suggests that the scale of food production was diverse across the region. Though small-scale food processing appears to have been common and widespread practice, the interconnection between processing and production is less clear and may have varied across different parts of the region (Brindle, 2016b, pp. 325-327).

With a lack of substantial environmental evidence in the south-west, interpretations relating to farming practices and food processing activities have been drawn using finds evidence from the region's sites. Due to a lower proportion of finds from the Devon area, the picture of activity is clearer in Cornwall. It has been suggested by Brindle (2016c), that this variation is indicative of notable socio-economic differences between life in Roman Cornwall and Devon, though there are numerous other reasons why such dissimilarities in evidence may have occurred. Differential preservation, recording and excavation strategies are factors for consideration and will be detailed further in the discussion part of this chapter. Nonetheless, the notable difference in the presence of field systems, agricultural tools and querns between the two areas appear to reflect a focus on arable production in the west of the region (figure 218). In terms of variance between site types, there were significantly more farmstead sites in Cornwall with food processing tools present when compared with hillfort sites. However, due to the low number of hillfort sites, when considered as an average frequency of finds per settlement, there is little difference between the numbers found at hillforts and village sites. As with the north, food processing tools are common finds and are present at 50% of farmstead and village sites. This is greater than that found in the south and the central belt regions and might indicate more prolific small-scale and domestic food processing practices (Brindle, 2016c, pp. 354-356).

For the upland Wales and the Marches region, finds evidence also plays a key role in determining the presence of food production and processing activities due to inconsistent environmental evidence. Querns are more common in the northern part of the region and are often accompanied by evidence for the presence of cereals. This may indicate that grain was more extensively consumed in this area or reflect taphonomic and publication factors. The higher prevalence of agricultural tools in the north also mirrors what is seen with the food processing tools. This pattern is also seen in the difference between major finds categories at farmsteads in the region (figure 219). The presence of querns at farmsteads in northern Wales far outweigh quantities in the south of Wales. With regards to agricultural tools, the number of sites showing a presence, in both the north and south, is too small for the difference to be considered significant (Brindle, 2016d, pp. 380-381).

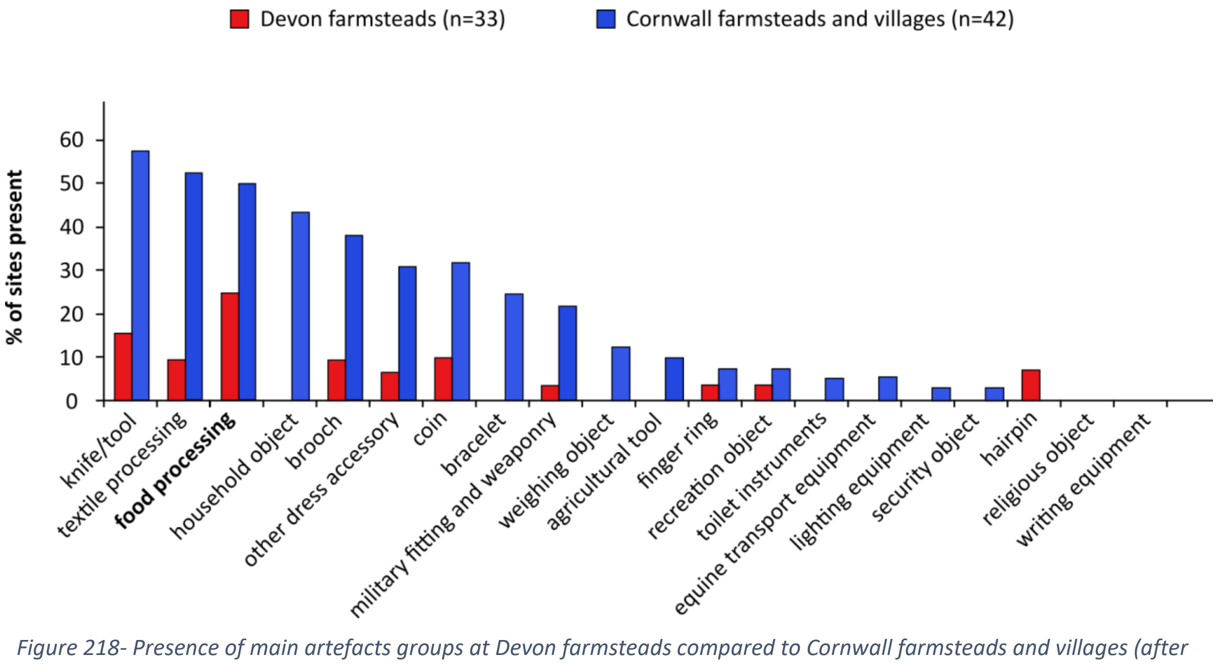


Figure 218- Presence of main artefacts groups at Devon farmsteads compared to Cornwall farmsteads and villages (after Brindle, 2016c, Fig. 10.22, p. 355).

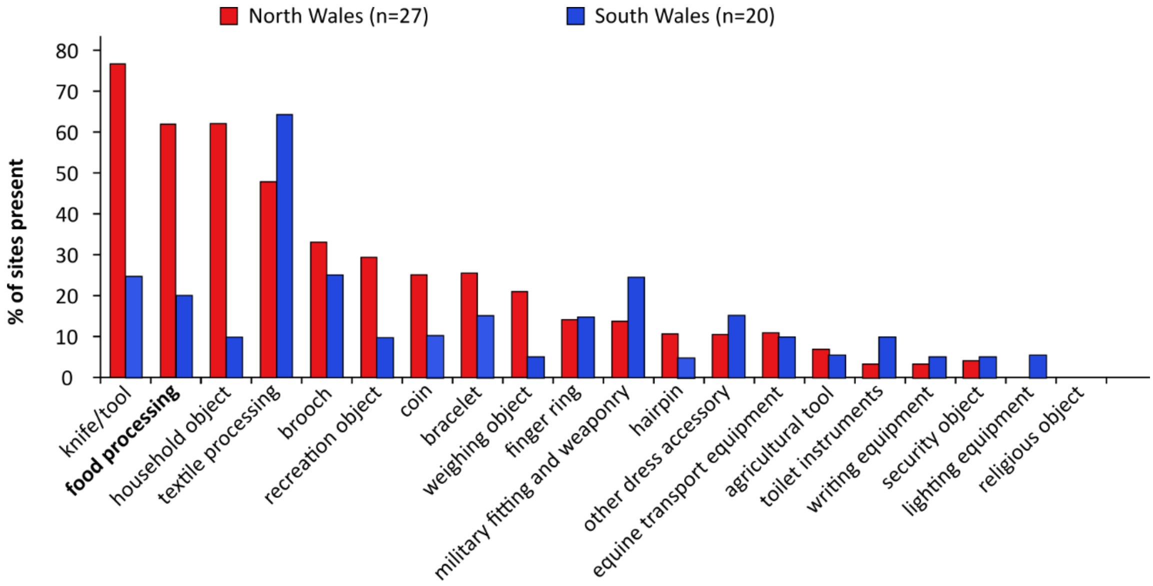


Figure 219- Presence of main artefact groups at farmsteads in the north of upland Wales and the marches compared to those in the south (after Brindle, 2016d, Fig. 11.21, p. 381).

In the central west region, most finds were recovered from villas and nucleated settlements, while farmsteads show much less of a range and presence of the main artefact groups (figure 220). This is less pronounced for food processing tools when compared with brooches or coins, though farmsteads do still present the lowest number of sites where querns or millstones were recovered (19%), compared to villas (38%) and nucleated settlements (29%). Furthermore, there is an apparent 'hierarchy' of access to material culture when comparing the hinterlands of Chester and Wroxeter, with a greater range of different object types present in the rural sites around Chester (Brindle, 2016a, pp. 303-304).

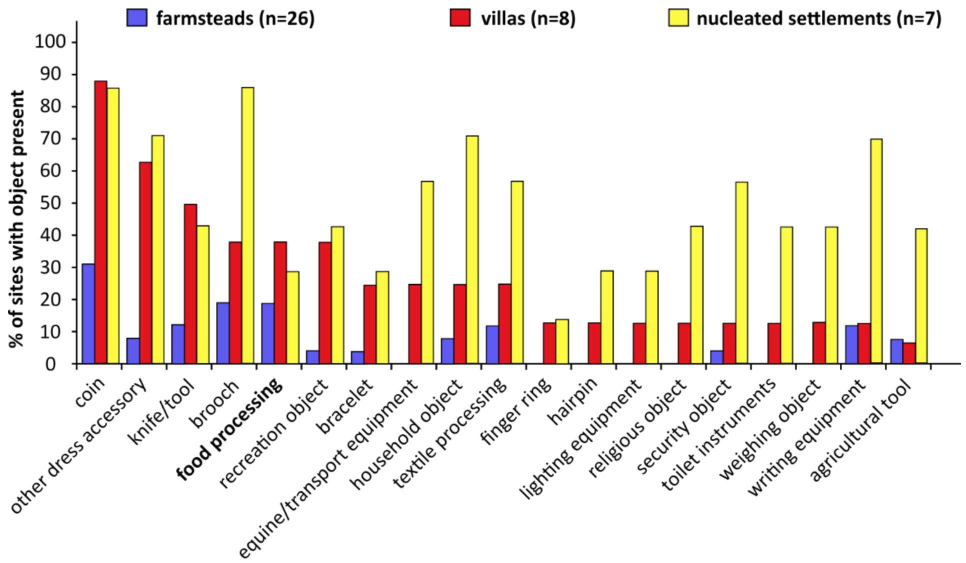


Figure 220- Presence of main artefact groups by site type in the central west region (after Brindle, 2016a, Fig. 8.23, p. 303).

Querns and Millstones as Proxies for the Romano-British Economy

These areas of analysis are built on further in the second volume published as part of the project, titled 'The Rural Economy of Roman Britain' (2017), which looks at the economic role of querns and millstones from a broader provincial perspective. It concludes that the use of saddle querns was rare after the Roman conquest, though they are still found on rural sites, mainly at traditional enclosed farmsteads of the north and south-west regions. The reuse of some rotary querns as saddle querns implies that chronological development in the use of the different modes of quern operation was not linear, though this could also be taken to suggest that different functions may have been associated with different forms. Rotary querns distinguished as Late Iron Age types, including Beehive and Wessex forms, were found to have continued in use at some rural sites, especially the north. These types were rarely found in Roman contexts in the south unless the site was found to have Iron Age origins. Flatter disc type querns are much more common (Brindle, 2017, pp. 71-72).

Millstone (defined by the RRS project as having a diameter of over 600mm) are shown to be much less widespread than querns. These were found to be present at 5% of sites in the dataset, being most prolific at roadside settlements (18% of sites with millstones present), villages (16%) and villas (15%). The sites where millstones were present were found to be predominately located in the south and the east of England where many of these site types were located. Direct evidence for mill structures was infrequent, occurring on only 17 occasions (figure 221). Millstones and querns were often found together within the same sites; showing how small and large-scale processing may have occurred concurrently to serve immediate food requirements and those within a wider distributive network, possibly in urban and religious centres. The occurrences of both querns and millstones within single sites also provides possible evidence for malt production, with the use of different tools to complete different processing needs. Environmental evidence for malting did occur at 29 sites with millstones present, supporting suggestions by Shaffrey (2015, p. 70-72) that the mill at Northfleet Villa, Kent was used for such purposes (Brindle, 2017, p. 72).

The use of environmental evidence in correlation with quern presence has been another important aspect of the multi-disciplinary methods used by the RSRB project. For example, late Roman complex farmsteads in the east show an increase in spelt wheat cultivation and processing. Final stage processing is evident in the prevalence of glume wheat de-husking waste in correlation with the regular presence of querns. This has been used to suggest that post-storage de-husking of such grains must have occurred 'en-masse' at these sites, pinpointing possible agricultural strategies that may have been commonly adopted and widespread in the West Anglian Plain (Allen & Lodwick, 2017, p. 149). In other areas, such as in North Wales, quern presence is used to support less

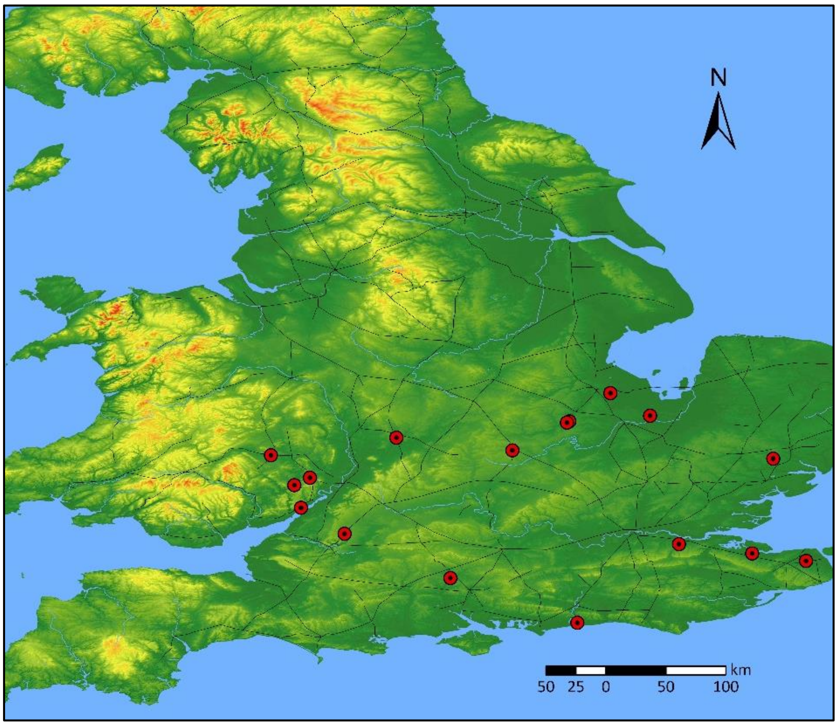


Figure 221- Locations where direct evidence for mill structures has been found according to data from RSRB.

consistent archaeobotanical and structural evidence for cereal processing, showing that small-scale processing was a common activity (Allen & Lodwick, 2017, p. 168).

With regards to the role of quern manufacture in the Roman economy, examples of quern quarries were recorded by the project. However, this is not a detailed discussion. The import of lava querns into Roman Britain is acknowledged, though this is also not considered in any depth in terms of the possible impact such imported goods may have had on the economy. Although it is recognised that evidence for quern quarrying and manufacture in Roman Britain is poor, the opportunity to harness the RSRB data to clarify some aspects of this 'industry' through distribution analysis of quern by stone type is not introduced (Brindle & Smith, 2017, p. 199).

Structured deposition on RRS project sites

The social character of quern use at Roman and Late Iron Age settlements in Britain has been tackled in Volume 3 of the project monographs, 'Life and Death in the Countryside of Roman Britain' (2018), which examines at the prevalence and context of objects within structured deposits (see pp.123-124 for definition of what constitutes a structured deposit in this case. The analysis produced a summary of the sites that, during these periods, were found to have structured deposits present, the types of features with which these were associated, and the types of objects that were contained within them. This was completed for different chronological periods to demonstrate a possible shift in ritualised behaviour (Smith, 2018, pp. 184-191). Querns are thought to have held a great deal of social significance in the past due to their vital function within food preparation activities. Deposition practices are one way that this significance and meaning can be identified and interpreted (Brück, 2006).

Structured deposition of querns in the Iron Age is a relatively well-recognised phenomenon (Watts, 2014; Heslop, 2008, pp. 68-75), and this is demonstrated well through examination of the RSRB data. Within the dataset, it was found that from the 84 sites that had evidence for structured deposits, 13 included quern stones (16%). One example is given, at Runfold Farm, Farnham Quarry in Surrey, where an intact quern was recovered from a ditch terminal with a brooch, animal bone, fossils, and pottery (figure 222) (Smith, 2018, p. 131). The treatment of the 12 querns from other sites is not captured in the data, nor are the types of features from which they were recovered or associated finds. Less well understood and identified is the part that querns and millstones may have played in religious or ritual activities in the Roman period. Although prehistorians are now familiar with the concept that querns held socio-cultural meaning as expressed in ritualised settings, this has not been fully explored for other periods despite the continued importance these objects must have held. There is a strong association between eating, drinking and ritual in Roman culture and this provides one avenue through which querns may have been involved in Romano-British ritualised activities. This is not to discount the pre-existing relationships between people and querns that may have endured from the Iron Age, albeit not necessarily in the same form or with the same meanings. Nonetheless, structured deposition involving querns and millstones is yet to be explored fully for the Roman period, but the RSRB project begins to address these questions.

Figure 222- Complete quern stone recovered as part of a possible ritual deposit from a ditch terminal (Lambert, 2013, p. fig 8).

One example of the use of the RSRB data to explore this theme involves the investigation of sacred rural sites to identify finds that could have ritual connotations due to the manner of their disposal but are not readily identifiable 'cult objects', being more utilitarian in nature. Querns fall into this category; they are often found as part of structured deposits but are generally related to more domestic or commercial functions. This definition has resulted in the categorisation of querns and millstones as 'non-votives' at these sites alongside other objects, such as writing equipment and tools. Interestingly, it was found that these types of objects were more likely to be present at 'rural sacred sites, such as at sanctuaries and shrines, than at sacred sites related to or connected to a settlement (Smith, 2018, pp. 173-174). This demonstrates a possible pattern in deposition and disposal practices that could be indicative of socio-cultural meaning associated with these objects.

Changing practices and changing meaning is also a worthwhile consideration and this has been explored by examining chronological changes in the presence of some artefacts, including querns, in structured deposits. It was found that there was a noticeable decrease in the number of querns that were incorporated into such deposits during the Roman period compared to the Late Iron Age, though other artefact groups, such as coins, increased in prevalence. In terms of differentiating which parts of society may have been engaged in ritualised quern deposition, farmsteads were more likely to have querns included in structured deposits than at villas, nucleated settlements, or religious sites.

Appendix 2. Dorchester-on-Thames

Background to the site

The modern-day village of Dorchester-on-Thames is located on the site of the former Roman settlement, close to the junction of the River Thames where is meets the Thame (figure 223). The town was situated on a road that connected it to the south with Silchester, and to the north with Alchester and Towcester and was surrounded on at least three sides by a wall that enclosed the main occupation area (Burnham & Wacher, 1990, p. 117). It is a site for which there are still many unanswered questions that are yet to be addressed when compared to other minor towns of the province. Although there have been several excavation projects undertaken over the past century, the most recent undertaken by the University of Oxford and Oxford Archaeology, these have been relatively limited. Consequently, we still are not aware of the presence or location of any public buildings, the town's 'Roman' name, its full extent, the dates of initial occupation and whether there were military structures or military occupation at the site (Morrison, 2009, pp. 26-46). The variety and scale of craft, agricultural or industrial activities undertaken at Dorchester-on-Thames have rarely been investigated and the role of the town within the scope of Romano-British society, politics and the economy will require further examination, especially in relation to the types of artefacts recovered.

There is clear evidence for the presence of Iron Age activity within a 'Belgic oppidum' site a short distance south-west of the Roman small town. Known as the Dyke Hills fort, excavations have demonstrated that Gallo-Belgic imports, including pottery, were entering the settlement in the Late Iron Age to early conquest period (Morrison, 2009, pp. 21-22). After excavations conducted by Frere in 1963, it has been suggested that the town saw an early military phase during the Roman era and that the town had initially been a *vicus* with a first century fort. Timber structures that were demolished after AD 78 are claimed to provide evidence for this, alongside a possible military ditch (Frere, 1984, pp. 91-97), though these features are not necessarily military in nature and more work needs to be done to prove or disprove this theory (Morrison, 2009, pp. 42-43). The town was 'defended', initially by second century ramparts and a ditch on the south and west sides, which were replaced in the second half of the third century by a masonry wall that has been traced on its north, west and south sides (Burnham & Wacher, 1990, p. 119). The discovery of these features probably led early excavators to the conclusion that these must have been associated with military activity and the need for fortification (cf. Wacher, 1975), an assumption that is often questioned today.

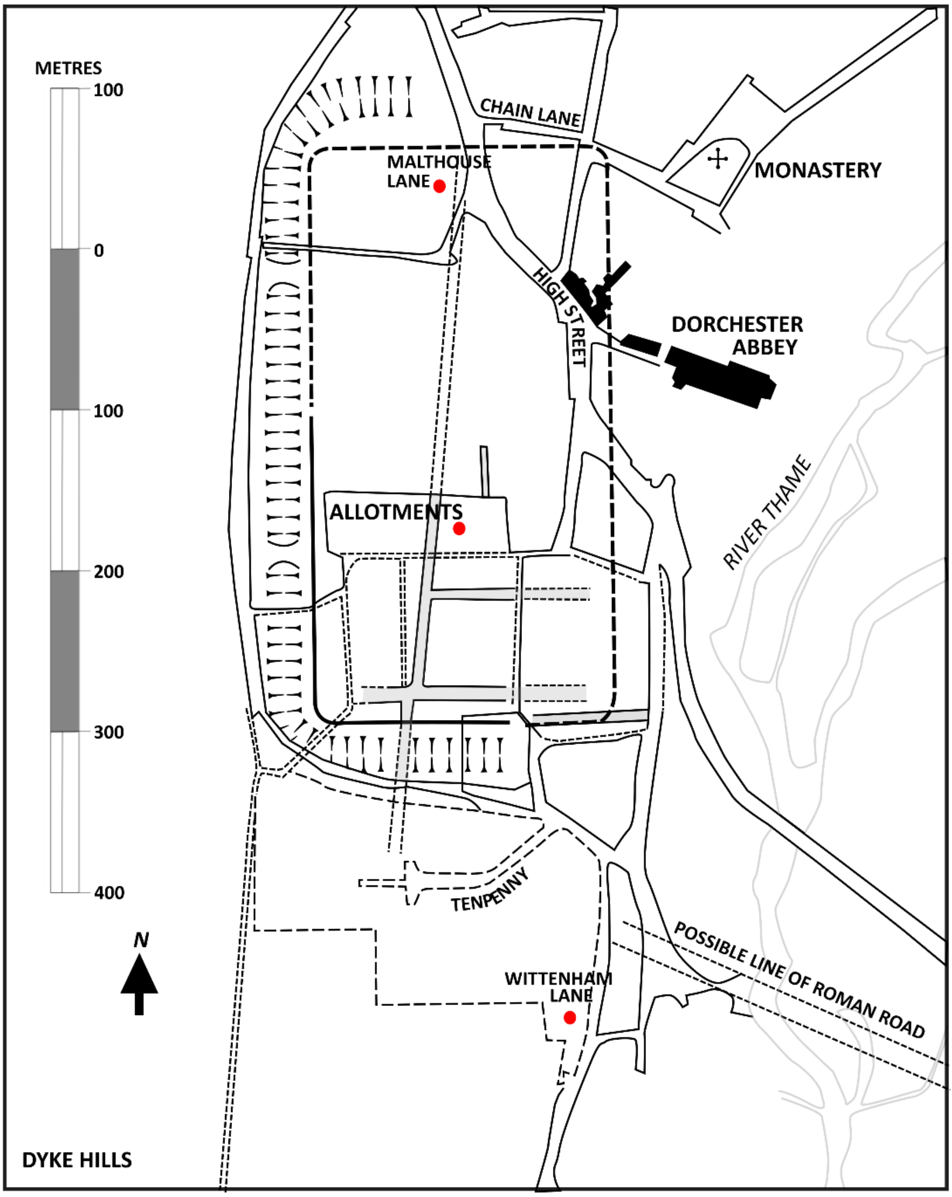


Figure 223- Plan of Dorchester showing location of town walls and key excavation sites (after Frere, 1962, p. 115, fig. 1).

The earliest buildings in the town, excluding those interpreted as belonging to the Roman 'fort', can be dated to around the middle of the second century and fronted various streets. Several kilns or ovens have been associated with a building dated to the late third or fourth century and are possibly associated with burning lime (Morrison, 2009, p. 46). Other signs of nearby industry include that of pottery production, with kilns identified approximately 1.5km north along the road to Alchester, but not within the town itself (Young, 1972). The geology of the region is that of chalkland that is well-known today for high quality grazing, and it seems probable that similar uses of the land may have existed in the past (Burnham & Wacher, 1990, pp. 119-120). Little is known of the role of agriculture in the hinterland of the town, or the type of crops that may have been cultivated. Small-scale environmental sampling has taken place for two developer-led excavations in the town, and these have indicated that crops had been processed at the locations where sampling had taken place: 11

Wittenham Lane, and 8 Malthouse Lane. The evidence at Wittenham Lane was associated with second century features and yielded charred grain with weed seeds and chaff, possibly indicating the later stages of crop processing when larger weeds seeds would be removed (Williams, 2013, p. 48). However, the type of grain was not identified, and this was also the case at Malthouse Lane (Čelovský, et al., 2015, p. 14). Future research may benefit from a more systematic approach to environmental sampling and analysis in order that questions relating to the local economy and food supply might be addressed.

The Dataset

The lava quern and millstone dataset for this section has been generated using excavated material from the more recent excavation project carried out by the University of Oxford, Oxford Archaeology, and the people of Dorchester-on-Thames since 2007 [4]. This forms one of the most substantial and targeted excavation projects undertaken in the town since the Frere investigations in the 1960s, with work focused on the Minchin Recreation Ground and the Village Allotments, close to the site of these previous excavations. These excavations produced the first quern dataset for the town that can be attributed to the Roman period, though some of the milling tools in the assemblage are difficult to separate from those dated to the Early Saxon period due to a great deal of intrusion from later features and activity at the site. This means that the objects themselves need to be considered individually, as typological variation may provide information on the period of manufacture where context information is unclear.

Overall, the lava quern assemblage is very small, comprising fourteen fragments, only three of which can be identified positively as being from Roman contexts, with a further one fragment that is diagnostically Roman despite being from a later context. A further three small and undiagnostic fragments were recovered from a developer-led excavation at Old Castle Inn, but these were associated with later post-medieval and Saxon deposits and have, therefore, been excluded. The non-lava querns provide the bulk of the data, with 31 examples recorded of various types. However, these are yet to be given spot dates and must be interpreted with caution as they may represent milling tools that were in use in later periods at the site. They have been included here to provide some context for discussion into the kinds of milling tools that were available and supplied to the town and what this might reveal about the kinds and scale of processing activities that may have taken place there. As the sample for this dataset is comparatively small and because of the

[4] https://oxfordarchaeology.com/news/332-more-of-roman-dorchester-on-thames-revealed.

ambiguity associated with the contextual information for the non-lava querns, the approach for exploring the data from Dorchester-on-Thames will deviate from the usual object biography method, and the data will be discussed as a group.

The Querns

As described in the previous section, there are three fragments of lava that were recovered from Roman contexts: one from an early and two from late Roman deposits. There was a further fragment from a Saxon context that can be identified as Roman due to the presence of dressing on its surfaces, a feature that is not present on Saxon or medieval lava querns. The remaining ten fragments, which are largely undiagnostic and small, were retrieved from contexts that could be broadly dated from the late Roman to Early Saxon period, suggesting that these could comprise residual Roman material. It is probable that this is the case as the import of Mayen lava milling tools appears to have slowed, or even ceased, by the mid-to-late third century (Buckley & Major, 1981, p. 76; Peacock, 1980, p. 50) (see also Chapter 4). Imports appear to have recommenced after the sixth or seventh century (Parkhouse, 1997, pp. 97-99; Mangartz, 2008, p. 124). It is, therefore, possible to assume that these Early Saxon fragments of quern were initially brought to the site in the Roman period and that they may have been reused or redeposited into later contexts (often for resurfacing or leveling), as is often seen at other sites. This makes it difficult to identify activity areas where these objects were in use for processing, and also provides some challenges in terms of dating these activities or understanding chronological changes in the scale of processing undertaken in the town.

The scale of lava use during the Roman era at Dorchester-on-Thames is difficult to ascertain, mainly due to the challenges associated with dating and the extent of fragmentation of the material. As most of the fragments are small and undiagnostic, it is impossible to determine the minimum number of querns present in the assemblage and fewer objects may be represented. The number of other querns does suggest that there were multiple milling tools in use in or near the site and that large scale processing may have occurred. However, the absence of dating for these objects does not allow for this to be necessarily associated with Roman period use and there may be many centuries of quern material within the dataset representing much smaller scale processing over a long duration.

The presence of at least one lava quern from an early Roman context is significant, and this example can be dated to between AD 70-120, which is around the time that the peak in lava imports to Britain was occurring. Though this is not an exceptionally early example compared to those from London and Colchester, where lava has been recovered from pre-Boudiccan deposits (Buckley &

Major, 1981; Dunwoodie, 2004), it is the earliest recovered from Dorchester-on-Thames thus far. Its occurrence at the site demonstrates that lava was being exchanged during this peak trading period as far west as Oxfordshire, and the scale of the trade was infiltrating into regions that traditionally made use of indigenous types of stone. The reason for this adoption of lava is not clear, as suitable stone for milling was both locally known, and also readily available. There may have been a preference for lava and its unique grain cutting properties, or the supply of locally manufactured milling tools may have not been able to keep up with demand, resulting in the need for imported goods. Shaffrey and Roe (forthcoming) has suggested that local Oxfordshire quern production was a minor industry for the Lower Greensand quarries at Faringdon, and may have been an ad-hoc affair for some of the other sources, implying that the scale of production of milling tools may not have matched the needs of possible increased agricultural production during certain phases of the Roman era.

The fact that Dorchester-on-Thames was well-connected with other parts of the province increases the liklihood for there to be lava present at the site. The placement of the town close to the Thames and the nearby road system would have enabled access to a range of different products, including imported lava. Though within the ‘catchment’ area for lava consumption in Britain, the town is located within a region where lava is not as prevalent in comparison with eastern and south-eastern Britain. This may be because other stone types were preferred. The range of different stone types at Dorchester shows that there was a breadth of choice available from a variety of relatively local sources (figure 224), though it is hard to say whether all of these were all in use in the Roman period. These include querns of Lodsworth stone from West Sussex, Hertfordshire Puddingstone, Millstone Grit, Oxfordshire Grit from Culham and Faringdon, and Old Red Sandstone from the Wye Valley and the Forest of Dean (Shaffrey, forthcoming). These stone types are all known to have been used elsewhere in Oxfordshire in the Roman era, though the degree to which specific types are dominant in certain parts of the county are yet to be fully explored. At Dorchester, Old Red Sandstone is prevalent, though this needs to be correlated with dating evidence to show whether this was associated with Roman period consumption. Regardless of this, it appears that there may have been multiple competitors in the quern trade that were able to supply a wide area that encompassed Dorchester and much of the area now covered by modern-day Oxfordshire.

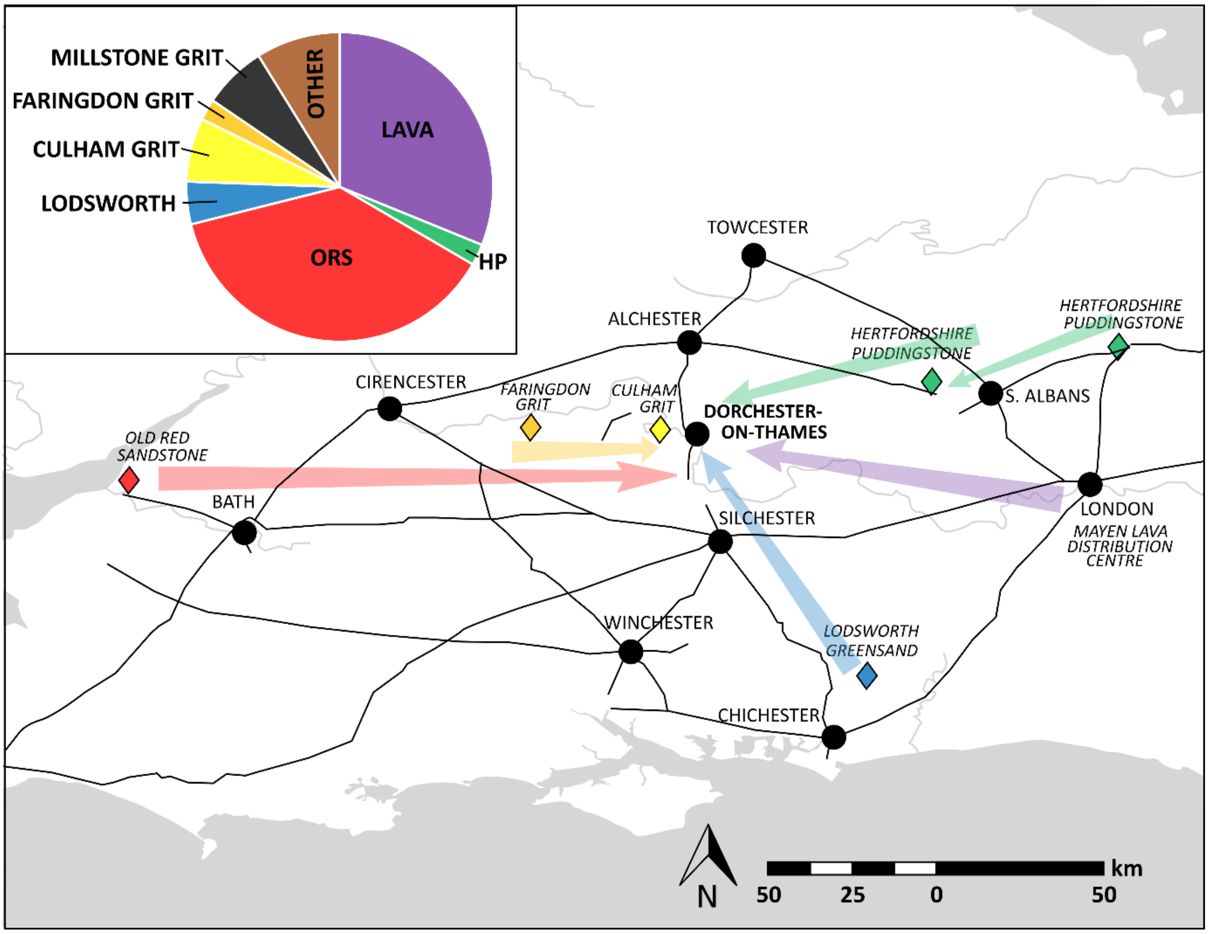


Figure 224- Map showing the sources and travelling distance of each quern stone type present at Dorchester-on-Thames and the relative proportions present (after Shaffrey 2021).

Appendix 3. Town and Country: An Investigation into Quern and Millstone Use at Chichester, Fishbourne Palace and its Wider Hinterland

Aims and Objectives

The aim of this chapter is to examine in more detail what the effect of non-lava quern production areas may have had on the use of imported lava milling tools in a specific region of Roman Britain, and how this varied between a town, an elite villa site and the surrounding hinterland. Currently, there has been no detailed analysis of this kind completed for the region, though the locally produced querns sourced from the Lodsworth Greensand quarries have been subject to more thorough investigation (Peacock, 1987; Shaffrey & Roe, 2011). There is, therefore, the opportunity to present a new and interesting exploration of the interplay between different quern sources across different social contexts. Lodsworth greensand is relatively easy to identify, and so the lithology classifications for querns in the wider Chichester district tend to be present and accurate in published site reports. Furthermore, as this tends to be the dominant type of quern present, there are fewer types to identify or contend with when interpreting the data, producing a simpler view to that of other regions.

There are several ways that this data can be examined. Distribution analysis may present the locations and site types where lava milling tools may have 'competed' with the local supply of querns and millstones, while also possibly revealing those areas with closer ties to the continent in terms of trade and exchange or social ties. The volumes of lava present in certain areas may reveal the extent to which such exchanges may have been occurring. This can be explored on both a regional basis with consideration of the hinterland and surrounding areas around Fishbourne Palace, and with regards to Noviomagus as a town and the specific areas of the town where lava milling tools are present or absent. This is, by no means, a complete examination of the evidence for querns and millstones, and there are areas where data is absent. However, it does provide a view of the potential that the data has for helping us understand the role that the district held in terms of food production, grain processing, local and intercontinental trade and exchange. The connection that Fishbourne and Chichester had with Northern Gaul during the early Roman era is well-established, but links with the Rhineland has received less attention in the current literature.

Further to this, the aim is to also examine centralised distribution vs small scale food processing in the area, and to understand how lava milling tools may have contributed to the economic arrangements seen. Analysis of the distribution of millstones compared to quern stones will also aim to identify locations where centralised distribution may have been occurring and the chronologies for when this may have been the case. Examination of the millstones themselves may provide details with regards to how they were operated, allowing a glimpse into how milling may have been organised.

Background Information

Chichester

Strong evidence exists for a connection between people living on the south coastal areas of Britain, Gaul and Belgic Gaul in the Late Iron Age. This includes literary accounts by Caesar in the early part of the first century BC (De Bello Gallico, V.12) and archaeological evidence such as Belgic coins, pottery forms and burial customs. It is not fully known whether this was the product of migration, trade links or a combination of both, and a range of theories have been proposed in an attempt to understand who controlled and inhabited the pre-Roman kingdoms that included the Chichester district (for some examples, see Cunliffe (2006, p. 5); Cunliffe (2006, pp. 5-6); Down (1988, p. 1); Cunliffe (1999, p. 19)). Regardless of the precise narrative relating to these significant phases of Late Iron Age life in the region, a clear connection with continental Europe and Rome is apparent prior to the invasion of AD 43, and it is highly likely that Chichester and its environs were part of a client kingdom overseen by Roman rule (Creighton, 2000, pp. 62-64).

Connectivity between southern Britain and Rome continued into the pre-conquest period, while finds evidence suggest a link between Sussex, Wiltshire and Hampshire, indicating that these regions may have belonged to one tribal territory (for example, see De Jersey (1997)). Literary sources state that Verica was the named ruler of this region prior to AD 43, and that he had turned to Rome for help because of incursions into his territories, in part prompting the Claudian invasion (Fulford, 2001, p. 45). After dealing with invading tribes, conquering Kent and London, it is thought that the military, in the form of Roman legionary forces, was sent to the south coast, probably to be stationed at, or near, the location of modern-day Chichester. From here it is speculated that they launched their attack on the south-west, probably starting with the Isle of Wight and the Solent (Webster, 1993, pp. 77-94; Mattingly, 2006, pp. 94-100). Site evidence at Fishbourne for storage and port facilities (Cunliffe, 1999, p. 31), coupled with legionary and auxiliary camps to the east of modern-day Chichester (Down, 1988, pp. 8-14) indicate that this could have been the location from where the southern military operations were launched.

Based on high status finds recovered from the vicinity, including gold coins (Bone & Burnett, 1986), it has been speculated that one stronghold of Verica prior to the invasion was at Selsey (figure 225), and that due to coastal erosion, among other factors, the centre of power moved to Chichester in the early Roman period (Down, 1988, pp. 2-3; Cunliffe, 1991, pp. 152-153). More recent debates have questioned this interpretation, and it is possible that no such focal area of settlement existed at Selsey (Davenport, 2003, p. 106; Haselgrove, 1987, p. 119; Willis, 2007, p. 123). It may have simply have acted as a port and ritual site during the Late Iron Age. Down (1988, p. 14) interprets Noviomagus Regensium (Chichester) as the product of a military presence during the conquest period, with military activity said to have been the earliest dated evidence at the location and surrounding area of the town; while more recent interpretions, such as Davenport (2003, p. 106), have argued that artefactual evidence from Chichester dating to the first century AD Iron Age is indicative of pre-Roman occupation, and that the gridded streetplan is not necessarily post-conquest, similar to the Late Iron Age format seen at Silchester (Fulford, 1987). Similarly, a study completed by Pitts (2014; 2010) on brooches and fineware pottery at different post-conquest towns in Britain has demonstrated a strong possibility that Chichester's foundations were as an *oppidum*.

Despite evidence to suggest the military were present at Chichester in the early post-conquest period (Down, 1988, p. 16; Burnham & Wacher, 1990), this is unlikely to have continued for a prolonged period (Down, 1978, pp. 41-58), and first century finds evidence is from the town is predominantly non-military in character (Pitts, 2010). Areas within the Chichester with an evidence of an early military presence include the north-west quadrant of Chichester, especially around the possible 'depot' located at Chapel Street, where armour and other military equipment, such as javelins and spears were recovered (Down, 1978, pp. 41-52); and the suburb outside of the east gate of the town, where the legionary and auxiliary camps were located, close to the Roman cemetery on the north side of Stane Street and where domestic occupation also existed between the first and fifth centuries (Down & Rule, 1971, pp. 57-67; Down, 1981, pp. 80-84; Down, 1989a, pp. 55-86).

The development of the town during the early post-conquest period has largely been interpreted around the idea of it being the domain of a 'King' Cogidubnus/Togidubnus from literary and epigraphic evidence (Tacitus, Agricola xiv; Down, 1988, pp. 22-23; RIB 91). That he was a member of the ruling elite and a 'client king' seems certain, though his precise role as ruler remains unclear. Cogidubnus has almost gained mythological status, in that urban developments, signs of regional wealth, high status buildings or finds at both Noviomagus and Fishbourne Palace have been interpreted with him at the forefront, despite there being little knowledge of his life or death. The Flavian Palace at Fishbourne, which is largely attributed to Cogidubnus, may not even have been built during his lifetime (Down, 1988, p. 24). Currently, there is no direct evidence that can connect him with either this structure, or the preceding 'proto palace' at the same site (cf. Henig, 2010). However, as stated by Cunliffe (1971a, p. 169), 'it is easier to argue that Cogidubnus was the owner than not', a view that is reflected in much of the work completed on Fishbourne Palace and its

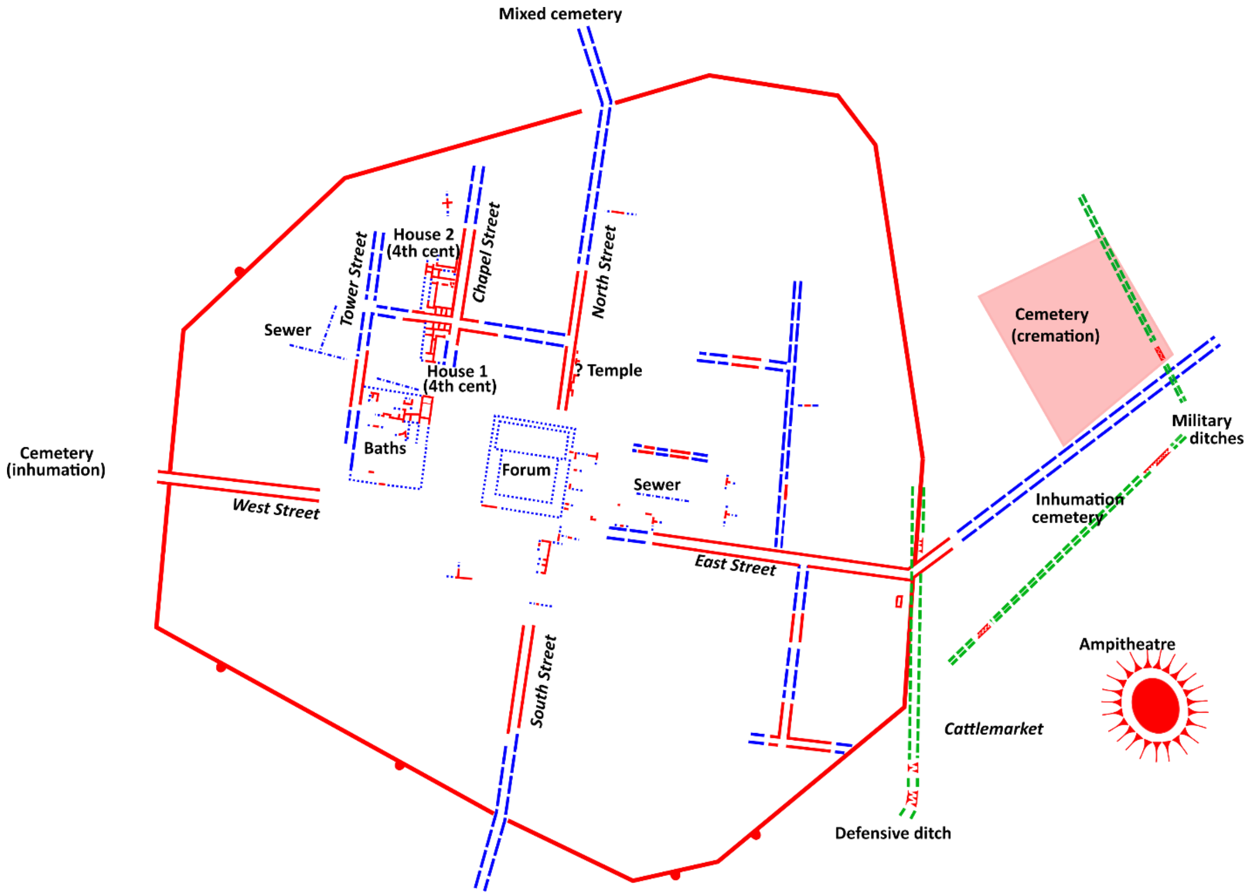


Figure 225- Plan of Chichester town with locations of some Roman features. Red indicates the locations of known features, while blue shows speculated or projected features. Green highlights projected ditch system. Names in Italics show modern locations and street names, regular text is used to label Roman period features (plan after Down (1988, pp. 15, fig 6)).

environs, including Chichester. The aim here is not to prove or disprove the role or influence any such individual had on the region of Chichester and Fishbourne, but simply to acknowledge that such a person existed and that their specific part in the history and archaeology of the region is too speculative to provide much interpretive assistance as part of this study.

In terms of the development of Noviomagus as a town, the earliest buildings have been largely associated with the military, belonging to the early post-conquest period. Evidence for timber barracks have been uncovered at the area of Chapel Street, while defensive ditches, probably as part of the early military camps, have been found east of the town. Redevelopment occurred in the last quarter of the first century AD, when buildings were demolished. A series of public buildings are likely to have been built during this phase, including a forum, basilica and bathhouse, though it is possible that such buildings existed prior to the redevelopment phase (Wacher, 1995, pp. 243-248).

Though the full extent of Noviomagus is not known, it is likely to have extended beyond the City walls, which were probably originally built towards the end of the second century AD. Occupation has been traced outside the north, east and south gates, but there are problems separating the earlier occupation phases from the urban sprawl of the succeeding centuries (Down, 1988, p. 38). On the northern side of Stane Street, there was a cemetery, and, to the south, there was domestic occupation dating from the first to the fifth centuries. The Cattlemarket site, which is in this area, has been interpreted as a possible tax collection site, where storage and processing of grain and the enclosure of cattle and sheep took place at scale (Down, 1989b, pp. 82-83). Production and manufacture were also important aspects of the regional economy, and a range of crafts and industries are evident (Down, 1981, pp. 70-72; Down, 1988a, p. 72; Down, 1978, pp. 52-89; Wilson, 1952, p. 167; Peacock, 1987; Down, 1988, p. 78; Rudling, 1986; Green, 1970).

Imports included a wide range of goods also, predominantly from Italy and Gaul in the Late Iron Age and early Roman periods, extending to other areas of the empire by the end of the first century AD. Noviomagus was clearly a well-connected and well-supplied part of the province, being able to export and trade the products of local manufacture, as well as receive goods from a range of different locations in the province and wider empire. The town was connected to the rest of the province and Empire via coastal routes from the ports at Fishbourne and Selsey and the four roads that emerged from the centre of the town, heading to: Silchester; Fishbourne and Southampton; Selsey, the Witterings and Sidleham; London (Stane Street), and Bognor Regis.

Agricultural production from the numerous farmsteads and villas in the area would also have contributed to the wider economic landscape of the region. Excavations in the Chilgrove Valley and Upmarden have provided a good view of rural life from the early second to fifth centuries. Both the Chilgrove villas saw multiple phases of development, beginning as timber buildings, before refurbishments in the fourth century that saw the construction of masonry buildings with underfloor heating, mosaic floors and a bathhouse. Imports from the Rhineland and Gaul were still finding their way to the villas in the fourth century, though a decline in fortunes at both sites is clear from around AD 360 (Down, 1979, pp. 40-52).

Fishbourne

At Fishbourne, the earliest phase of activity is associated with a ditch to the north-east of the palace site and timber structures beneath the proto-palace. At the time of excavation, these were initially interpreted as military in nature and dating to the early post-conquest period, immediately after AD 43 (Cunliffe, 1963, pp. 4-5). More recent investigations of the ditch feature and reanalysis of the pottery recovered from it has instead revealed that the evidence relates to a Late Iron Age high status site with signs that feasting was taking place nearby (Manley & Rudkin, 2005). Since then, there has been greater consensus regarding pre-Roman activity at the site, and interpretations regarding the foundation of Chichester have also been re-evaluated to reflect a similar chronology (Pitts, 2010; Creighton, 2000). The outcome of this investigation throws doubt over the phasing of the nearby timber buildings that were also initially interpreted as military and post-conquest. This, in turn, raises questions about the succeeding 'civil development phase' that followed (Cunliffe, 1999, pp. 34-37), in the form of two interconnected timber buildings of a more domestic nature that showed signs of Roman influence.

The harbour was a significant feature of Fishbourne and stone ballast, coming from Cornwall, the Channel Islands and the Armorican peninsula show that the movement of goods must have included heavy cargoes leaving Fishbourne and lighter ones returning (Sanderson, 1971, pp. 2-3). Provenance of the stone ballast can indicate the regions with which Fishbourne, and the Chichester district were trading. In the early post-conquest period, this was similar to that of the Late Iron Age, with the south coast of Britain and northern Gaul maintaining their roles as important trading hubs. The central southern coastal region must have been exporting bulky goods to these regions; perhaps in the form of grain and iron, goods that are less archaeologically visible and/or difficult to provenance. Whether the high-status dwelling was a product of the fortunes of the harbour, and a precursor to the palace that later developed, is a matter for consideration.

In the early 60s AD, the timber buildings were demolished, but not before the construction of a substantial 'Roman style' masonry building, dubbed the 'proto-palace,' was almost completed. Continuity of occupation is speculated from the design and layout of the buildings (Cunliffe, 1999, p. 46). Stone for construction was brought from local and distant sources, including from the Wealden area of Sussex, Italy, and the Cote d'Or in Eastern France (Cunliffe, 1971b, p. 1; Cunliffe, 1999, p. 40). The original building comprised a colonnaded garden, a bath suite and two ranges of rooms (Cunliffe, 1999, p. 41), decorated in a lavish style for the period (Cunliffe, 1971b, pp. 52-56). Construction is likely to have made use of continental craftspeople from Italy or southern Gaul (Strong, 1971, pp. 11-15).

The proto-palace in its original form was not long-lived and was eventually incorporated into the south-eastern eastern corner of a new larger building around AD 70-80 (Cunliffe, 1999, pp. 51-52). Materials for the Flavian palace were more widely sourced than for its predecessor, being both of local and foreign sources (Cunliffe, 1999, p. 52; 73). The famous mosaic floors were elaborate and would have required highly skilled persons to create (Neal & Cosh, 2009, p. 530). Every part of the palace structure and its gardens demonstrate the wealth, status and connections of the owner.

It is not only the structural evidence that demonstrates the highly unusual nature of Fishbourne Palace and its connections to wider reaches of the empire, but also the finds and environmental evidence. For example, coins (Reece, 1971; 1991), gemstones and other jewellery (Henig, 1971) and faunal remains (Allen & Sykes, 2011). Evidence for the consumption of exotic foods is sadly lacking, but environmental evidence for garden plants has shown a range of imported ornamental types were being grown (Lodwick, 2017). Furthermore, recent isotopic analysis completed by Madgwick, et al., (2013) has shown that fallow deer may have been introduced to Britain in the early Roman period, with Fishbourne being one of the first places to hold and manage these animals as a food source and a display of wealth, exclusivity and novelty.

A gradual change in status and wealth is visible in the artefactual and structural evidence after the second century AD, when parts of the palace were altered or demolished. Efforts appear to have been made to maintain the presentation and the comforts of the original palace design (Cunliffe, 1999, p. 116). For example, new mosaics were created where redesign took place and new floors laid down. The adjustments show that the palace was still in use, though the overall structure had decreased considerably in size due to these changes. The quality of the new design was still of a high standard, but does not compare to the previous grandeur and elite show of the Flavian palace (Cunliffe, 1999, pp. 132-133). At the time the palace was destroyed by fire towards the end of the third century, there were signs of further refurbishment and redesign. These may represent efforts to maintain living standards in an aging building (Cunliffe, 1999, pp. 138-139). However these works were not completed at the time of destruction, and the buildings were abandoned shortly after.

The Dataset

The data used as part of this case study has been taken from a variety of sources. Publications were used where available, and where detailed information relating to milling tools was provided. As this study aims to include other stone types, lithological descriptions and identifications were required, and sites could not be included where this data was absent. Most of the data was recorded in-person from the Fishbourne and Chichester District Museum archives. The archives contain material from sites that are loosely defined as being from the 'Chichester District', defined by Down (1978) as comprising both Chichester and Fishbourne Palace, and their hinterlands; to include rural settlement sites and villas that would have possibly used Noviomagus (Chichester) as the main 'market centre'. These were explored as part of research into the wider region around Roman Chichester during the

1970's and 80's and published in the 'Chichester Excavations' series monographs, which contain summaries of excavations carried out within the district at the time of publication, with an overview of earlier finds and investigations that were unpublished or published elsewhere. There is very little information within these monographs and reports on the quern or millstone finds, with multiple unpublished sites also being held in the archives at Fishbourne, and so it was necessary to record these in-person. Not all archived sites were recorded due to Covid restrictions, but a good sample was collated to produce insight into, what has been, a neglected aspect of Roman Chichester and its hinterland. The quern and millstone data has never been recorded in detail, and there has been no detailed holistic examination into the distribution and use of these objects for this region. In total, there were 38 sites included in the dataset, comprising a total of 186 milling tools, 15 of lava and 171 of non-lava.

Regional Distribution

Location data was used to plot the presence of milling tools, while separating them into the following categories: lava quern, non-lava quern, lava millstone and non-lava millstone (figure 226). Sites dated to the Roman period that were found to have no milling tools present were also recorded. The aim of this approach was to see where lava was present in the region and the extent to which it was used in different forms when compared to other stone types. Though there are some gaps in the data and more information in areas that have been subject to higher levels of development, it is possible to see some patterns. Overall, lava is quite rare – i.e. never makes up more than 28% on a site in this region. Lava is only present in the locations that are well connected to the coast and is more likely to have been in use around Fishbourne, Chichester and Angmering. In these locations, lava querns are more dominant than lava millstones, though a small number of millstones are also found. As one moves further away from these centres, there is a much lower chance that a lava quern or millstone was in use, including at Bignor Roman Villa, which as an 'elite' site, is a location where the use of lava might be expected when considering the pattern of lava use seen elsewhere at villa sites in the province (see Chapter 5).

There are some clear differences and similarities seen between the three villa sites of Fishbourne, Angmering and Bignor, though the deficit of data for locations around Bignor means that we should treat this site with some caution. One of the most significant observations is the scale of food processing at, and around, Fishbourne and Angmering. The volume of milling tools found at these locations and in the surrounding area is high when compared to individual sites in the wider hinterland. This could be a factor relating to the scale of excavation at each of the sites and, also, the duration of occupation, though it may also be indicative of more large-scale food processing activities occurring at these locations. The number of millstones recovered from these sites are also considerable in view of their relative scarcity in the wider archaeological record, especially at the site of the Rustington bypass, close to Angmering Villa where 27 fragments of millstone were recorded (Rudling & Gilkes, 2000). The coastal plain region of the south of Britain may have held an important role in the processing of grain to produce flour. This could be indicative of higher population levels and the need for a greater scale of food processing to cater for these needs but could also suggest that milling was occurring as a non-domestic activity. For example, to provide ready-to-use food products for those who held specialist roles with limited time to spend grinding grain. The presence of millstones indicates that milling itself may have been a centralised and specialist role, undertaken as part of commercial or mandated work to keep other parts of the economy and society functioning more efficiently.

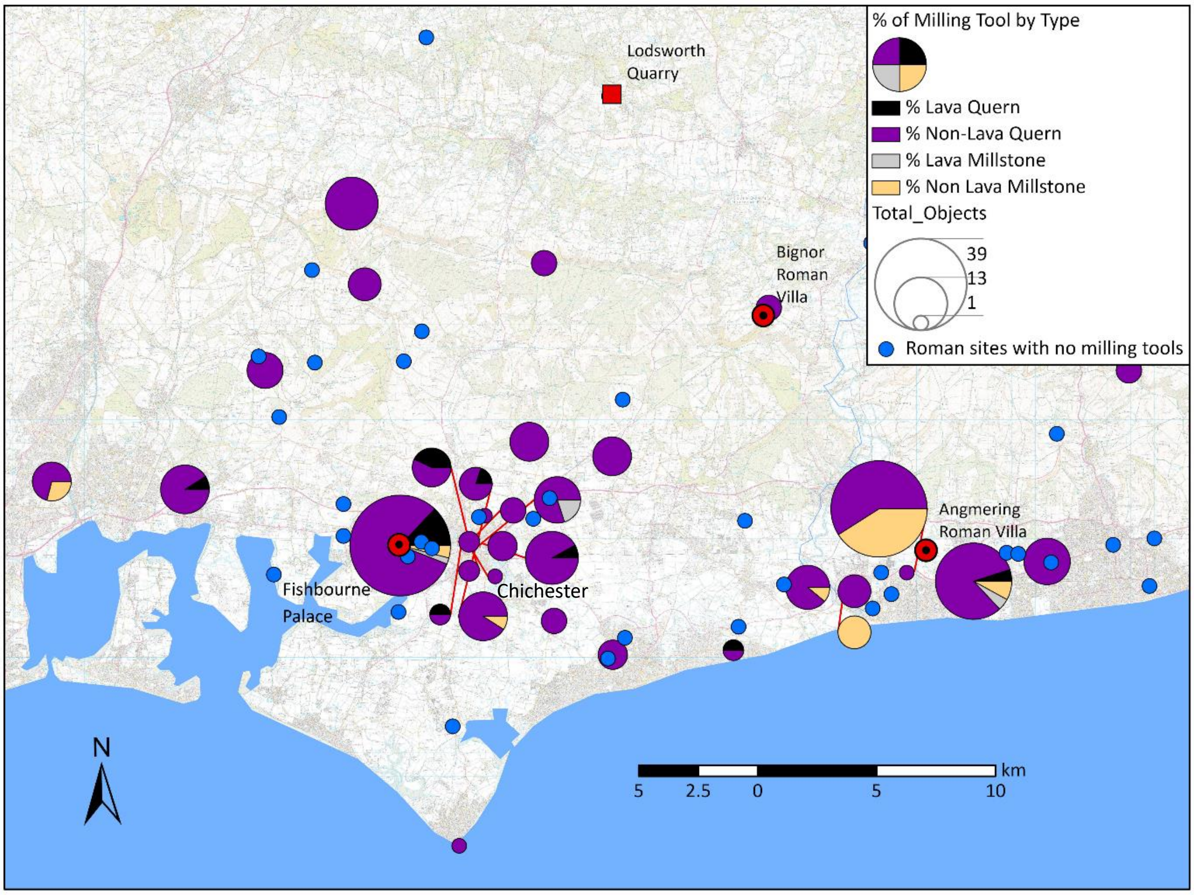


Figure 226- Presence of different types of milling tools in the region of Noviomagus (Chichester) and Fishbourne Palace (Backdrop map © Ordnance Survey).

The dense clusters of millstones seen around Angmering and Fishbourne could, therefore, be indicative of more complex and integrated economic behaviours, whereby more populous regions, such as urban centres, were maintained and grew wealthy primarily through taxation, exchange and rent payments generated from agricultural production. The enormous wealth seen at Fishbourne Palace in the first centuries of Roman rule and, albeit on a smaller scale, at Angmering Villa would not have occurred in a vacuum. The surrounding agricultural regions are likely to have sent grain and other goods towards the 'market centres' for taxation and trading purposes, where other exchange could also take place (Millett, 1990). The absence of lava in the rural areas around the villas and Chichester, however, suggest that any exchange taking place between the rural hinterland and urban or villa sites was not an equal one, from both a social and economic perspective. Perhaps lava was rejected in the (non-villa) rural areas as being too foreign or representative of Roman culture, or it may have been too expensive for rural populations to acquire (Pitts, 2016). Locations benefitting from taxation or exchanges with the rural areas must have included Angmering, Noviomagus and Fishbourne.

Lava querns and millstones were not the preferred milling tools of choice in the Chichester District, probably due to the locally supplied Lodsworth Greensand versions. Saddle querns of Lodsworth stone are known to have been in use from the Neolithic, while Lodsworth rotary querns were being produced by the Late Iron Age (Shaffrey & Roe, 2011). Exploitation of the stone for this purpose continued into the Roman period, ceasing at an unknown time but was most certainly not sustained after the Roman era (Peacock, 1987, pp. 67-69). Therefore, people living in the Chichester District would have had a long-term pre-existing knowledge of the Lodsworth quarries and that was a plentiful supply of good quality stone from which to make milling tools. Local knowledge and skills would have been available of how to work this material, which tools were needed for the job, where to cut the stone from and how long it would take to make the desired object. This stone type would have been used by generations of families, recognisable from its distinct colour, texture and properties. It may have had a specific feel or weight and produced predictable results and yields due to years of experienced use. Multiple generations may have used the same quern, producing significant socio-cultural value associated with a specific stone type (see Puddingstone example in (Griffin, 2003)). Stone tools can also be a material representation of the connection between landscape and people, as stone and other geology can be highly evocative of a person's place in the landscape and the meaning that they hold to that place (Clarkson, 2008, p. 490). Any or all these reasons may have influenced the choices made in relation to whether new types of quern were adopted over the use of locally supplied and produced milling tools.

The extent to which Lodsworth greensand was used within the Chichester District can be seen in figure 227. This map presents all data collected in-person, and that from publications where specific lithologies were identified. This has reduced the number of sites within the case study area. Nonetheless, it does show the prevalence of Lodsworth greensand use over all other types. It was clearly both a popular and widespread choice for milling tool material. Interestingly, the sites with lava present were much more likely to have the only other imported quern type present; French Puddingstone, which is a conglomerate similar to the Hertfordshire Puddingstone quarried in Britain. These were present at Fishbourne Palace, Roundstone Lane in Angmering and at The Hornet in Chichester. These querns have been identified as being made of French Puddingstone, probably of the Fécamp type from Normandy, due to their lithologies and, in two of the cases, the presence of a handle slot that fully perforates the stone to the hopper (figure 228), a feature that does not occur in Hertfordshire Puddingstone types. French Puddingstone querns were produced in the Late Iron Age until the early Roman period when manufacture moved to Britain, to the Worms Heath and Hertfordshire quarries, in the early part of the first century AD (Green , 2017, p. 167). It should be

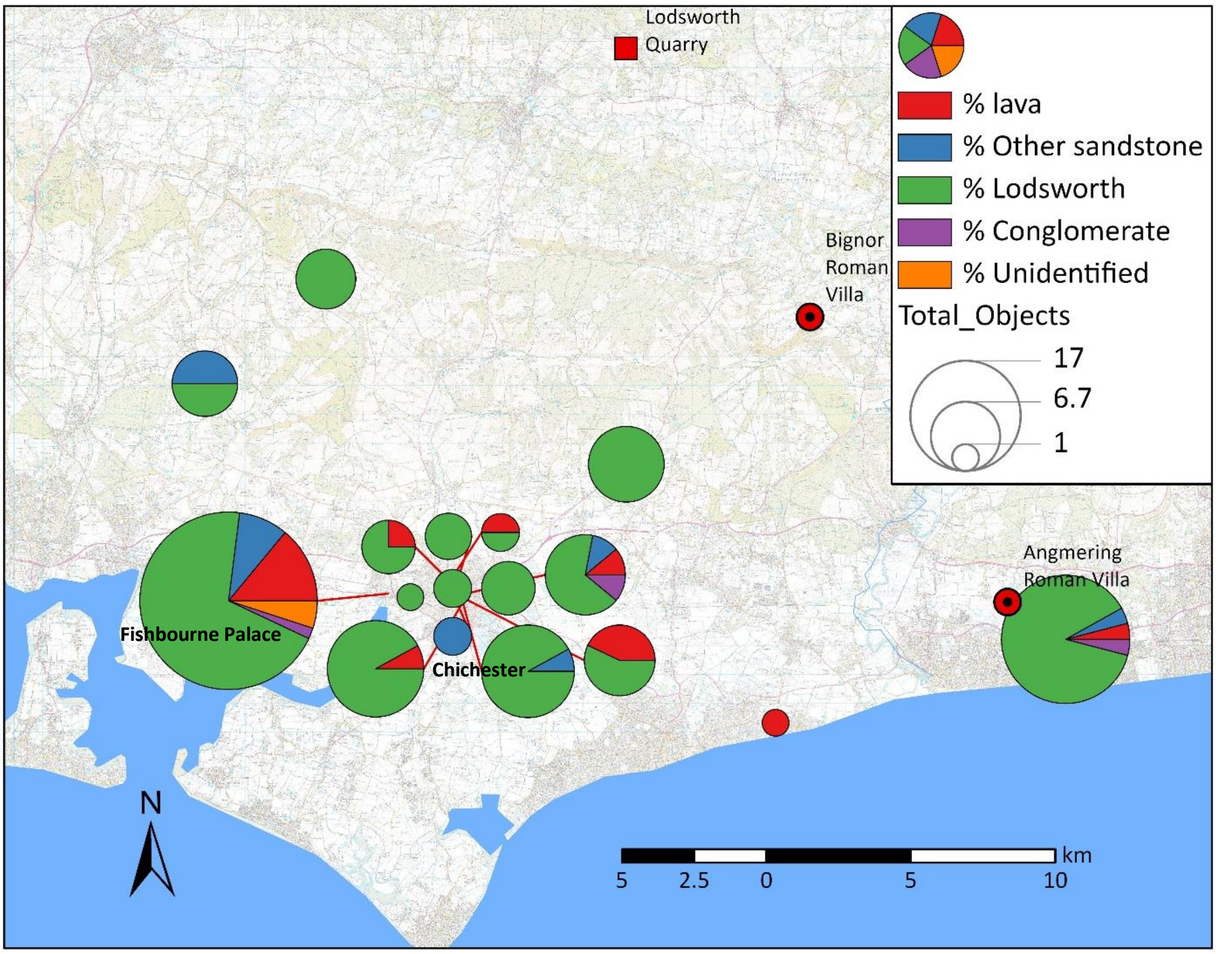


Figure 227- Map showing the relative proportions of different lithologies for querns and millstones at a range of sites in the Chichester and wider district (backdrop map © Ordnance Survey).

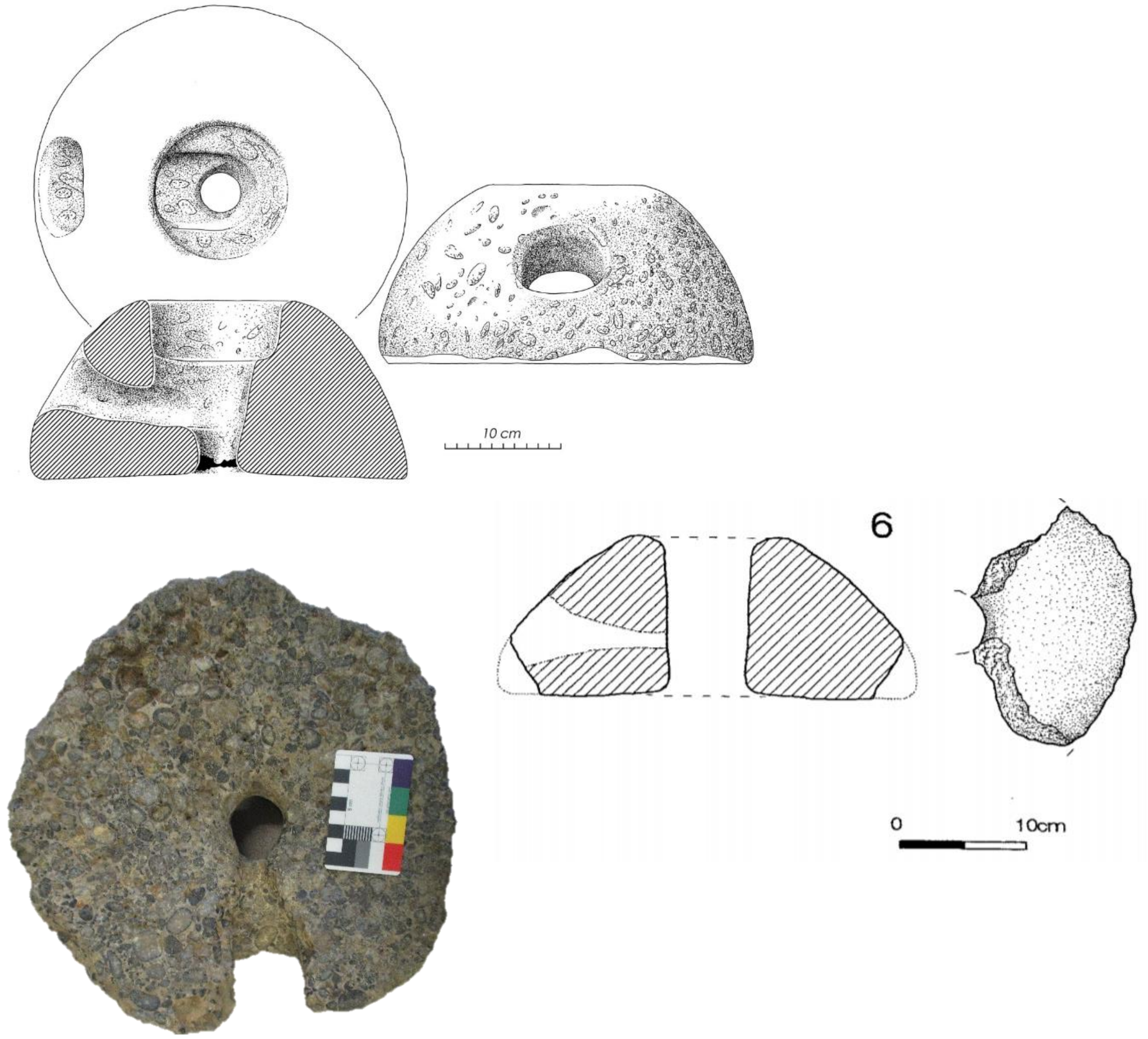


Figure 228- Top left, example of the form of a Fécamp type quern from Normandy (source unknown). Middle right, drawing for quern fragment with perforating handle socket from Roundstone Lane in Angmering (Griffin, 2003, fig. 28.6). Bottom left, complete but heavily worn upper stone from The Hornet in Chichester, pictured to view the grinding surface that has worn to fully perforating handle socket (image used with permission from Fishbourne Palace).

noted that none of these examples have been recorded as French Puddingstone prior to this investigation and that misidentification of this type could be downplaying the role of the stone trade between Britain and Gaul in the Late Iron Age and very early Roman periods. Though good evidence exists for social and economic connections between southern coastal Britain and northern Gaul during the early post-conquest period, this new information provides another dimension to our current understandings.

What is significant however, is the co-occurrence of lava with another imported type of quern at each of these three sites. Unfortunately, there is a lack of good contextual information for these objects, and it is difficult to attribute them to the same periods of use. Both were present in Britain in the earliest period of Roman conquest, though the use of lava continues for much longer than that of the French Puddingstone. It is possible that those already used to using a foreign stone quern, i.e., the imported French Puddingstone, might be more inclined to adopt lava as another alien type. It could also imply that the people living at these sites had much greater access to imported and exotic goods, a matter that certainly fits well with what we currently know of Fishbourne Palace.

Lava Millstones in the Chichester District

The study area is unusual in that it has produced several lava millstones, a rarity in the archaeological record. Due to misidentification and poor preservation in the circumstances of certain soil and conditions or deposition practices, it is likely that others existed within the study region (Shaffrey, 2015, p. 60). There are four recorded within this region: two from sites in Chichester, one from Fishbourne and one from Roundstone Lane in Angmering. Whether these should all be categorised as millstones is a matter for debate, as per the discussion presented by Shaffrey (2015, p. 73-78), and each example will be considered separately below. However, it is interesting to note that all the locations from which these millstone were recovered have been connected archaeologically to Fishbourne Palace; economic and political associations between Fishbourne and Chichester are known to have existed, and there are also notable similarities between Angmering Villa and Fishbourne with regards to time of construction, design and relative wealth (Cunliffe, 1999, p. 46).

Lava millstones are known to have been produced at Mayen, though the scale at which they were manufactured and the period of their export to Britain is less certain (see Chapter 2). What is certain, is that these objects would have had to have been commissioned, as the size and mechanical parts of a mill would have required very specific stones for them to operate correctly. The work of finishing a millstone would have required skilled craftspeople who understood the material they were working with and how to cut it, and knew the tools required for the job (see Chapter 2). The whole project of acquiring and fitting a lava millstone to a mill is likely to have been an expensive undertaking; something that is unlikely to have been a barrier at the sites where their presence has been observed, where lava millstones may have been a marker of status as an imported exotic stone and a visual reminder of Mediterranean culture. Nonetheless, in more ordinary scenarios, expense could be one reason why fewer lava millstones have been recovered from Romano-British contexts than indigenous types (Shaffrey, 2015, pp. 58-60). Alternatively, a decrease in lava exchange in the later Roman period when milling technology was more prevalent may have been responsible. This might suggest that mills in the Chichester district were early introductions, which would match well with the considerations of wealth associated with these sites during the early Roman period.

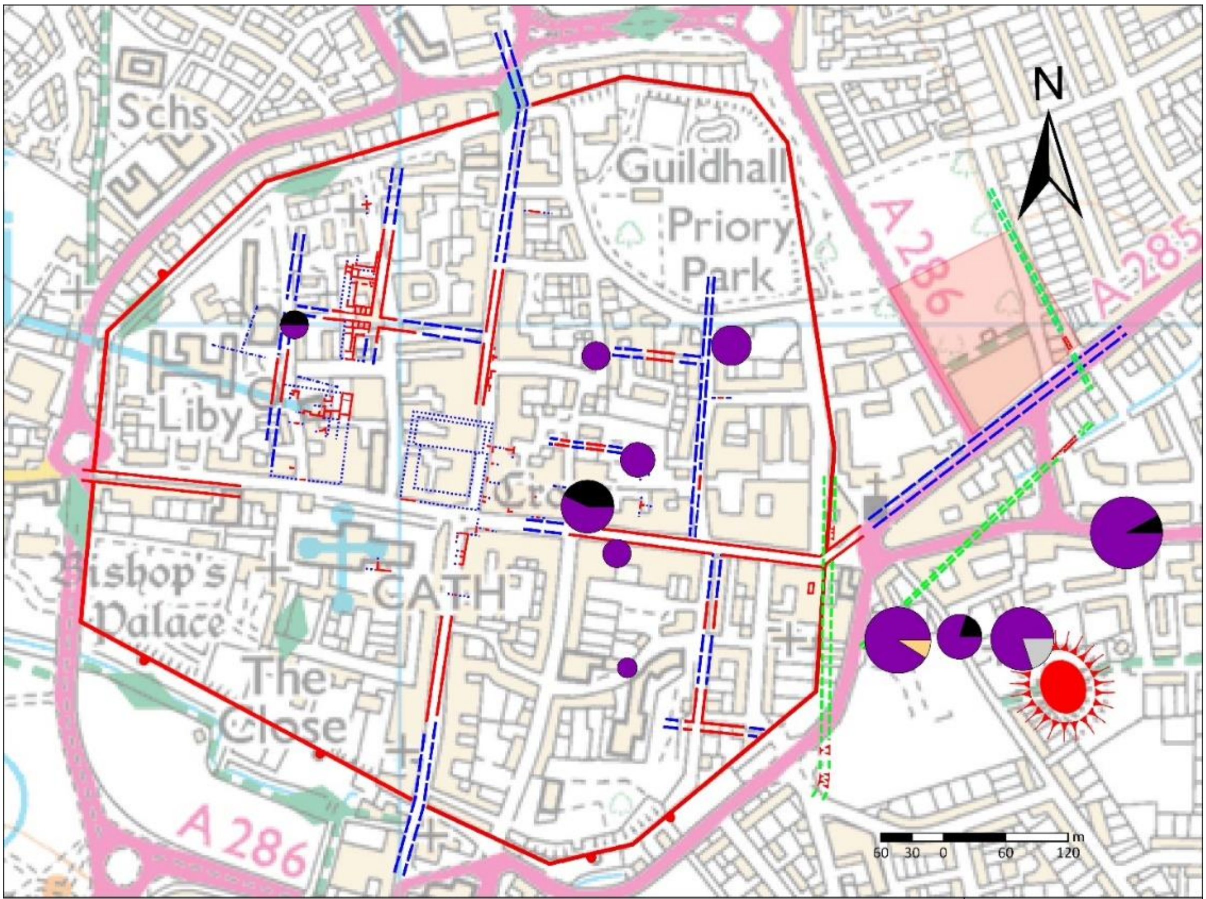
The coastal plain region, where Noviomagus and Angmering lie, is an excellent location for watermills due to the numerous streams and rivers that feed into the area. The district was used in such a way during the Medieval and modern periods (Gregory & Martin, 1997; Sussex Mills Group, 2021), and grain and grain processing has been an important part of the farming and trading landscape for many generations. It is entirely possible that a water mill existed at Fishbourne, as shown by the presence of a Medieval watermill that existed on the local stream that could have been similarly exploited in the Roman era (Shaffrey, 2015, p. 69), and there is also the possibility of one at Angmering on the Black Ditch, probably to serve the nearby villa (Griffin, 2003, p. 74). There may also have been a mill at Chichester on the River Lavant, and we know that it is likely that the flow of the water was diverted in the Roman era (Newman, 1994), possibly to make better use of its energy. Diversion of the Lavant also occurred in the Late Saxon period precisely for this reason, and a watermill existed at the Eastgate of the town, which was powered by the Lavant (Chichester District Council, 2005). The possibility of Roman mills at this location should be considered, especially with regards to the intensity of milling seen in the same area during this era. Alternatively, any of these sites could also have been used for animal or human powered mills, or both types may have been simultaneously present. The presence of quern stones at sites that also produced millstones indicates that milling and grinding may have involved a range of different tools.

All the millstones in the dataset can be described as disc-types, in that they are cylindrical. Unfortunately, it is not possible to carry out an assessment of the geochemistry for the Chichester district lava at this time, and only typological analysis can be used to identify possible sources or chronology. This can be done by examining characteristics that might relate to the mode of operation, which will also help to clarify how people might have engaged with the objects. For the Chichester district examples, this is unclear, as little remains of the features that would indicate how they may have been fitted to a mill mechanism. As described in Chapter 2, the main feature that would be used to determine the mechanism type is the rynd (Wilson, 1952; Shaffrey, 2015, pp. 67-69). A discussion of the identifiable mill features from Fishbourne, and the Chichester district can be found later in this chapter.

Distribution of Querns and Millstones in Noviomagus

Distribution analysis for the querns and millstones in Noviomagus is presented in figure 229. The expectation is that Noviomagus probably served as a ‘market centre’ for the wider region. The hinterland and neighbouring agricultural land, that is still widely farmed today, would have made for a large and highly profitable food producing region. It is likely that Noviomagus played an important role in securing taxes from the rural areas (Down, 1988, p. 72). Taxation in kind may have resulted in the need for goods and livestock to be brought to the town, providing an opportunity for other exchange to also take place as part of private or commercial trade. Grain would have been a fundamental feature of both taxation and, also, of other exchange.

Interpretations of the Cattlemarket site, outside the eastern gate of the town have suggested that this may have been a location where such exchanges may have taken place, and where taxation may



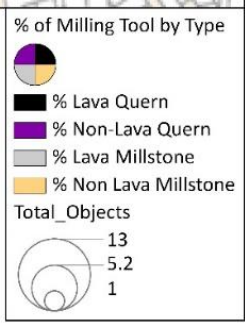


Figure 229- Distribution map showing the volumes and locations of lava and non-lava millstones in and around Noviomagus (backdrop map © Ordnance Survey, town plan after (Down, 1988, pp. 15, fig 6).

have been collected from the rural areas. There is a wealth of evidence to support this theory in the form of faunal and environmental evidence, such as dung beetles, grain and flour beetles and butchery waste (Down, 1989a, p. 82). The quern and millstone finds can also help interpretations. The distribution map shows that the Cattlemarket site is associated with three other sites that are also to the east of town, and south of the Hornet (the lower road running from east to west that exits the east gate). All four of these sites have a high number of querns present when compared with the sites within the town walls, and there are also two millstones in the assemblage (table 25). From these four sites, there are twice as many querns and millstones as there are from the six sites from within the town. Though this is a small dataset, and more needs to be done to confirm the results, it does appear that there was much more intensive flour processing taking place in and around the Cattlemarket area. The presence of the millstones, where there are none within the town walls further emphasises this.

Table 25- Numbers of querns and millstones within the town walls of Noviomagus and outside the east of the town.

		OUTSIDE EAST OF TOWN			
Site Name	**Nº Lava querns**	**Nº Lava millstones**	**Nº non-lava querns**	**Nº non lava millstones**	**Total**
Cattlemarket	0	0	11	1	12
The Hornet 1990	1	0	4	0	5
The Hornet 94-6	0	1	7	1	9
Rowes Garage	1	0	12	0	13
Total	***2***	***1***	***34***	***2***	***39***
		INSIDE TOWN WALLS			
East Pallant	0	0	1	0	1
69-70 East Street	0	0	2	0	2
David Grieg 1987	2	1	4	0	7
David Grieg 2	0	0	3	0	3
S.Martin Square	0	0	2	0	2
Friar's Gate	0	0	4	0	4
Total	***2***	***1***	***16***	***0***	***19***

This gives us some indication of the scale at which this grain was being processed, which, in turn, allows for interpretations relating to the scale of consumption of flour, as flour must be used within a few days of being produced. This can be used to gain a general understanding of population and the extent to which a town might be reliant on centralised food processing operations. Large-scale processing can also be generally related to a greater extent of craft specialisation and bureaucratic roles, more typical or an urban environment where food processing may not have been carried out as a daily domestic chore in the same way as in rural areas. We know from Pompeii that large scale food processing within bakeries did occur in urban settings (Peacock, 1989), and it is probable that British towns had similar arrangements in places with larger populations. The millstones suggest a nearby mill may have been employed to produce flour at a much larger scale.

We know from ancient texts that flour was incorporated into food products in a range of different ways, from the mundane everyday bread (made by pistrina) to patisserie (made by pistrina dulciaria), which would have required skilled bakers and specialist equipment. Though the cultural context is different, the tomb of Eurysaces in Rome shows us that baking could be a profession that involved a complex series of stages and tools, and a job that was well-esteemed and worthy of commemoration (Peterson, 2003) (figure 230). The elaborate tomb shows that such a role could be profitable, and it should be considered that similar enterprises would be attempted elsewhere in the empire as a way of providing the tastes and familiar foods that the Roman provincial elite would have sought out. Noviomagus, with its clear high levels of wealth and socio-economic connections to Rome, especially in the earlier periods, would have been an excellent location for a bakery. Unfortunately, the lack of chronological information for either of the millstones makes it impossible to determine when this large-scale milling may have taken place or if there may have been multiple mills operating at the same time. Nonetheless, the clustering of milling tools seen in the area outside the east gate does indicate that processing was occurring at scale, that mills may have been involved, and that food preparation and processing was occurring alongside that of other consumables within the same location. Alternative interpretations would also consider the probability that reused querns were being used for construction or road building activities outside of the town.

Elsewhere in the town, there is too little data to fully explore possible meanings or interpretations. The lack of contextual information also makes it challenging to provide much other than speculation with regards to the use of milling tools. The smaller numbers of querns at sites in the town do appear to suggest small-scale food processing and is similar to that expected of domestic food production. Lava querns appear at two locations in small numbers, on Chapel Street and East Street, (both unpublished) showing that imported goods were accessible to those living in the town. As a place that clearly produced a range of different goods, some of which may have been exported, the presence of lava shows that the town had connections and were engaged in exchange that involved trade routes to the Rhineland.

Figure 230- The tomb of Eurysaces in Rome, which presents several friezes depicting the processes involved at a bakery, showing a complexity and need for specialist knowledge. The elaborate nature of the monument indicates that the profession of baking could be highly lucrative (Piperno, 2020).

The Millstones at Fishbourne Palace

CAT 0569

The lava millstone from Fishbourne Palace (Figure 231) was found unstratified, but as it was retrieved from a Roman site, can be attributed safely to the Roman period and to the palace itself. The millstone is currently on display in the museum, which has restricted some the measurements taken. It is a partial lower stone, comprising approximately 45% of a full stone, with a diameter of 710mm, making it a larger example within the range of what can be expected for a Roman period millstone. Large white phenocrysts can be observed within the material structure, indicating that this is likely to be a Mayen lava millstone. The maximum thickness at the edge is 75mm, with a minimum thickness of 60mm showing that it had been significantly worn prior to its deposition. The uneven state of the wear seems unusual for a mechanically driven mill and implies an inconsistent force on the upper stone as it was rotated, similar to that seen with rotary querns. As this is a lower stone, there is nothing to indicate how the mill may have operated, though human or animal power might be tentatively suggested due to this uneven wear. The central hole is circular in shape and fully perforates the stone, with a diameter of 130mm at its widest point. The edges of the rounded side are cut straight and vertical. There is no clear sign of dressing on the grinding surface or on the edges, a feature that is often present on Mayen lava quern stones but is easily worn off or removed due to weathering.

Figure 231- Lava millstone from Fishbourne Palace (CAT 0569) that is currently on display in the museum (photo by author with permission from Fishbourne Palace Museum).

CAT X0148

The first non-lava example (figure 232, CAT X0148) is an upper stone (runner) of Lodsworth Greensand, with a slightly concave grinding surface and an estimated diameter of 580mm. Though only a quarter of this stone remains, this is sufficient for a confident estimated measurement. There are no features present that might indicate how it was operated, and it is assumed that the size would have been too large to have been turned by hand as a rotary quern. The stone has been very roughly worked into shape and it has been broken in a way that appears to have been deliberate. This may have been occurred when the millstone went out of use, allowing it to be repurposed, or may have been an act of ritual or cultural significance. There are no signs of the stone having been used for other processing activities, as is often seen on broken quern stones (for example CAT 0021, 0048, 0605), and the context of deposition gives no clue as to why to may have been treated in this way. Breakage may simply have made the millstone easier to dispose of. This stone is significantly smaller than the lava example and if it had been operated as part of a mill, may not have been with the same mechanism. However, seasonal changes in water volume may have necessitated the use of differently sized stones for the same mill, with the heavier larger stones only viable for use during times of increased rainfall.

Figure 232- Millstone of Lodsworth Greensand (CAT X0148) from Fishbourne Palace (photo by author with permission from Fishbourne Palace Museum).

CAT X0151

The second non-lava millstone, (figure 233 and 234, CAT X0151), is an upper stone also of Lodsworth Greensand and has not been identified as a millstone in the excavation report (Cunliffe, 1971b, p. 154). When estimating its diameter in-person, it was found to be 760mm, significantly different to the 300mm suggested in the catalogue. By looking at the photographed image of the stone, it is clear to see that the angle of the curved edge should be extrapolated much further than the suggested 300mm. This is clearly a millstone, and though only 20% of the total stone remains, it can confidently be identified as such. The grinding surface is slightly concave and there are no signs of dressing. The eye appears to be circular in plan, estimated to have a diameter of 130mm, being slightly wider near the upper surface to create a slight hopper to channel the grain. The edges are straight and vertical and have been well-tooled and shaped with care. The upper surface, not used for grinding, is more roughly tooled, but has been shaped well too. Forming this millstone was undertaken with great care and skill, which is not always the case in some of the Lodsworth greensand querns. This is understandable as the material is very hard and must have been difficult to work, meaning that many hours must have gone into creating the smoothed finish on the millstone. There are two rynd slots cut into the lower grinding surface, making this an underdrift example. These are at right angles to each other and rectangular in shape, indicating that this millstone may have been turned by water. The similarity in size with the lava millstone is interesting, and it is possible that there is a relationship between the use of these two stones. The stone was, unfortunately, recovered from a robber trench and so date and context of deposition is possible to identify.

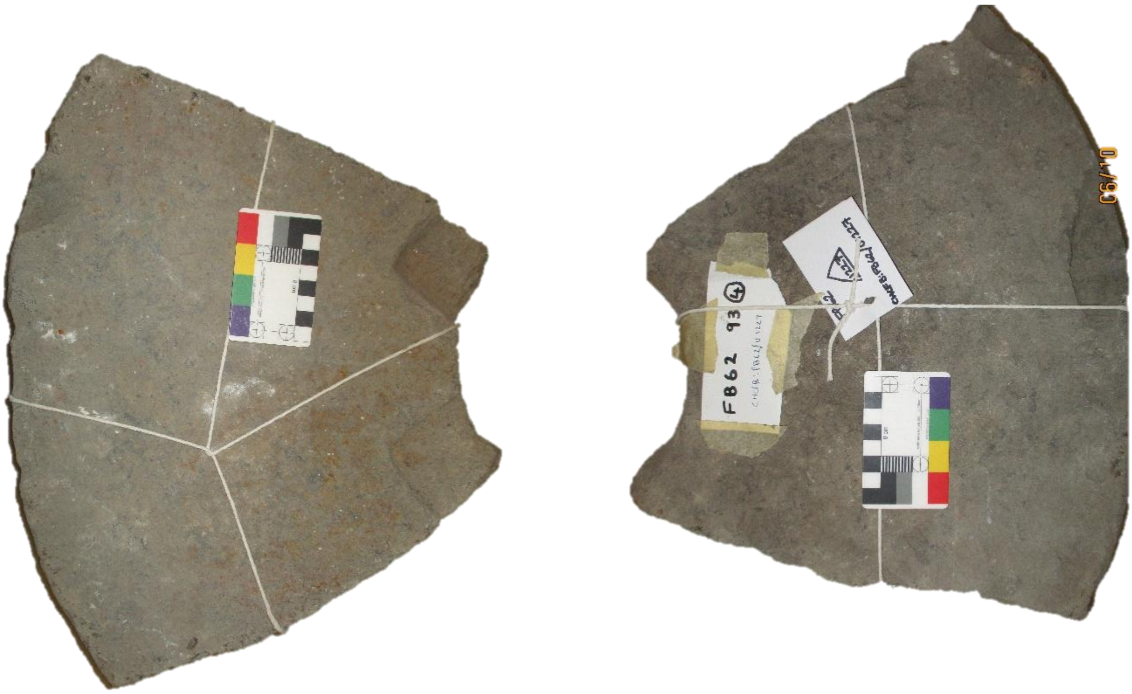


Figure 233- Photograph of upper millstone of Lodsworth Greensand (CAT X0151) from Fishbourne Palace showing rynd chase for an underdrift mode of operation (photo by author with permission from Fishbourne Palace Museum).

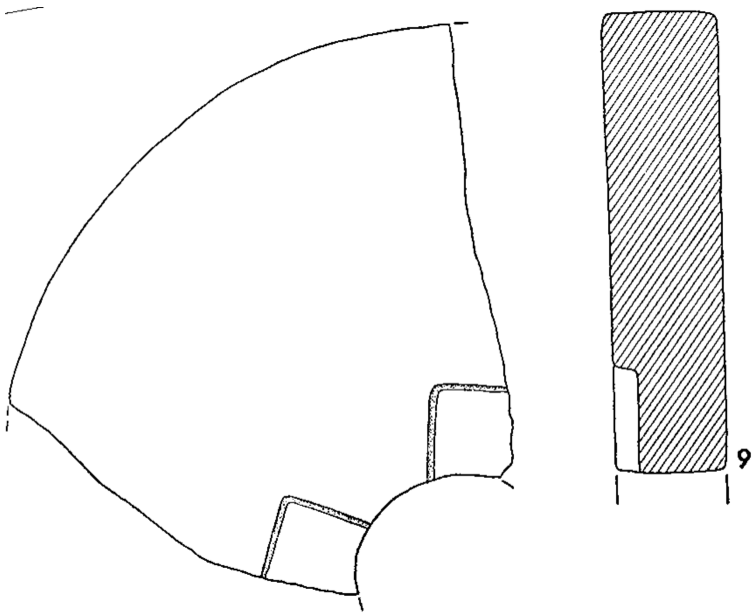


Figure 234- Line drawing of upper millstone of Lodsworth Greensand (CAT X0151) from Fishbourne Palace showing rynd chase for an underdrift mode of operation (Cunliffe, 1971b, p. 154).

Interpretation of the Fishbourne Palace Millstones

The millstones recovered from Fishbourne are unlikely to have come from far, and they strongly suggest the presence of a nearby mill. Fishbourne Palace probably made use of mills to grind grain or malt as part of large-scale processing. It is likely that the estate had a requirement to feed a very large workforce and that time and money was saved with the use of mechanisation. There was probably a watermill that served the estate. Divers searching the millpond at Fishbourne in the 1970's reported the presence of Roman stonework in the water, and though unproven, this may have been the remains of a possible watermill (Symmonds, 2022, pers. comm.). We know that watermills were in use on the same stream that feeds into Fishbourne harbour during the Medieval period, meaning that the potential to power such a device did possibly exist (Shaffrey, 2015, p. 69).

The wealth and status associated with the palace buildings implies that the means to construct a mill also existed, while the presence of such an innovation would be another visible show of the power and prosperity of the estate. The presence of a lava millstone at the site is a similar marker of the means and influence of the palace owner(s). The relative lack of lava use in the Chichester region indicates that the area was not within the normal scope of North Sea trade, and so connectivity that brough such goods to Fishbourne must have made a significant statement with regards to the owner's links with the wider empire. Specialist milling equipment in the form of lava millstones would likely have been expensive to obtain, creating an exclusivity with regards to who had the option to operate one. It is possible that lava millstones produced a different type or standard of flour product to that of other stone types, and this standard may have been a matter of importance to the palace owner(s), due to culture, status or preference. Whether the lava and Greensand millstones were used synonymously, or during different periods is unknown, but neither option should be disregarded due to the fact that different products may have been milled in different ways with a range of different stone types, and various standards of milling may have been acceptable depending on who the likely recipient of the final product was to be.

Conclusion

Overall, there have been some interesting outcomes from this investigation that show a very different lived experience for populations in rural areas of the Chichester district from that of the urban area of Noviomagus, and the elite villa site at Fishbourne. One of the most significant of these has been the extent to which lava was rejected by or inaccessible to people living at sites in the rural hinterland, where continued use of Lodsworth stone for querns dominates. Unequal access to imported goods, in combination with a lack of preference for lava products are likely to have been factors that drove the limited uptake of lava milling tools seen in the distributions of the rural hinterland. Continued use of the locally sourced Lodsworth stone probably had both an economic and social dimension, as it was a stone type that had been utilised for milling tools on the area since the Neolithic (Shaffrey & Roe, 2011). It was both a familiar and an accessible product, and there does not appear to have been a change in access after the Claudian invasion. In some ways, this may reflect the socio-political conditions present in the area prior to and immediately after AD 43; for rural people in a district that may have not resisted Roman rule, life continued much as it had before. The results should be contrasted to the rural areas in Eastern Britain, in modern day East Anglia and Essex, where lava take-up was widespread (Chapter 4). Not only did the region have a deficit of suitable local stone for milling tools, but the pre-existing socio-political conditions, a more intensive early Roman military presence and greater connectivity with the Rhineland all promoted a different outcome in terms of who was using lava and where.

Meanwhile, both Chichester and Fishbourne had several examples of lava milling tools, including querns and millstones, as did the nearby Angmering villa and its immediate surrounds. Access to and a willingness to use imported lava for querns and millstones appears to have only occurred at the villas on the coastal plain, and at Chichester. The absence of lava at Bignor villa, further inland, needs further investigation. Both Fishbourne and Angmering villa had previously yielded evidence to show that they were well-connected to other parts of continental Europe and had occupants that were wealthy and of high status. The co-occurrence of imported French Puddingstone querns at sites that had lava present indicates that imported milling tools at these sites were more accepted and possibly sought after, either as a reflection of cultural identity, or as a marker of status and connection to wider exchange opportunities.

Centralisation of food processing occurred at scale at the Cattlemarket site in Chichester, and also at Fishbourne and Angmering villa. Larger population sizes may have necessitated the need for mills at these locations, while a complex economy with specialised craftspeople and/or bureaucrats may have driven changes in the organisation of labour relating to food processing activities. It is likely that the central southern coast was a region where watermills were used, and millstones recovered close to potential suitable heads of water at Chichester, Angmering and Fishbourne support this suggestion.

Appendix 4. Quern Recording Sheet

Catalogue Nº	Date	Entered in DB?	
Site Name	Grid Ref	Fig Nº	Photo Nº
Collection/Museum	SF Nº	Acc Nº	Zone Phase
Context	Part of quern *Upper/lower/both*		
Condition % Circumference % Weight (g) Nº fragments *v.small frag* *half* *small frag* *incomplete* *quarter* *complete*	Description of edges Description of other surface Wear		
Diameter (mm) Min diameter (mm) *Estimated* *Measured* *Unknown*			
Max thickness (mm) Centre Edge	Min thickness (mm) Centre Edge		
Curvature and angle and grinding surface Dressing of grinding surface	**Hopper** diameter Depth Description **Handle slot** type Dimensions		
Centre hole *Full/partial* Diameter Depth Plan Profile	**Rims?**	**Decoration?**	
	Rynd slot description		
Notes			
Reference Pg Nº	Fig Nº		

Bibliography

Adams, C., 2007. *Quantifying Egyptian Evidence for Transport.* [Online]
Available at:
http://oxrep.classics.ox.ac.uk/working%20papers/quantifying_egyptian_evidence_transport/
[Accessed 23rd March 2020].

Alberti, M., 2018. The Construction, Use, and Discard of Female Identities: Interpreting Spindle Whorls at Vindolanda and Corbridge. *Theoretical Roman Archaeology Journal,* 1(1), pp. 1-16.

Alcock, J. P., 2001. *Fod in Roman Britain.* 1st ed. Stroud: Tempus.

Allen, J. R., 2012. A Rhenish Pompeian-style Mill from Early Roman Silchester (Calleva Atrebatum). *Britannia,* 43(1), pp. 260-268.

Allen, J. R., 2018. The Whetstones from Roman Silchester at Reading Museum: The Vitorian-Edwardian Excavations. *Proceedings of the Hampshire Field Club Archaeological Society,* 73(1), pp. 156-158.

Allen, J. R. L., 2014. *Whetstones from Roman Silchester (Calleva Atrebatum), North Hampshire: Character, manufacture, provenace and use.* 1st ed. Oxford: BAR Publishing.

Allen, J. R. L., forthcoming, 2022. Whetstones in Roman Britain: Character, Distribution, Provenance and Industries. *Britannia.*

Allen, J. R. L., Rose, E. J. & Fulford, M., 2003. Reuse of Roman stone in the Reedham area of East Norfolk: intimations of a possible 'lost' Roman fort. *Britannia,* 34(1), pp. 129-141.

Allen, M., 2016a. The North-East. In: M. Fulford & N. Holbrook, eds. *The Rural settlement of Roman Britain.* London: Society for the Promotion of Roman Studies, pp. 242-281.

Allen, M., 2016b. The South. In: M. Fulford & N. Holbrook, eds. *The Rural Settlement of Roman Britain.* London: Society for the Promotion of Roman Studies, pp. 75-140.

Allen, M. et al., 2018. *The Rural Settlement of Roman Britain: an online resource [data-set].* [Online]
Available at: https://doi.org/10.5284/1030449
[Accessed 27th February 2022].

Allen, M. & Lodwick, L., 2017. Agricultural Strategies in Roman Britain. In: M. Fulford & N. Holbrook, eds. *The Rural Economy of Roman Britain.* London: Society for the Promotion of Roman Studies, pp. 142-177.

Allen, M. et al., 2017. *The Rural Economy of Roman Britain.* 1st ed. London: Soicety for the Promotion of Roman Studies.

Allen, M. & Sykes, N., 2011. New animals, new landscapes and new world views: The Iron Age to Roman transition at Fishbourne. *Sussex Archaeological Collections,* 149(1), pp. 7-24.

Allison, P., 2006. Mapping for gender: Interpreting artefact distribution inside 1st and 2nd century forts in Roman Germany. *Archaeological Dialogues,* 13(1), pp. 1-20.

Amouric, H., 1997. L'anille et les meules. In: D. Garcia & D. Meeks, eds. *Techniques et économie antiques et médiévales. Le temps de l'innovation: Colloque d'Aix-en-Provence, 21-23 mai 1996.* Paris: Travaux du Centre Camille-Jullian, 21, Editions Errance, pp. 39-47.

Ancient World mapping Centre, 2021. *Resources.* [Online]
Available at: http://awmc.unc.edu/wordpress/map-files/
[Accessed 18th August 2020].

Anderson, H. E., 2009. Risk, Shipping and Roman Law. *Tulane Maritime Law Journal,* 1(1), pp. 183-210.

Anderson, T. J., Grenne, T. & Soler, J. M. F., 2011. Volcanic Quern and Millstone Quarries in Cabo de Gata (Almería) and Campo de Calatrava (Ciudad Real), Spain. In: D. Williams & D. Peacock, eds. *Bread for the People. The Archaeology of Mills and Milling: Proceedings of a Colloquium Held in the British School or Rome, 4th-7th November 2009.* Oxford: Archaeopress, pp. 151-167.

Antonelli, F. & Lazzarini, L., 2010. Mediterranean trade of the most widespread Roman volcanic millstones from Italy and petrochemical markers of their raw materials. *Journal of Archaeological Science,* 37(1), pp. 2081-2092.

Antonelli, F., Lazzarini, L. & Luni, M., 2005. millstones in Tripolitania and Cyrenaica (Libya) Preliminary study on the import of lavic millstones in Tripolitania and Cyrenaica (Libya). *Journal of Cultural Heritage,* 6(1), pp. 45-137.

Antonelli, F., Nappi, G. & Lazzarini, L., 2001. Roman millstones from Orvieto (Italy): petrographic and geochemical data for a new archaeometric contribution. *Archaeometry,* 43(2), pp. 89-167.

Appadurai, A., 1986. *The social life of things: commodities in cultural perspective.* 1st ed. Cambridge: Cambridge University Press.

Attanasio, D., Bruno, M. & Yavuz, A. B., 2009. Quarries in the Region of Aphrodisias: The black and white marbles of Göktepe. *Journal of Roman Archaeology,* 22(1), pp. 312-348.

Baatz, D., 1995. Die Wassermühle bei Vitruv X. *Saalburg Jahrbuch,* 48(1), pp. 5-18.

Bang, P. F., 1998. *Antiquity between "Primitivism" and "Modernism".* [Online]
Available at: http://www.hum.au.dk/ckulturf/pages/publications/pfb/antiquity.htm
[Accessed 15th March 2020].

Bang, P. F., 2008. *The Roman Bazaar: A comparative study of trade and markets in a tributary empire.* 1st ed. Cambridge: Cambridge University Press.

Barry, C., Burnham, J. & Wacher, S., 1990. *The Small Towns of Roman Britain.* 1st ed. Berkley: University of California Press.

Bastow, M. E., 1999. The Botanical Material. In: P. Abramson, D. S. Berg & M. R. Fossick, eds. *Roman Castleford. Excavations 1974-85, Volume II. The Structural and Environmental Evidence.* Wakefield: Yorkshire Archaeology Service, pp. 163-122.

Baur, V., 2012. Die ländliche Besiedlung im Umfeld der Basaltsteinbrüche und des vicus von Mayen (Lkr. Mayen Koblenz) in römischer Zeit. In: M. Grünewald & S. Wenzel, eds. *Römische Landnutzung in der Eifel- neue Ausgrabungen und Forschungen, Tagung in Mayen, vom 3. bis zum 6. November 2011.* Mainz: RGZM, pp. 235-246.

Bekker-Nielsen, T., 1988. Terra incognita: The Subjective Geography of the Roman Empire. In: E. Christiansen, E. Hallager & A. Damsgaard-Madsen, eds. *Studies in Ancient History and Numismatics presented to Rudi Thomsen.* Aarhus: Aarhus Universitetsforlag, pp. 148-161.

Belmont, A., 2011. Why Dig a Millstone Quarry? The Case of Claix in the South-West of France (5th-19th Centuries). In: D. Williams & D. Peacock, eds. *Bread for the People. The Archaeology of Mills and Milling: Proceedings of a Colloquium Held in the British School or Rome, 4th-7th November 2009.* Oxford: Archaeopress, pp. 1-18.

Belmont, A. & Mangartz, F., 2006. *Millstone Quarries. Research, Protection and Valorization of a European Industrial Heritage (Antiquity-21st Century), Colloque international Grenoble, 22-25 septembre 2005, Maison des Sciences de I'Homme-Alpes.* 1st ed. Mainz: RGZM.

Bémont, C., Jeanlin, M. & Lahanier, C., 1993. *Les figurines en terre cuite gallo-romaines.* 1st ed. Paris: Maison des Sciences de l'Homme.

Bennet, R. & Elton, J., 1898. *History of Corn Milling 1. Handstones, Slave and Cattle Mills.* 1st ed. London: Simpkin, Marshall and Company Ltd.

Bidwell, P., 1983. *The Roman Fort of Vindolanda at Chesterholm, Northumberland.* 1st ed. London: English Heritage.

Bidwell, P., 1999. *Hadrian's Wall 1989–99.* 1st ed. Carlisle: Cumberland & Westmorland Antiquarian & Archaeological Society.

Bidwell, P. T., 1985. *The Roman Fort of Vindolanda.* 1st ed. London: Historic Buildings and Monuments Commission for England.

Bijker, W., 1997. *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change.* 1st ed. London: MIT Press.

Birley, A., Birley, A. R. & de Bernardo Stempel, P., 2013. A Dedication by the "Cohors I Tungrorum" at Vindolanda to a Hitherto Unknown Goddess. *Zeitschrift für Papyrologie und Epigraphik,* 186(1), pp. 287-300.

Birley, A. R., 2016. The complexity of intramural and extramural relationships on the northern frontier of Roman Britain- a Vindolanda case study. In: S. Hoss & A. Whitmaore, eds. *Small finds and ancient social practice in the north-west provinces of the Roman Empire.* Oxford: Oxbow, pp. 223-262.

Birley, E. B., 1961. *Research on Hadrian's Wall.* 1st ed. Kendal: Titus Wilson & Son.

Birley, E., Birley, R. & Birley, A., 1993. *Vindolanda Research Reports, New Series. Volume II: The early wooden forts. Reports on the auxilliaries, the writing tablets, inscriptions, brands and graffitti.* 1st ed. Hexham: Roman Army Museum Publications.

Birley, R., 2009. *Vindolanda: A Roman frontier fort on Hadrian's Wall.* 1st ed. Stroud: Amberley Publishing.

Bishop, M. C. & Dore, J. N., 1988. *Corbridge: Excavations of the Roman fort and town 1947-80.* 1st ed. London: Historic Buildings and Monuments Commission for England.

Blagg, T. F. C., 1976. Tools and Techniques of the Roman Stonemason in Britain. *Britannia,* 7(1), pp. 152-172.

Blagg, T. F. C., 1980. Roman Civil and Military Architecture in the Province of Britain: Aspects of Patronage, Influence and Craft Organization. *World Archaeology,* 12(1), pp. 27-42.

Bloxam, E., 2011. Visualising the Invisible: re-discovering the ancient grinding stone quarries of the Aswan West Bank, Egypt. In: D. Williams & D. Peacock, eds. *Bread for the People. The Archaeology of Mills and Milling: Proceedings of a Colloquium Held in the British School or Rome, 4th-7th November 2009.* Oxford: Archaeopress, pp. 43-53.

Blumell, L. H., 2007. Beware of Bandits! Banditry and Land Travel in the Roamn Empire. *Journeys,* 8(1-2), pp. 1-20.

Blümner, H., 2022. *Wellcome Collection- Technologie und Terminologie der Gewerbe und Künste bei Griechen und Römern / von Hugo Blümner.* [Online]
Available at: https://wellcomecollection.org/works/bsvz95v8/items?canvas=1
[Accessed 22nd March 2022].

Bogaers, J. E., 1967. Reviewed Work(s): The Civitas Capitals of Roman Britain by J. S. Wacher. *The Journal of Roman Studies,* 57(1), pp. 230-234.

Bone, A. & Burnett, A., 1986. The 1986 Selsey Treasure Trove. *British Numismatic Journal,* 56(1), pp. 179-180.

Boon, G. C., 1969. Belgic and Roman Silchester. *Archaeologia,* 102(1), pp. 1-81.

Bosanquet, R. C., 1904. The Roman camp at Housesteads. *Archaeologia Aeliana,* 2(1), pp. 193-300.

Bowman, A. K., 1974. Roman Military Records from Vindolanda. *Britannia,* 5(1), pp. 360-373.

Bowman, A. K. & Thomas, J. D., 1975. The Vindolanda Writing Tablets and Their Significance: An Interim Report. *Historia: Zeitschrift für Alte Geschichte,* 24(3), pp. 463-478.

Bowman, A. K. & Thomas, J. D., 1983. *Vindolanda: The Latin Writing Tablets.* 1st ed. London: Society for the Promotion of Roman Studies.

Breeze, D., 2018. The Value of Studying Roman Frontiers. *Theoretical Roman Archaeology Journal,* 1(1), pp. 1-17.

Breeze, D. J. & Dobson, B., 1976. *Hadrian's Wall.* 1st ed. London: Penguin Books.

Breeze, D. J. & Dobson, B., 1987. *Hadrian's Wall.* 1st ed. London: Penguin.

Brien, D. L., 2019. Object biography: Writing the lives of objects, artefacts and things. In: J. Parnell, ed. *New and Experimental Approaches to Writing Lives.* London: Bloomsbury Publishing, pp. 34-46.

Brindle, T., 2016a. The Central West. In: M. Fulford & N. Holbrook, eds. *The Rural Settlement of Roman Britain.* London: Society for the Promotion of Roman Studies, pp. 282-307.

Brindle, T., 2016b. The North. In: M. Fulford & N. Holbrook, eds. *The Rural Settlement of Roman Britain.* London: Society for the Promotion of Roman Studies, pp. 308-330.

Brindle, T., 2016c. The South-West. In: M. Fulford & N. Holbrook, eds. *The Rural Settlement of Roman Britain.* London: Society for the Promotion of Roman Studies, pp. 331-359.

Brindle, T., 2016d. Upland Wales and the Marches. In: M. Fulford & N. Holbrook, eds. *The Rural Settlement of Roman Britain.* London: Society for the Promotion of Roman Studies, pp. 360-384.

Brindle, T., 2017. Miling and Grinding. In: M. Fulford & N. Holbrook, eds. *The Rural Economy of Roman Britain.* London: Society for the Promotion of Roman Studies, pp. 71-72.

Brindle, T. & Smith, A., 2017. Artefact Production: Stone, Jet and Glass. In: M. Fulford & N. Holbrook, eds. *The Rural Economy of Roman Britain.* London: Society for the Promotion of Roman Studies, pp. 198-200.

Brück, J., 2006. Fragmentation, Personhood and the Social Construction of Technology in Middle and Late Bronze Age Britain. *Cambridge Archaeological Journal,* 16(3), pp. 297-315.

Bücher, K., 1911. *Die Entstehung der Volkswirtschaft.* 8th edition, first published 1893 ed. Tübingen: H. Laupp.

Buckland, P., 1981. The early dispersal of insect pests of stored products as indicated by archaeological records. *Journal of stored products research,* 17(1), pp. 1-12.

Buckley, D. G. & Major, H., 1983. Quernstones. In: *Colchester Archaeological Report 2: The Roman Small Finds from Excavations in Colchester 1971-79.* Colchester: Colchester Archaeological Trust, pp. 73-76.

Buckley, D. & Major, H., 2016. Quern Stones. In: S. Lucy & C. Evans, eds. *Romano-British Settlement and Cemeteries: Mucking Excavations by Margaret and Tom Jones, 1965-1978.* Oxford: Oxbow Books, pp. 131-138.

Buffone, L., Lorenzoni, S., Pallara, M. & Zanettin, E., 2003. The millstones of ancient Pompei: A petro-archaeometric study. *European Journal of Minerology,* 15(1), pp. 15-207.

Burnham, B. C. & Wacher, J., 1990. *The 'Small Towns' of Roman Britain.* 1st ed. London: B T Batsford.

Burnham, B., Hunter, F. & Fitzpatrick, A., 2004. Roman Britain in 2003. *Britannia,* 35(1), pp. 253-316.

Burridge, K., 1969. *Tangu Traditions.* 1st ed. Oxford : Clarendon Press.

Burström, N. M., 2014. Things in the Eye of the Beholder: A Humanistic Perspective on Archaeological Object Biographies. *Norwegian Archaeological Review,* 47(1), pp. 65-82.

Butler, C. & Lyne, M., 2001. *The Roman Pottery Production Site at Wickham Barn, Chiltington, East Sussex.* 1st ed. Oxford: Archaeopress.

Campbell, D. B., 2010. Women in Roman forts." Residents visitors or barred from entry. *Ancient Warfare,* 4(6), pp. 48-53.

Carroll, M., 2005. The preparation and consumption of food as a contributing factor towards communal identity in the Roman army. In: Z. Visy, ed. *Limes XIX. Acts of the XIXth International Congress of Roman Frontier Studies.* Pécs: University of Pécs Press, pp. 363-372.

Čelovský, A., Blinkhorn, P., Denis, S. & Timby, J., 2015. *Archaeological Evaluation at 8 Malthouse Lane, Dorchester-on-Thames, Oxfordshire.* [Online]
Available at: https://archaeologydataservice.ac.uk/archiveDS/archiveDownload?t=arch-988-1/dissemination/pdf/johnmoor1-230657_1.pdf
[Accessed 26th October 2021].

Chapman, A., 2019. The querns and grinding stones. In: S. Morris, ed. *Archaeological Excavation on Land at Foxhills, Brackley, Northampton, February-May 2016.* London: MoLA unpublished report.

Chapman, H., Unpublished. Querns and Mills. In: P. D. Brown & H. Chapman, eds. *Roman Technology.* London: Museum of London.

Chichester District Council, 2005. *Chichester Conservation Area Reappraisal,* Chichester: Chichester District Council.

Clarkson, C., 2008. Lithics and Landscape Archaeology. In: D. Bruno & J. Thomas, eds. *Handbook of Landscape Archaeology.* London: Routledge, pp. 490-501.

Clauss, M., Kolb, A., Slaby, W. A. & Woitas, B., 2022. *Epigraphik-Datenbank Clauss/Slaby. CIL XIII 6820.* [Online]
Available at:
https://db.edcs.eu/epigr/epi_einzel.php?s_sprache=en&p_belegstelle=CIL+13%2C+06820&r_sortierung=Belegstelle
[Accessed 24th February 2022].

Cleere, H., 1978. Roman harbours in Britain south of Hadrian's Wall. In: J. du Plat Taylor & H. Cleere, eds. *Roman Shipping and Trade: Britain and the Rhine provinces.* London: Council for British Archaeology, pp. 36-40.

Collingwood, R. G. & Wright, R. P., 1992. Volume II, Fascicule 4: Instrumentum Domesticum. In: S. S. Frere & R. S. O. Tomlin, eds. *The Roman Inscriptions of Britain.* Stroud: Alan Sutton Publishing, pp. 94-100.

Cool, H. E. M., 2003. Introduction. In: P. Wilson & J. Price, eds. *Aspects of Industry in Roman Yorkshire and the North.* Oxford: Oxbow, pp. 1-11.

Cool, H. E. M., 2006. *Eating and Drinking in Roman Britain.* 1st ed. Cambridge: Cambridge University Press.

Corder, P., 1943. A Decorated Lava Quern from Verulamium. *The Antiquaries Journal,* 23(3-4), p. 158.

Craven, J. A., 2012. *MUGA Pitch, Hartismere School, Eye. Post-Excavation Assessment Report 2012/145.,* Bury St Edmunds: Suffolk County Council Archaeological Service.

Crawford, O. G. & Röder, J., 1955. The Quern Quarries of Mayen in the Eifel. *Antiquity,* 29(1), pp. 68-77.

Creighton, J., 2000. *Coins and Power in Late Iron Age Britain.* 1st ed. Cambridge: Cambridge Univeristy Press.

Creighton, J., 2006. *Britannia: The Creation of a Roman Province.* 1st ed. London: Routledge.

Creighton, J. & Fry, R., 2016. *Silchester : changing visions of a Roman town : integrating geophysics and archaeology : the results of the Silchester mapping project, 2005-10.* 1st ed. London: Society for the Promotion of Roman Studies.

Crow, J., 1995. *Housesteads.* 1st ed. London: BT Batsford.

Crummy, N. & Eckardt, H., 2003. Regional Identities and Technologies of the Self: Nail-Cleaners in Roman Britain. *The Archaeological Journal,* 160(1), pp. 44-69.

Crummy, P., 1977. Colchester: The Roman Fortress and the Development of the Colonia. *Britannia,* 8(1), pp. 65-105.

Crummy, P., 1997. *City of Victory: The story of Colchester- Britain's first Roman town.* 1st ed. Colchester: Colchester Archaeological Trust.

CSAD, 2019. *Vindolanda tablets online.* [Online]
Available at: http://vindolanda.csad.ox.ac.uk
[Accessed 25th November 2019].

Cunliffe, B., 1963. Excavations at Fishbourne 1962. *The Antiquaries Journal,* 43(1), pp. 1-14.

Cunliffe, B., 1971a. *Fishbourne: A Roman Palace and its Garden.* 1st ed. London: Thames and Hudson.

Cunliffe, B., 1971b. *Fishbourne 1961-69: Vol 2, The Finds.* 1st ed. London: The Society of Antiquaries.

Cunliffe, B., 1999. *Fishbourne Roman Palace.* 1st ed. Tempus: Stroud.

Cunliffe, B., 2006. Britain and the Continent: Networks of Interaction. In: M. Todd, ed. *A Companion to Roman Britain.* London: Blackwell, pp. 1-11.

Curle, J., 1911. *A Roman Frontier Post and its People: The Fort of Newstead in the Parish of Melrose.* 1st ed. Glasgow: Univeristy of Glasgow.

Curwen, C. E., 1937. Querns. *Antiquity,* 11(1), pp. 133-151.

Daguet-Gagey, A., 1997. *Les 'opera publica' à Rome (180-305 ap. J.-C.): Collection des Études augustiniennes. Série Antiquité Series (EAA): 156.* 1st ed. Paris: Brepols.

Davenport, C., 2003. The Late Pre-Roman Iron Age of the West Sussex Coastal Plain: Continuity or Change?. In: D. Rudling, ed. *The Archaeology of Sussex to AD 2000.* Great Dunham: Heritage Marketing & Publications, Limited, pp. 101-110.

Davies, R. W., 1971. The Roman Military Diet. *Britannia,* 2(1), pp. 122-142.

Dawson, M., 1994. *A Late Roman Cemetery at Bletsoe. Monograph 1,* Bedford: Bedfordshire County Council .

Dawson, M.-J., 2019. *Rethinking small town market status in Roman Britain: a review of the data for five case studies in the Thames Valley region.* [Online]
Available at: https://kar.kent.ac.uk/76363/1/9Volume%201.pdf
[Accessed 23rd February 2022].

de Beaune, S. A., 2004. The Invention of Technology. Prehistory and Conginition. *Current Anthropology,* 45(1), pp. 139-162.

De Jersey, P., 1997. Counting the Coinage. *Sussex past and Present,* 81(1), p. 6.

de Souza, P., 2008. Rome's Contribution to the Development of Piracy. *Memoirs of the American Academy in Rome. Supplementary Volumes,* 6(1), pp. 71-96.

Deiss, J. J., 1966. *Herculaneum: Italy's buried treasure.* 1st ed. London: Thomas Y. Crowell Company.

Demosthenes, 1936. *Private Orations: With an English Translation by A.T. Murray.* 1st ed. Cambridge: Havard Univeristy Press.

Derochette, J. M., 2010. *Banne d'ordanche, Monts d'Ore.* [Online]
Available at: http://jm-derochette.be/volcanic_rocks/lame_43.htm
[Accessed 25th April 2022].

Deutsche Forschungsgemeinschaft, 2019. *Roman Port Andernach.* [Online]
Available at: http://www.spp-haefen.de/en/projects/der-rhein-als-europaeische-verkehrsachse/die-teilprojekte/roman-port-andernach/
[Accessed 2nd April 2019].

Dimbleby, G. W., 1978. A Pollen Analysis from Verulamium. *Hertfordshire Archaeology,* 6(1), pp. 112-115.

Dobson, B. & Breeze, D. J., 2000. *Hadrian's Wall.* 4th ed. London: Penguin.

Domergue, C., 1990. *Les mines de la Peninsule Iberique dans l'Antiquité Romaine.* 1st ed. Rome: Publications de l'École Française de Rome.

Down, A., 1978. *Chichester Excavations 3.* 1st ed. Chichester: Phillimore & Co.

Down, A., 1979. *Chichester Excavations 4.* 1st ed. Chichester: Phillimore.

Down, A., 1981. *Chichester Excavations 5.* 1st ed. Chichester: Phillimore.

Down, A., 1988. *Roman Chichester.* 1st ed. Chichester: Phillimore.

Down, A., 1989a. *Chichester Excavations 6.* 1st ed. Chichester: Phillimore.

Down, A., 1989b. *Chichester Excavations 7.* 1st ed. Chichester: Phillimore.

Down, A. & Rule, M., 1971. *Chichester Excavations 1.* 1st ed. Chichester: Chichester Civic Society Excavations Committee.

Dreesen, R. et al., 2014. Unraveling geological and geographical provenances of lithic materials during Roman times in Belgium: a fruitful collaboration between geologists and archaeologists. *European Geologist,* 38(1), pp. 10-14.

Duncan-Jones, R., 1977. *The Economy of the Roman Empire: Quantitative Studies.* Revised edition ed. Cambridge: Cambridge University Press.

Dunwoodie, L., 2004. *Pre-Boudican and Later Activity on the Site of the Forum.* 1st ed. London: Museum of London Archaeology Service.

Dunwoodie, L., Harwood, C. & Pitt, K., 2015. *An early Roman fort and urban development on Londinium's Eastern Hill, MOLA Monograph 65.* London: s.n.

Dworakowska, A., 1983. *Quarries In Roman Provlnces.* 1st ed. Wrocław: Zakład Narodowy Imienia Ossolińskich Wydawnictwo Polskiej Akademii Nauk.

Eaton, T., 2000. *Plundering the Past: Roman Stonework in Medieval Britain.* 1st ed. Cheltenham: Tempus.

Eckardt, H., 2005. The social distribution of Roman artefacts: the case of nail-cleaners and brooches in Britain. *Journal of Roman Archaeology,* 18(1), pp. 139-160.

Eckardt, H., 2006. The Character, Chronology, and Use of the Late Roman Pits: The Silchester finds assemblage. In: M. Fulford, A. Clarke & H. Eckardt, eds. *Life and Labour in Late Roman Silchester: Excavations in Insula IX since 1997.* London: Society for the Promotion of Roman Studies, pp. 221-248.

Eckardt, H., 2015. *Objects and Identities: Roman Britain in the north-western provinces.* 1st ed. Oxford: Oxford University Press.

Eckardt, H., 2018. *Writing and power in the Roman world: Literacies and material culture.* 1st ed. Cambridge: Cambridge University Press.

Eckardt, H. & Williams, H., 2003. Objects without a past? The use of Roman objects in early Anglo-Saxon graves. In: 1st, ed. *Archaeologies of Remembrance.* London: Plenum, pp. 141-170.

Edwards, B. J. & Breeze, D. J., 2000. *The Twelfth pilgrimage of Hadrian's Wall, 1999 : a report.* 1st ed. Kendal: Cumberland and Westmorland Antiquarian and Archaeological Society.

English Heritage, 2016. *History of Corbridge Town.* [Online]
Available at: https://www.english-heritage.org.uk/visit/places/corbridge-roman-town-hadrians-wall/history-and-stories/history/
[Accessed 27th January 2022].

Erdkamp, P. P., 2001. Beyond the Limits of the 'Consumer City'. A Model of the Urban and Rural Economy in the Roman World. *Historia: Zeitschrift für Alte Geschichte,* 50(3), pp. 332-356.

Evans, E., 1994. Military Architects and Building Design in Roman Britain. *Britannia,* 25(1), pp. 143-164.

Evans, J., 2002. Pottery from Thornbrough Farm. In: P. R. Wilson, ed. *Cataractonium. Roman Catterick and its Hinterland: Excavations and Research, 1958-1997. Part I.* York: Council for British Archaeological Research Report, pp. 479-476.

Evans, J., 2007. The Roman pottery from Wroxeter's hinterland. In: V. L. Gaffney, R. H. White & H. Goodchild, eds. *Wroxeter, the Cornovii, and the Urban Process: Final Report on the Wroxeter Hinterland Project 1994-1997. Vol. 1, Researching the Hinterland.* Portsmouth: Journal of Roman Archaeology Supplementary Series 68, pp. 146-167.

Evans, R., 2017. *Mass and Elite in the Greek and Roman Worlds: From Sparta to Late Antiquity.* 1st ed. Abingdon: Taylor and Francis.

Evers, K. G., 2011. *The Vindolanda tablets and the ancient economy.* 1st ed. Oxford: Archaeopress.

Faulkner, N., 2000. *The Decline and Fall of Roman Britain.* 1st ed. Stroud: Tempus.

Fenwick, V., 1978. *The Graveney boat: a 10th Century find from Kent.* 1st ed. Oxford: BAR Publishing.

Finley, M., 1999. *The Ancient Economy.* 3rd, renewed by trustees of Darwin College, University of Cambridge ed. London: University of California Press.

Firth, R., 2012. *Primitive Economics of the New Zealand Maori.* 2nd ed. London: Routledge.

Fischer, M. L., 1998. *Marble Studies: Roman Palestine and the Marble Trade.* 1st ed. Konstanz: Xenia.

Fischler, C., 1988. Food, Self and Identity. *Anthropology of Food,* 27(2), pp. 275-292.

Fitzpatrick, A. P., 2017. 'The famous volcanic rock of the Eifel': Was it imported to Britain in prehistory?. In: R. Shaffrey, ed. *Written in Stone; Papers on the function, form and provenancing of prehistoric stone objects in memory of Fiona Roe.* Oxford: Oxbow Books, pp. 195-214.

Fox, C., 1947. *The Personality of Britain: Its Influence on Inhabitant and Invader in Prehistoric and Early Historic Times.* 4th ed. Cardiff: National Museum of Wales.

Frankenstein, S. & Rowlands, M. J., 1978. The Internal Structure and Regional Context of Early Iron Age Society in South-Western Germany. *Bulletin of the Institute of Archaeology, University of London,* 15(1), pp. 73-112.

Frere, S., 1964. Verulamium - Then as Now. *University of London Institute of Archaeology Bulletin,* 4(1), pp. 61-82.

Frere, S., 1972. *Verulamium Excavations Vol 1.* 1st ed. London: Society of Antiquaries of London.

Frere, S., 1983. *Verulamium Excavations: Volume 2.* 1st ed. London: The Society of Antiquaries of London .

Frere, S., 1984. Excavations at Dorchester on Thames, 1963. *Archaeological Journal,* 141(1), pp. 91-174.

Frere, S. S. & St Joseph, J. K., 1974. The Roman Fortress at Longthorpe. *Britannia,* 5(1), pp. 1-129.

Frere, S. S. & Stow, S., 1983. *Excavations in the St George's Street and Burgate Street Areas, Canterbury.* 1st ed. Maidstone: Archaeology of Canterbury.

Fryer, J., 1978. *Ports in Roman Britain,* Univeristy of Keele: Unpublished PhD thesis.

Fry, J., 2009. A Late Bronze Age, Anglo-Saxon and medieval Settlement Site at Manston Road, Ramsgate: Stone. In: P. Andrews, et al. eds. *Kentish Sites and Sites of Kent. A Miscellany of four archaeological excavations.* Salisbury: Wessex Archaeology, pp. 228-229.

Fulford, M., 1984. *Silchester Defences 1974-80.* 1st ed. London: Society for the Promotion of Roman Studies.

Fulford, M., 1987. Calleva Atrebatum: an Interim Report on the Oppidum 1980-1986. *Proceedings of the Prehistoric Society,* 53(1), pp. 271-278.

Fulford, M., 1989. *The Silchester Amphitheatre: Excavations of 1979-85.* 1st ed. London: Society for the Promotion of Roman Studies.

Fulford, M., 2001. Links With the Past: Pervasive 'ritual' behaviour in Roman Britain. *Britannia,* 32(1), pp. 199-218.

Fulford, M., 2008. Nero and Britain: The Palace of the Client King at Calleva and Imperial Policy towards the Province after Boudicca. *Britannia,* 39(1), pp. 1-13.

Fulford, M., 2020a. Introduction. In: M. Fulford, A. Clarke, E. Durham & N. Pankhurst, eds. *Silchester Insula IX: The Claudio-Neronian Occupation of the Iron Age Oppidum.* London: Society for the Promotion of Roman Studies, pp. 3-10.

Fulford, M., 2020b. Discussion and Synthesis. In: M. Fulford, A. Clarke, E. Durham & N. Pankhurst, eds. *Silchester Insula IX: The Claudio-Neronian Occupation of the Iron Age Oppidum.* London: Society for the Promotion of Roman Studies, pp. 567-600.

Fulford, M., 2021. *Silchester Revealed: The Iron Age and Roman Town of Calleva.* 1st ed. Oxford: Oxbow.

Fulford, M. & Bird, J., 1975. Imported Pottery from Germany in the Late Roman Period. *Britannia,* 6(1), pp. 171-181.

Fulford, M. & Brindle, T., 2016. Introduction. In: M. Fulford & N. Holbrook, eds. *The Rural Settlement of Roman Britain.* London: Society for the Promotion of Roman Studies, pp. 1-16.

Fulford, M. & Clarke, A., 2011. *Silchester, City in Transition. The Mid-Roman Occupation of Insula IX c. A.D. 125-250/300: A report on excavations undertaken since 1997.* 1st ed. London: Society for the Promotion of Roman Studies.

Fulford, M. et al., 2018b. *Silchester Roman Town: The baths 2018.* 1st ed. Reading: University of Reading.

Fulford, M., Clarke, A., Durham, E. & Pankhurst, N., 2018a. *Late Iron Age Calleva : the pre-conquest occupation at Silchester Insula IX.* 1st ed. London: Society for the Promotion of Roman Studies.

Fulford, M., Clarke, A., Durham, E. & Pankhurst, N., 2020. *Silchester Insula IX : the Claudio-Neronian occupation of the Iron Age oppidum : the early Roman occupation at Silchester Insula IX.* 1st ed. London: Society for the Promotion of Roman Studies.

Fulford, M. et al., 2019. *Silchester Roman Town: The Baths 2019,* Reading: University of Reading.

Fulford, M., Clarke, A. & Eckardt, H., 2006. *Life and Labour in Late Roman Silchester: Excavations in Insula IX since 1997.* 1st ed. London: Society for the Promotion of Roman Studies.

Fulford, M., Clarke, A., Eckardt, H. & Shaffrey, R., 2002. Victorian Excavation Methodology: The Society of Antiquaries at Silchester in 1893. *The Antiquaries Journal,* 82(1), pp. 285-306.

Fulford, M. et al., 2017. *Silchester Insula XXX: Temple excavation 2017.* 1st ed. Reading: University of Reading.

Fulford, M., Clarke, A. & Lucas, S., 2011. *Silchester Insula IX: The 'Town Life' Project 2011,* Reading: Univeristy of Reading.

Fulford, M. & Machin, S., 2021. Building Britannia: Pre-Flavian Private and Public Construction across Southern Britain. *Britannia,* Volume doi:10.1017/S0068113X2100009X, pp. 1-19.

Fulford, M. & Timby, J., 2000. *Late Iron age and Roman Silchester: Excavations on the site of the Forum-Basilica, 1977, 1980-86.* 1st ed. London: Society for the Promotion of Roman Studies.

Gallala, W., Younes, A., Ouazaa, N. L. & Hadjzobir, S., 2018. Roman Millstones of Carthage (Tunisia): a Geoarchaeological Study Using Petrological and Geochemical Methods. *Geoheritage,* 10(1), pp. 673-686.

Gallardo, F., Castro, V. & Miranda, P., 1999. Riders on the storm: rock art in the Atacama Desert. *World Archaeology,* 31(2), pp. 225-242.

Gallery V Exibits, 1998. *Appalachia Through the Eyes of Doris Ulmann: A Photograph Exhibit.* [Online] Available at: http://community.berea.edu/galleryv/GrindCn.HTML
[Accessed 5th March 2019].

Gardner, A., 2017. Roman Britain from the Outside: Comparing Western and Northern Frontier Cultures. In: S. Gonzalez Sanchez & A. Guglielmi, eds. *Romans' and 'barbarians' beyond the frontiers: archaeology, ideology and identities in the north.* 1st ed. Oxford: Oxbow Books, pp. 34-47.

Garrow, D., 2012. Odd Deposits and Average Practice: A critical history of the concept of structured deposition. *Archaeological Dialogues,* 19(2), pp. 85-115.

Gibbon, E., 1997. *The History of the Decline and Fall of the Roman Empire Vol 1.* Reprint of 1977 ed. ed. London: Routledge.

Giljohann, R., Hunold, A. & Wenzel, S., 2017. Rural Life and Industry between the Eifel and the Rhine. In: M. Reddé, ed. *Gallia Rustica 1: les campagnes du nord-est de la Gaule, de la fin de l'âge du fer à l'antiquité tardive.* Bordeaux: Université Bordeaux Montaigne, pp. 125-152.

Gillam, J. & Greene, K., 1981. Roman Pottery and the Economy. In: Anderson & Anderson, eds. *Roman Pottery Research in Britain and North-West Europe.* Oxford: British Archaeological Research, pp. 1-25.

Glauben, A. M., 2012. Der vicus von Mayen (Lkr. Mayen-Koblenz).. In: M. Grünewald & S. Wenzel, eds. *Römische Landnutzung in der Eifel- neue Ausgrabungen und Forschungen, Tagung in Mayen, vom 3. bis zum 6. November 2011.* Mainz: RGZM, pp. 87-98.

Gledhill, J., 1978. Formative Developments in the North America South-West. In: D. Green, C. Haselgrove & M. Spriggs, eds. *Social Organisation and Settlement.* Oxford: British Archaeological Reports, pp. 241-290.

Gluhak, T., 2010. Mühlen für das römische Militär. Geochemische Herkunftsanalysen von Mühlsteinen aus den augusteischen Lagern Haltern, Oberaden, Anreppen und Barkhausen. *Archäologisches Korrespondenzblatt,* 40(1), pp. 273-284.

Gluhak, T. M. & Hofmeister, W., 2009. Roman lava quarries in the Eifel region (Germany): geochemical data for millstone provenance studies. *Journal of Archaeological Science,* 36(1), pp. 1774-1782.

Gluhak, T. M. & Hofmeister, W., 2011. Geochemical Provenance Analyses of Roman Lava Millstones North of the Alps: a Study of their Distribution and Implications for the Beginning of Roman Lava Quarrying in the Eifel Region (Germany). *Journal of Archaeological Science,* 38(1), pp. 1603-1620.

Goldsworthy, A. K., 1998. *The Roman Army at War: 100 BC-AD 200.* 1st ed. Oxford: Clarendon Press.

Goodburn, R. & Grew, F., 1984. Objects of Stone. In: S. Frere, ed. *Verulamium Excavations III.* Oxford: Oxford University Committee for Archaeology, pp. 77-82.

Gosden, C. & Marshall, Y., 1999. The cultural biography of objects. *World Archaeology,* 31(2), pp. 169-178.

Gosden, C. & Marshall, Y., 1999. The Cultural Biography of Objects. *World Archaeology,* 31(2), pp. 169-178.

Green , C., 2017. Querns and Millstones in Late Iron Age and Roman London and South-East England. In: D. Bird, ed. *Agriculture and Industry in South-Eastern Roman Britain.* Oxford: Oxbow Books, pp. 156-179.

Greenaway, J., 1981. The Neronian Stamped Tile from Little London, near Silchester. *Britannia,* 12(1), pp. 290-291.

Greene, E., 2013. Female networks in the military communities of the Roman west: a view from the Vindolanda tablets. In: E. Hemelrijk & G. Woolf, eds. *Women and the Roman City in the Latin West.* Leiden: Brill, pp. 369-390.

Greene, K., 1986. *The Archaeology of the Roman Economy.* 1st ed. Berkeley: California Univeristy Press.

Gregory, F. & Martin, R., 1997. *Sussex Watermills.* 1st ed. Seaford: SB Publications.

Griffin, N., 2003. *Archaeological investigations at Roundstone Lane, Angmering, West Sussex,* Brighton: Archaeology South East unpublished report series.

Groenman-van Waateringe, W., 1997. Classical Authors and the Diet of Roman Soldiers: true or false?. In: W. Groenman-van Waateringe, B. L. van Beek, W. J. H. Willems & S. L. Wynia, eds. *Roman Frontier Studies 1995.* Oxford: Oxbow Books, pp. 261-265.

Grünewald, M., 2012. Der Wirtschaftsstandort Mayen. *Antike Welt,* 1(1), pp. 79-84.

Gutiérrez Garcia, A., 2011. The exploitation of local stone in Roman times: the case of north-eastern Spain. *World Archaeology,* 43(2), pp. 318-341.

Hackworth Petersen, L., 2003. The Baker, His Tomb, His Wife, and Her Breadbasket: The Monument of Eurysaces in Rome. *The Art Bulletin,* 85(2), pp. 230-257.

Hajnalová, M. & Rajtár, J., 2009. Supply and subsistence: the Roman fort at Iža. In: W. S. Hanson, ed. *The army and frontiers of Rome." Papers offered to David Breeze on the occasion of his sixty-fifth birthday and his retirement from Historic Scotland.* Portsmouth: Journal of Roman Archaeology, pp. 194-207.

Hamilakis, Y., 1999. Stories from exile: fragments from the cultural biography of the Parthenon (or 'Elgin') Marbles. *World Archaeology,* 31(2), pp. 303-320.

Hamilton, S., 2002. Between Ritual and Routine: interpreting British Prehistoric pottery production and distribution. In: A. Woodward & J. D. Hill, eds. *Prehistoric Britain: the ceramic basis.* Oxford: Oxbow Books, pp. 38-53.

Hansen, S. S. & Larsen, A.-C., 2000. Miniature querns and millstones from Shetland's Scandinavian Past. *Acta Archaeologica,* 71(1), pp. 105-121.

Hanson, W. S., Daniels, C. M., Dore, J. N. & Gillam, J. P., 1979. The Agricolan Supply Base at Red House, Corbridge. *Archaeologia Aeliana (5th Series),* 7(1), pp. 1-98.

Harding, D. W., 2009. *The Iron Age Round-House: Later Prehistoric Building in Britain and Beyond.* 1st ed. Oxford: OUP Oxford.

Harman, G., 2002. *Tool-being: Heidegger and the metaphysics of objects.* 1st ed. Chicago: Open Court.

Harrell, J. A. & Storemyr, P., 2009. Ancient Egyptian Quarries: an illustrated overview. In: N. Abu-Jaber, E. G. Bloxam, P. Degryse & T. Heldal, eds. *QuarryScapes: Ancient Stone Quarry Landscapes in the Eastern Mediterranean Geological Survey of Norway Special Publication 12.* Trondheim: Geological Survey of Norway, pp. 7-50.

Hartmut, G. Z., 2006. The Consumer City Once Again Revisited. *Analele Universităţii 'Dunărea de Jos' Galaţi,* 19(5), pp. 21-40.

Hartoch, E. et al., 2015. Moudre au Pays des Tungri. *Atuatuca,* 7(1), p. 416.

Haselgrove, C., 1987. *Iron Age Coinage in South-East England: the archaeological context.* 1st ed. Oxford: BAR British Series.

Hatherley, C., 2020. *Doune Roman fort, Stirlingshire: excavations in 1999, 2008 and 2010. Scottish Archaeological Internet Reports 92.* [Online]
Available at: https://doi.org/10.9750/issn.2056-7421.2020.92
[Accessed 25th February 2022].

Haverfield, F., 1912. *The Romanization of Roman Britain.* 1st ed. Oxford: Clarendon Press.

Haverfield, F., 1920. *The Provisioning of Roman Forts.* 1st ed. Highgate: Titus Wilson & Son.

Hayward, K. M., 2009. *Roman Quarrying and Supply on the Periphery: A geological study of first-century funerary monuments and monumental architecture.* 1st ed. Oxford: Archaeopress.

Henig, M., 1971. The Gemstones and Other Jewellery. In: B. Cunliffe, ed. *Fishbourne Excavations 1961-1969, Vol 2.* London: The Society of Antiquaries, pp. 83-92.

Herz, N. & Wenner, D., 1981. Tracing the Origin of Marble. *Archaeology,* 34(1), pp. 14-21.

Heslop, D. H., 2008. *Patterns of Quern Production, Acquisition and Deposition: A Corpus of Beehive Querns from Northern Yorkshire and Southern Durham.* 1st ed. Leeds: Yorkshire Archaeological Society.

Hill, J. D., 1995. *Ritual and Rubbish in the Iron Age of Wessex. BAR British Series 242.* 1st ed. Oxford: BAR Publishing.

Hill, J. & Rowsome, P., 2011. *Roman London and the Walbrook Stream Crossing: Excavations at 1 Poultry and Vicinity, City of London. MOLA Monograph 37.* 1st ed. London: Museum of London Archaeology.

Hingley, R., 1989. *Rural settlement in Roman Britain.* 1st ed. London: Seaby.

Hingley, R., 2000. *Roman Officers and English Gentlemen.* 1st ed. London: Routledge.

Hirschfield, O., 1905. *Die kaiserlichen Verwaltungsbeamten bis auf Diokletian.* 1st ed. Berlin: Weidmann.

Hirt, A. M., 2010. *Imperial Mines and Quarries in the Roman World: Organizational Aspects 27 BC-AD 235.* 1st ed. Oxford: Oxford University Press.

Historic England, 1999. *Reculver Saxon Shore fort, Anglo-Saxon monastery and associated remains.* [Online]
Available at: https://historicengland.org.uk/listing/the-list/list-entry/1018784
[Accessed 9th September 2021].

Hodgson, N., 1999. *History of Chesters Roman Fort.* [Online]
Available at: https://www.english-heritage.org.uk/visit/places/chesters-roman-fort-and-museum-hadrians-wall/history/#footnote-4
[Accessed 3rd February 2022].

Hodgson, N., 2000. The Stanegate: A Frontier Rehabilitated. *Britannia,* 31(1), pp. 11-22.

Hodgson, N., 2008. The Development of the Roman Site at Corbridge from the First to Third Centuries AD. *Archaeologia Aeliana,* 37(1), pp. 47-92.

Hodgson, N., 2009. *Hadrian's Wall 1999-2009.* 1st ed. Kendal: Cumberland & Westmorland Antiquarian & Archaeological Society.

Hodgson, N., 2014. The accomodation of soldiers' wives in Roman fort barracks- on Hadrian's Wall and beyond. In: R. Collins & F. McIntosh, eds. *Life in the Limes: Studies of people and objects of the Roman frontiers.* Oxford: Oxbow Books, pp. 18-28.

Hodgson, N. & Bidwell, P. T., 2004. Auxiliary Barracks in a New Light: Recent Discoveries on Hadrian's Wall. *Britannia,* 35(1), pp. 121-157.

Hopkins, K., 1980. Taxes and Trade in the Roman Empire (200 B.C.-A.D. 400). *The Journal of Roman Studies,* 70(1), pp. 101-125.

Horden, P. & Purcell, N., 2000. *The Corrupting Sea: A study of Mediterranean history.* 1st ed. Oxford: Blackwell.

Hörter, F., 1994. *Getreidereiben und Mühlsteine aus der Eifel: Ein Beitrag zur Steinbruch- und Mühlengeschichte.* 1st ed. Mayen: Geschichts- und Altertumsverein für Mayen und Umgebung.

Hörter, F. & Röder, M. J., 1951. Die Geschichte der Basaltlava-Industrie von Mayen und Niedermendig Teil I: Vor- und Frühgeschichte. *Sonderdruck Jahrbuch: für Geschichte und Kultur des Mittelrheins und seiner Nachbargebiete,* 1(1), pp. 1-35.

Howgego, C., Butcher, K., Ponting, M. & Heuchert, V., 2013. *Coinage and the Roman Economy in the Antonine Period: the view from Egypt.* [Online]
Available at: http://oxrep.classics.ox.ac.uk/oxrep/docs/Howgego2010.pdf
[Accessed 23rd March 2020].

Hunn, J. R., 1992. The Verulamium Oppidum and its Landscape in the Late Iron Age. *The Aracheological Journal,* 149(1), pp. 39-68.

Ingrem, C., 2006. The Animal Bone. In: M. Fulford, A. Clarke & H. Eckardt, eds. *Life and Labour in Late Roman Silchester: Excavations in Insula IX since 1997.* London: Society for the Promotion of Roman Studies, pp. 167-188.

Jaccottey, L. & Longepierre, S., 2011. Pompeian Millstones in France. In: D. Williams & D. Peacock, eds. *Bread for the People. The Archaeology of Mills and Milling: Proceedings of a Colloquium Held in the British School or Rome, 4th-7th November 2009.* Oxford: Archaeopress, pp. 97-116.

Jacobi, H., 1914. Römische Getreidemühlen. *Saalburg Jahrbuch,* 3(1), pp. 75-96.

Jermy, K. E., 1990. The 'North Cheshire Ridge' Roman Road. *Britannia,* 21(1), pp. 283-285.

Jodry, F., 2011. First Century Querns of the Roman Army in the Light of Modern Texts. In: D. Williams & D. Peacock, eds. *Bread for the People. The Archaeology of Mills and Milling: Proceedings of a Colloquium Held in the British School or Rome, 4th-7th November 2009.* Oxford: Archaeopress, pp. 85-92.

Jones, A. H., 1964. *The Later Roman Empire.* 1st ed. Oxford : Blackwell Publishing.

Jones, B. & Mattingly, D., 1991. *An Atlas of Roman Britain.* 1st ed. Oxford: Oxbow.

Jones, M., 2000. The Plant Remains. In: 1st, ed. *Late Iron Age and Roman Silchester: Excavations of the site of the Forum Basilica 1977, 1980-86.* London: Society for the Promotion of Roman studies, pp. 505-5012.

Jones, M. J., 2004. Cities and Urban Life. In: M. Todd, ed. *A Companion to Roman Britain.* Oxford: Blackwell, pp. 162-192.

Jongman, W., 2007. The Early Roman Empire: Consumption. In: W. Scheidel, I. Morris & P. R. Saller, eds. *The Cambridge Economic history of the Greco-Roman World.* Cambridge: Cambridge University Press, pp. 592-618.

Jouffroy, H., 1986. *La Construction Publique en Italie et dans L'Afrique Romaine (Groupe de recherche d'histoire romaine de l'Université des sciences humaines de Strasbourg, etudes et travaux II).* 1st ed. Strasbourg: AECR.

Joyce, R. A. & Gillespie, S. D., 2015. *Things in motion: Object histories, biographies and itineraries.* 1st ed. Sante Fe: SAR Press.

Joy, J., 2009. Reinvigorating object biography: reproducing the drama of object lives. *World Archaeology,* 41(4), pp. 540-556.

Kling, J., 2008. The underground Millstone Quarries at Niedermendig and Mayen. History, Research, Threats and Valuation. In: J. Silvertant & J. Ni Mháirtin, eds. *What Lies Beneath: Proceedings of the 3rd International Symposium on Archaeological Mining History.* Maastricht: Institute Europe Subterranea, pp. 138-169.

Kohl, P. L., 1978. The Balance of Trade in Southwestern Asia in the Mid-Third Millenium BC. *Current Anthropology,* 19(1), pp. 463-492.

Kopytoff, I., 1986. The cultural biography of things: commoditization as process. In: A. Appadurai, ed. *The Social Life of things: commodities in cultural perspective.* Cambridge: Cambridge University Press, pp. 64-91.

Köstner, E., 2012. Stad, Land, Fluss: Rechtliche aspekte der landnutzung in der Eifel nach dem Gallischen krieg. In: M. Grünewald & S. Wenzel, eds. *Römische Landnutzung in der Eifel- neue Ausgrabungen und Forschungen, Tagung in Mayen, vom 3. bis zum 6. November 2011.* Mainz: Römisch-Germanischen Zentralmuseums, pp. 73-85.

Künow, J., 1980. *Negotiator et Vectura: Händler und Transport im freien Germanien.* 1st ed. Marburg: Universität Marburg.

Lakin, D., 1997. *Summerton Way, Thamesmead, London, SE8: A post-excavation assessment,* London: Museum of London Archaeological Service.

Lane, F. C., 2019. *Venice and History: The Collected Papers of Frederic C. Lane.* 1st ed. Baltimore: John Hopkins Univeristy Press.

Laurence, R. & Trifilò, F., 2015. The global and the local in the Roman empire: connectivity and mobility from an urban perspective. In: M. Pitts & M. J. Versluys, eds. *Globalisation and the Roman world: world history, connectivity and material culture.* Cambridge: Cambridge University Press, pp. 99-122.

Lepareux-Couturier, S., 2014. Complex dressing patterns on grinding surfaces of rotary querns and millstones from Antiquity in the Paris Basin, France: state of research and perspectives. *AmS-Skrifter ,* 24(1), pp. 149-158.

Lockyear, K. & Shlasko, E., 2016. Under the Park. Recent geophysical surveys at Verulamium (St Albans, Hertfordshire, UK). *Archaeological Prospection,* 24(1), pp. 17-36.

Lodwick, L., 2017. Evergreen Plants in Roman Britain and Beyond: Movement, Meaning and Materiality. *Britannia,* 48(1), pp. 135-173.

Lodwick, L., 2020. The plant remains. In: M. Fulford, ed. *Silchester Insula IX: The Claudio-Neronian Occupation of the Iron Age Oppidum.* London: Society for the Promotion of Roman Studied.

Lundock, J., 2015. *A Study of the Deposition and Distribution of Copper Alloy Vessels in Roman Britain.* 1st ed. Oxford: Archaeopress.

MacGregor, G., 1999. Making sense of the past in the present: a sensory analysis of carved stone balls. *World Archaeology,* 31(2), pp. 258-271.

MacKie, E. W., 2007. Rotary Quernstones. In: W. S. Hanson, ed. *Elginhaugh: a Flavian fort and its annexe.* London: Society for the Promotion of Roman Studies, pp. 492-505.

Madgwick, R. et al., 2013. Fallow deer (Dama dama dama) management in Roman South-East Britain. *Journal of Archaeological Anthropological Science,* 5(1), pp. 111-122.

Major, J. K., 1982. The Manufacture of Millstones in the Eifel Region of Germany. *Industrial Archaeology Review,* 6(3), pp. 194-204.

Malinowski, B., 1926. *Crime and Custom in Savage Society.* 1st ed. London: Routledge.

Malmendier, U., 2002. *Societas publicanorum: staatliche Wirtschaftsaktivitäten in den Händen privater Unternehmer.* 1st ed. Köln: Böhlau Verlag.

Mangartz, F., 2007. Een 'logboek' voor De Meern 1: beschrijving en determinatie van de herkomst van het natuursteen. In: T. de Groot & J. M. Morel, eds. *Een Romeinse Rijnaak, gevonden in Utrecht-De Meern: Resultaten van het onderzoek naar de platbodem 'De Meern 1'.* Amersfoort: Rapportage Archeologische Monumentenzorg, pp. 246-255.

Mangartz, F., 2008. *Römischer Basaltlava-Abbau zwischen Eifel und Rhein: Monographien des Römisch-Germanisches Zentralmuseum 7; Vulkanpark Forschungen 7.* 1st ed. Mainz: RGZM.

Mangartz, F., 2012. Römerzeitliche Mühlsteinproduktion in den Grubenfeldern des Bellerberg-Vulkans bei Mayen (LKR. Mayen-Koblenz). In: M. Grünewald & S. Wenzel, eds. *Römische Landnutzung in der Eifel: Neue Ausgrabungen und Forschungen, Tagung in Mayen, vom 3. bis zum 6. November 2011.* Mainz: RGZM, pp. 1-24.

Manley, J. & Rudkin, D., 2005. A Pre-a.d. 43 Ditch at Fishbourne Roman Palace, Chichester. *Britannia,* 36(1), pp. 55-99.

Mattingly, D., 2006. *An Imperial Posession: Britain in the Roman Empire.* 1st ed. London: Penguin Books.

Mattingly, D., 2011. *Imperialism, Power and Identity: Experiencing the Roman Empire.* 1st ed. Oxford: Princeton University Press.

Mattingly, D. J., 1997. Beyond Belief? Drawing a Line Beneath the Consumer City. In: H. M. Parkins, ed. *Roman Urbanism: Beyond the consumer city.* London: Routledge, pp. 210-218.

Mattingly, D. J. & Salmon, J., 2001. *Economies Beyond Agriculture in the Classical World.* 1st ed. London: Routledge.

Maxwell, G. S., 1976. The Roman Road East of Castledykes. *Glasgow Archaeological Journal,* 4(1), pp. 93-98.

McAlister, D., 2013. Childhood in Viking and HibernoScandinavian Dublin 800-1100. In: D. Hadley & L. T. Harkel, eds. *Everyday Life in Viking Towns: Social approaches to towns in England and Ireland 800-1100.* Oxford: Oxbow, pp. 86-102.

McIntosh, F. C., 2019. *The Clayton Collection: An archaeological appraisal of a 19th century collection of Roman artefacts from Hadrian's Wall.* 1st ed. Oxford: BAR Publishing.

McLaren, D. & Hunter, F., 2008. New aspects of rotary querns in Scotlan. *Proceedings of the Society of Antiquaries Scotland,* 138(1), pp. 105-128.

Meyer, R. & Foulger, G. R., 2007. *The European Cenozoic Volcanic Province is not caused by mantle plumes.* [Online]
Available at: http://www.mantleplumes.org/Europe.html
[Accessed 25th April 2022].

Millett, M., 1979. How Much pottery?. In: M. Millet, ed. *Pottery and the Archaeologist.* London: Institute of Archaeology, pp. 77-80.

Millett, M., 1990. *The Romanization of Britain.* 1st ed. Cambridge: Cambridge University Press.

Millett, M. & Wilmott, T., 2003. Rethinking Roman Richborough. In: P. Wilson, ed. *The Archaeology of Roman Towns.* Oxford: Oxbow Books, pp. 184-194.

Moore, T., 2007. Perceiving communities: Exchange, landcapes and social networks in the later Iron Age of western Britain. *Oxford Journal of Archaeology,* 26(1), pp. 79-102.

Moore, T., 2017. Beyond Iron Age 'towns': Examining oppida as examples of low-density urbanism. *Oxford Journal of Archaeology,* 36(3), pp. 287-305.

Moritz, L. A., 1956. Vitruvius' water-mill. *Classical Review,* 6(3-4), pp. 193-196.

Moritz, L. A., 1958. *Grain Mills and Flour in Classical Antiquity.* 1st ed. Oxford: Clarendon Press.

Morris, F. M., 2010. *North Sea and Channel Connectivity during the Late Iron Age and Roman Period (175/150 BC- AD 409).* 1st ed. Oxford: BAR .

Morrison, W. A., 2009. *A Synthesis of Antiquarian and Archaeological Excavation at Dorchester-on-Thames, Oxfordshire.* 1st ed. Oxford: Archaeopress.

Muldowney, M., 2008. *Land Adjacent to Beech House, Exning,* Bury St Edmunds: Suffolk County Council Archaeological Service.

Neal, D., Hunn, J. & Wardle, A., 1990. *Excavation of the Iron Age, Roman and Medieval settlement at Gorhambury, St Albans.* 1st ed. Swindon: English Heritage.

Neal, D. S. & Cosh, S. R., 2009. *Roman Mosaics of Britain. Vol III, South-East Britain.* 1st ed. London: Society for the Antiquaries of London.

Neeson, L., 1991. Zur Rolle und Bedeutung der Produzierenden Gewerbe in Antiken Städten. *Ancient Society,* 22(1), pp. 25-40.

Newman, M. J., 1994. *River Lavant Flood Investigation,* Haywards Heath: Posford Duvivier.

Niblett, R., 1999. *The Excavation of a Ceremonial Site at Folly Lane St Albans.* 1st ed. London: The Society for the Promotion of Roman Studies.

Niblett, R., 2001. *Verulamium: The Roman City of St Albans.* 1st ed. Stroud: Tempus.

Niblett, R., Manning, W. & Saunders, C., 2006. Verulamium: Excavations within the Roman town 1986-88. *Britannia,* 37(1), pp. 53-188.

Oesterwind, B. C., 2012. Spätlatenezeit und frühe Römische Kaiserzeit in und um Mayen (Lkr. Mayen-Koblenz). In: M. Grünewald & S. Wenzel, eds. *Römische Landnutzung in der Eifel- neue Ausgrabungen und Forschungen, Tagung in Mayen, vom 3. bis zum 6. November 2011.* Mainz: RGZM, pp. 49-72.

Olsen, B., 2010. *In defense of things: Archaeology and the ontology of objects.* 1st ed. Plymouth: Rowman & Littlefield.

Omerod, H. A., 1997. *Piracy in the Ancient World.* 2nd ed. Baltimore: John Hopkins Univeristy Press.

Orton, C., 1989. An Introduction to the Quantification of Assemblages of Pottery. *Journal of Roman Pottery Studies,* 2(1), pp. 94-97.

Parkhouse, J., 1997. The Distribution and Exchange of Mayen Lava Quernstones in Early Medieval Northwestern Europe. In: G. De Boe & F. Verhaeghe, eds. *Exchange and Trade: Papers of the Medieval Europe Brugge 1997 conference Vol 3.* Zellik: Instituut voor het Archeologisch Patrimonium, pp. 97-106.

Parkins, H., 1997. The 'Consumer City' Domesticated? The Roman City in Elite Economic Strategies. In: H. Parkins, ed. *Beyond the Consumer City.* London: Routledge, pp. 83-111.

Peacock, D., 1987. Iron Age and Roman quern production at Lodsworth, West Sussex. *Antiquaries Journal,* 67(1), pp. 61-85.

Peacock, D., 1989. The Mills of Pompeii. *Antiquity,* 63(1), pp. 205-214.

Peacock, D., 2013. *The Stone of Life: Querns, Mills and Flour Production in Europe up to c. AD 500.* 1st ed. Southampton: The Highfield Press.

Peacock, D. P., 1980. The Roman millstone trade: a petrological sketch. *World Archaeology,* 12(1), pp. 43-53.

Peacock, D. P., 1998. *The Archaeology of Stone: A report for English Heritage.* 1st ed. Swindon: English Heritage.

Peacock, D. P. S. & Williams, D., 1986. *Amphorae and the Roman Economy: An introductory guide.* 1st ed. London: Longman.

Peacock, D., Williams, S. & Jones, S., 2007. Basalt as ships' ballast and the Roman incense trade. In: D. P. S. Peacock & D. Williams, eds. *Food for the gods : new light on the ancient incense trade.* Oxford: Oxbow, pp. 28-70.

Pearce, J., 2002. Food as a substance and symbol in the Roman army: a case study from Vindolanda. In: P. Freeman, J. Bennett, Z. T. Fiema & B. Hoffmann, eds. *Limes XVIII. Proceedings of the XVIIIth International Congress of Roman Frontier Studies held in Amman, Jordan (September 2000), Volume II.* Oxford: British Archaeological Research Reports International Series 1084, pp. 931-944.

Pearson, A., 2006. *The Work of Giants: Stone and quarrying in Roman Britain.* 1st ed. Stroud: Tempus.

Pearson, A. F., 1999. Building Anderita: Late Roman Coastal Defences and the Construction of the Saxon Shore Fort at Pevensey. *Oxford Journal of Archaeology,* 18(1), pp. 95-117.

Peers, L., 1999. Many tender ties: the shifting contexts and meanings of the S Black bag. *World Archaeology,* 31(2), pp. 288-302.

Peterson, L. H., 2003. The Baker, His Tomb, His Wife, and Her Breadbasket: The Monument of Eurysaces in Rome. *The Art Bulletin,* 85(2), pp. 230-257.

Picavet, P. et al., 2018. The Macquenoise sandstone (Devonian – Lochkovian), a suitable raw material for ancient querns and millstones: quarries, properties, manufacture and distribution in France and Belgium. *Geologica Belgica,* 21(1-2), pp. 27-40.

Piperno, R., 2020. *Porta Maggiore.* [Online]
Available at: https://www.romeartlover.it/Vasi07.html
[Accessed 16th May 2021].

Pitts, M., 2010. Rethinking the southern Brittish opidda: Netwoks, kingdoms and material culture. *European Journal of Archaeology,* 13(1), pp. 32-63.

Pitts, M., 2014. Reconsidering Britain's first urban communities. *Journal of Roman Archaeology,* 27(1), pp. 133-173.

Pitts, M., 2016. Rural Transformation in the Urbanized Landscape. In: M. Millet, L. Revell & A. J. Moore, eds. *The Oxford Handbook of Roman Britain.* Oxford: Oxford Univeristy Press.

Polanyi, K., 1968. *Primitive, Archaic and Modern Economies: Essays of Karl Polanyi, Edited by George Dalton.* 1st ed. New York: Garden City.

Polanyi, K., 1977. *The Livelihood of Man.* 1st ed. New York: Academic Press.

Reece, R., 1971. The Coins. In: B. Cunliffe, ed. *Excavations at Fishbourne 1961-1969, Vol 2.* London: The Society of Antiquaries, pp. 91-100.

Reniere, S., 2018. *Sourcing the Stone in Roman Northern Gaul: on the provenance, use and socio-economics of stone tools in a stoneless landscape: the case of the northern civitas Menapiorum.* 1st ed. Gent: Universiteit Gent.

Reniere, S. et al., 2016. Querns and mills during Roman times at the northern frontier of the Roman Empire (Belgium, northern France, southern Netherlands, western Germany): Unravelling geological and geographical provenances, a multidisciplinary research project. *Journal of Lithic Studies,* pp. 403-428.

Renzulli, A. et al., 2002. Provenance and trade of volcanic rock millstones from Etruscan-Celtic and Roman archaeological sites in Central Italy. *European Journal of Mineralogy,* 14(1), pp. 175-783.

Richardson, A., 2004. Granaries and garrisons in Roman forts. *Oxford Journal of Archaeology,* 23(4), pp. 429-442.

Rickman, G. & Rickman, G. R., 1971. *Roman Granaries and Store Buildings.* 1st ed. Cambridge: Cambridge University Press.

Rippon, S., 2008. Coastal Trade in Roman Britain: the Investigation of Crandon Bridge, Somerset, a Romano-British Trans-shipment Port beside the Severn Estuary. *Britannia,* 39(1), pp. 85-144.

Rippon, S., Smart, C. & Pears, B., 2015. *The Fields of Britannia: Continuity and Change in the Late Roman and Early Medieval Landscape.* 1st ed. Oxford: Oxford University Press.

Robinson, M., 2011. The Macroscopic Plant and Invertebrate Remains. In: 1st, ed. *Silchester: City in Transition: The Mid-Roman occupation of Insula IX c. AD 125-250/300. A report on excavations undertaken since 1997.* London: Society for the Promotion of Roman Studies, pp. 281-293.

Röder, J., 1953. Zur Lavaindustrie von Mayen und Volvic. *Germania,* 31(1), pp. 24-7.

Röder, J., 1955. Die Lavasteinbrüche von Volvic. *Jahrbuch für Geschichte und Kultur des Mittelrheins und seiner Nachbargebiete 1954/55,* 6(7), pp. 33-41.

Rogers, A., 2013. *Water and Roman Urbanism: Towns, Waterscapes, Land Transformation and Experience in Roman Britain.* 1st ed. Boston: Brill.

Rostovtzeff, M. I., 1957. *The Social and Economic History of the Roman Empire.* 2nd ed. Oxford: Clarendon Press.

Rudling, D. & Gilkes, O., 2000. Important archaeological discoveries made during the construction of the A259 Rustington Bypass, 1990. *Sussex Archaeological Collections,* 138(1), pp. 15-28.

Rushworth, A., 2009. *Housesteads Roman Fort- The Grandest Station.* 1st ed. Swindon: English Heritage.

Russell, B., 2013. *The Economics of the Roman Stone Trade.* 1st ed. Oxford: Oxford University Press.

Salisbury, R. B. & Rebay-Salisbury, K., 2017. Processes of theory: from production sequences and process to chaînes opératoires and object biographies. In: *Material chains in late prehistoric Europe and the Mediterranean.* Bordeaux: Ausonius Editions, pp. 15-29.

Saller, R. P., 1982. *Personal Patronage under the early Empire.* 1st ed. Cambridge: Cambridge University Press.

Sanderson, R. W., 1971. Eratic Stone Boulders. In: B. Cunliffe, ed. *Fishbourne 1961-1969: Volume 2, The Finds.* London: The Society of Antiquaries, pp. 2-3.

Saunders, N. J., 1999. Biographies of brilliance: pearls, transformations of matter and being c. AD 1492. *World Archaeology,* 31(2), pp. 243-257.

Scheidel, W. & Meeks, E., 2022. *ORBIS The Stanford Geospatial Network Model of the Roman World.* [Online]
Available at: https://orbis.stanford.edu/
[Accessed 21st August 2022].

Scholl, R. & Schubert, C., 2005. Lex Hadriana de agris rudibus und lex Manciana. *Archiv für Papyrusforschung und verwandte Gebiete,* 50(1), pp. 79-84.

Sefryn, P., 2013. Archaeologies of the Postindustrial Body. In: P. Graves-Brown, R. Harrison & A. Piccini, eds. *The Oxford Handbook of the Archaeology of the Contemporary World.* Oxford: Oxford University Press, pp. 685-699.

Seip, L. P., 1999. Transformations of meaning: the life history of the Naxalk mask. *World Archaeology,* 31(2), pp. 272-287.

Shaffrey, R., 2003. The Rotary Querns from the Society of Antiquaries' Excavations at Silchester, 1890-1909. *Britannia,* 34(1), pp. 143-174.

Shaffrey, R., 2006. *Grinding and Milling: A Study of Romano-British Rotary Querns and Millstones Made from Old Red Sandstone.* 1st ed. Oxford: Archaeopress.

Shaffrey, R., 2015. Intensive Milling Practices in the Romano-British Landscape of Southern England: Using newly established criteria for distinguishing millstones from rotary querns. *Britannia,* 46(1), pp. 55-92.

Shaffrey, R., 2019. The Movement of Ideas in the Late Iron Age and Early Roman Britain: an imported rotary quern design in south-western England. *Britannia,* 50(1), pp. 393-402.

Shaffrey, R., 2021. *Feeding Roman Silchester: Querns and Millstones in and around Roman towns.* [Online]
Available at: https://www.cambridge.org/core/journals/britannia/article/feeding-roman-silchester-querns-and-millstones-in-and-around-roman-towns/FAE81E498D5A01F7667237E412F3CDFF
[Accessed 9th September 2021].

Shaffrey, R. & Gluhak, T., 2020. Provenenancing lava querns: petrographic and geochemical analysis of three early Roman querns from Kent. *Council For British Arcaheology Newsletter: South East,* 53(1), pp. 1-3.

Shaffrey, R. & Roe, F., 2011. The Widening Use of Lodsworth Stone: Neolithic to Romano-British quern distribution. In: D. Williams & D. Peacock, eds. *Bread for the People: The archaeology of mills and milling.* Oxford: Archaeopress, pp. 309-324.

Shaffrey, R. & Roe, F., forthcoming. Querns from the Bronze Age to the Saxon period: making use of local resources in the 'Oxfordshire grits'. *Oxonesia.*

Sheldon, M. R., 2002. Caesar, Intelligence, and Ancient Britain. *International Journal of Intelligence and CounterIntelligence,* 15(1), pp. 77-100.

Sijpesteijn, P. J., 1987. *Customs duties in Graeco-Roman Egypt.* 1st ed. Amsterdam: Terra Publishing.

Simpson, F. G., 1976. *Watermills and Military Works on Hadrian's Wall.* 1st ed. Kendal: Titus Wilson & Son.

Smith , A., 2016a. The East. In: M. Fulford & N. Holbrook, eds. *The Rural Settlement of Roman Britain.* London: Society for the Promotion of Roman Studies, pp. 208-241.

Smith, A., 2016b. The Central Belt. In: M. Fulford & N. Holbrook, eds. *The Rural Settlement of Roman Britain.* London: Society for the Promotion of Roman Studies, pp. 141-207.

Smith, A., 2018. Religion and the Rural Population. In: M. Fulford & N. Holbrook, eds. *Life and Death in the Countryside of Roman Britain.* London: Society for the Promotion of Roman Studies, pp. 120-204.

Smith, A., Allen, M., Brindle, T. & Fulford, M., 2016. *The Rural Settlement of Roman Britain.* 1st ed. London: The Society for the Promotion of Roman studies.

Smith, A. T. et al., 2018. *Life and Death in the Countryside of Roman Britain.* 1st ed. London: Society for the Promotion of Roman Studies.

Smithsonian Institution, 2021. *East Eifel Volcanic Field.* [Online]
Available at:
https://volcano.si.edu/volcano.cfm?vn=210812#:~:text=Activity%20at%20the%20East%20Eifel,from%200.45%20to%200.35%20Ma.

Spaul, J. E. H., 1994. *The Auxiliary Cavalry Units of the Pre-Diocletianic Imperial Roman Army.* 1st ed. Andover: Nectoreca Press.

St Albans and Hertfordshire Architectural and Archaeological Society, 2019. *Plan of Verulamium.* [Online]
Available at: https://www.stalbanshistory.org/archaeology/the-roman-city-of-verulamium/map-of-verulamium
[Accessed 27th September 2021].

Starley, D., 2003. Analysis of Ferrous Metalworking Evidence. In: F. Hammer, ed. *Industry in North-West Roman Southwark: Excavations, 1986-8.* London: Museum of London Archaeology, pp. 131-140.

Stead, I. M., 1976. *Excavations at Winterton Roman villa and other Roman sites in north Lincolnshire,* s.l.: Inspectorate of Ancient Monuments, unpublished works.

Stead, I. M. & Rigby, V., 1989. *Verulamium: The King Harry Lane Site.* 1st ed. London: English Heritage.

Steensgaard, N., 1981. Violence and the Rise of Capitalism: Frederic C. Lane's Theory of Protection and Tribute. *Review (Fernand Braudel Center),* 2(1), pp. 247-273.

Strabo, 1923. *Geography, Volume II: Books 3-5. Translated by Horace Leonard Jones.* 1st ed. Havard: Harvard University Press.

Strong, D. E., 1971. Corinthian Capitals. In: B. Cunliffe, ed. *Fishbourne 1961-69: Vol 2, The Finds.* London: The Society of Antiquarians, pp. 11-15.

Sussex Mills Group, 2021. *Sussex Watermills.* [Online]
Available at: https://www.sussexmillsgroup.org.uk/water.htm
[Accessed 21st May 2021].

Swift, E., 2012. Object biography, reuse and recycling in the Late to Post-Roman transition period and beyond. *Britannia,* 43(1), pp. 167-215.

Swift, E., 2014. Design, function and use-wear in spoons: reconstructing everyday Roman social practice. *Journal of Roman Archaeology ,* 27(1), pp. 203-237.

Swift, E., 2017. *Roman Artefacts and Society: Design, Behaviour and Experience.* 1st ed. Oxford: Oxford Univeristy Press.

Täckholm, U., 1937. *Studien über den Bergbau der Römischen Kaiserzeit.* 1st ed. Uppsala: Appelbergs Boktryckeri Aktiebolag.

Taylor, J., 2007. *An atlas of Roman Rural Settlement in England.* 1st ed. York: Council for British Archaeology.

Temin, P., 1980. Modes of Behavior. *Journal of Economic Behavior and Organsiation,* 1(2), pp. 175-195.

Thomas, R. I., 2014. Roman Naukratis and its Alexandrian context. *British Museum Studies in Ancient Egypt and Sudan,* 21(1), pp. 193-218.

Thurmond, D. L., 2006. *A Handbook of Food Processing in Classical Rome: For Her Bounty No Winter.* 1st ed. Leiden: Brill.

Tomlin, R. S. O., Wright, R. P. & Collingwood, R. G., 2009. *The Roman Inscriptions of Britain, Volume 1: Inscriptions on Stone.* 2nd ed. Stroud: Alan Sutton Publishing.

Topping, P., 2008. Landscape narratives: the South-East Cheviots Project. *Proceedings of the Prehistoric Society,* 74(1), pp. 323-364.

Tucker, D. G., 1972. Millstone Making at Penallt, Monmouthshire. *Industrial Archaeology,* 8(1), pp. 229-236.

Tucker, G. D., 1982. Millstones north and south of the Scottish border. *Industrial Archaeology Review,* 6(3), pp. 186-193.

Tyers, P., 1996b. *Potsherd: Atlas of Roman Pottery- BB2.* [Online]
Available at: http://potsherd.net/atlas/Ware/BB2
[Accessed 27th March 2020].

Tyers, P., 1996c. *Argonne Ware.* [Online]
Available at: http://potsherd.net/atlas/Ware/ARGO
[Accessed 9th September 2020].

Tyers, P., 1996d. *Potsherd: Atlas of Roman Pottery- Mayenware.* [Online]
Available at: https://potsherd.net/atlas/Ware/MAYN
[Accessed 14th September 2021].

Tyers, P., 1996d. *Potsherd: Atlas of Roman Pottery- Pascual 1 Amphoras.* [Online]
Available at: http://potsherd.net/atlas/Ware/PAS1
[Accessed 27th August 2020].

University of Oxford, 2021. *The Oxford Roman Economy Project.* [Online]
Available at: https://www.romaneconomy.ox.ac.uk/
[Accessed 12th March 2021].

van Driel-Murray , C., 1995. Gender in Question. *Theoretical Roman Archaeology: Second Conference Proceedings,* 14(1), pp. 3-21.

van Driel-Murray, C., 2001. Vindolanda and the Dating of Roman Footwear. *Britannia,* 32(1), pp. 185-197.

van Tilburg, C., 2007. *Traffic and Congestion in the Roman Empire.* 1st ed. London: Routledge.

Vanderbilt, S., 2020. *Roman Inscriptions of Britain: RIB 586.* [Online]
Available at: https://romaninscriptionsofbritain.org/inscriptions/586
[Accessed 25th February 2022].

Velde, F., 2004. A Review of Peter Temin's "The Roman Market Economy". *Journal of Economie Literature,* 52(4), pp. 1151-1159.

Wacher, J., 1978. *Roman Britain.* 1st ed. London: Book Club Associates.

Wacher, J., 1995. *The Towns of Roman Britain.* 2nd ed. Abingdon: Routledge.

Wacher, J. S., 1975. Earthwork Defences of the Second Century. In: J. S. Wacher, ed. *The Civitas Capitals of Roman Britain.* Leicester: Leicester University Press, pp. 60-69.

Ward-Perkins, J. B., 1980b. Nicomedia and the Marble Trade. *Papers of the British School of Rome,* 48(1), pp. 23-69.

Ward-Perkins, J. B., 1992. Materials, Quarries and Transportation. In: H. Dodge & B. Ward-Perkins, eds. *Marble in Antiquity: Collected papers of J.B Ward-Perkins.* London: The British School of Rome, pp. 23-30.

Watts, M., 2002. *The Archaeology of Mills and Milling.* 1st ed. Stroud: Tempus.

Watts, M., Watts & Sue, 2016. *The Application of Animal and Water Power: from the Mediterranean to Britain.* [Online]
Available at: https://millsarchive.org/explore/features-and-articles/entry/171161/from-quern-to-computer-the-history-of-flour-milling/11664
[Accessed 29th January 2018].

Watts, S., 2014. *The Life and Death of Querns: The Deposition and Use-contexts of Querns in South-Western England from the Neolithic to the Iron Age.* 1st ed. Southampton: Highfield Press.

Watts, S., 2019. Rotary Querns, Rubbing Stones and a Stone Bowl. In: A. Poulter, ed. *The Transition to Late Antiquity on the lower Danube: Excavations and survey at Dichin, a Late Roman to early Byzantine Fort and a Roman aqueduct.* Oxford: Oxbow Books, pp. 391-408.

Weber, M., 1924. *Agrarverhältnisse im Altertum.* 1st ed. Tübingen: Mohr Siebeck.

Weber, M., 1960. *The City.* 2nd edition, translated and edited by Don Martindale and Gertrud Neuwirth ed. London: Heinemann.

Webster, G., 1993. *The Roman Invasion of Britain.* 2nd ed. London: Routledge.

Webster, G., 2004. *Boudica: The British revolt against Rome AD 60.* 1st ed. London: Routledge.

Webster, J., 2001. Creolizing the Roman Provinces. *American Journal of Archaeology,* 105(2), pp. 209-225.

Webster, J., 2005. Archaeologies of slavery and servitude: Bringing 'New World' perspectives to Roman Britain. *Journal of Roman Archaeology,* 18(1), pp. 161-179.

Weinandt, H., 2019. *Photograph of Etringer Lay Quarry site.* [Art].

Welfare, A. & Campbell, E., 1995. The milling stones. The petrology of the querns. In: W. H. Manning, J. Price & J. Webster, eds. *Report on the Excavations at Usk, 1965–1976. The Roman Small Finds.* Cardiff: University of Wales Press, pp. 214-237.

Welsby, D. A., 2009. The Stonework, Brick and Tile. In: A. Rushworth, ed. *Housesteads Roman Fort-The Grandest Station.* Swindon: English Heritage, pp. 339-361.

Wenzel, S., 2011. Villa und Burgus von Obermendig 'Im Winkel' (LKR. Mayen-Koblenz) im kontext der Römischen Besiedlung des Segbachtals. In: M. Grünewald & S. Wenzel, eds. *Römische Landnutzung* *in der Eifel: Neue Ausgrabungen und Forschungen.* Mainz: Römisch-Germanisches Zentralmuseum, pp. 131-158.

Wenzel, S., 2019. Mühlsteine aus den Graubungen des Jahres 2014 in Wederath- Belginum. In: D. Sauer, N. Hasslinger & R. Cordie, eds. *Was aßen Kelten und Römer? Umwelt, Landwirtschaft und Ernährung westlich des Rheins.* Morbach: Archäologiepark Belginum, pp. 161-168.

Wenzel, S., 2020. Lava rotary querns of 'Iron Age type' in Roman times. *Journal of lithic studies: Proceedings of the 2nd Meeting of the Association for Ground Stone,* 7(3), p. doi: https://doi.org/10.2218/jls.3096.

Wheeler, R. E. M., 1932. A Prehistoric Metropolis: The first Verulamium. *Antiquity,* 6(22), pp. 133-147.

Wheeler, R. E. M., 1936. *Verulamium: A Belgic and two Roman cities.* 1st ed. London: Society of Antiquaries of London.

Wheeler, R. E. M., 1938. Verulamium Again. *The Antiquaries Journal,* 18(2), pp. 137-141.

White, D., 1963. A Survey of Millstones from Morgantina. *American Journal of Archaeology,* 67(2), pp. 199-206.

Whittaker, C. R., 2004. *Rome and Its Frontiers : The Dynamics of Empire.* 1st ed. London: Routledge.

Williams, D. F., 2000. The Amphorae. In: M. Fulford & J. Timby, eds. *Late Iron Age and Roman Silchester: Excavations on the site of the Forum Basilica 1977, 1980-86.* London: Society for the Promotion of Roman Studies, pp. 219-225.

Williams, D. & Peacock, D., 2011. Pompeian Style Mills in Britain. In: D. Williams & D. Peacock, eds. *Bread for the People. The Archaeology of Mills and Milling: Proceedings of a Colloquium Held in the British School or Rome, 4th-7th November 2009.* Oxford: Archaeopress, pp. 117-122.

Williams, G., 2013. *11 Wittenham Lane, Dorchester-on-Thames, Oxfordshire: Archaeological Excavation Report.* [Online]
Available at: https://archaeologydataservice.ac.uk/archiveDS/archiveDownload?t=arch-988-1/dissemination/pdf/johnmoor1-175697_1.pdf
[Accessed 26th October 2021].

Williams, R. J. & Zeepvat, R. J., 1994. *Bancroft. A late Bronze Age/Iron Age settlement, Roman villa and temple-Mausoleum.* s.l.:Buckinghamshire Archaeological Society Monograph no. 7, Buckinghamshire Archaeological Society.

Williams-Thorpe, O., 1988a. Provenancing and archaeology of Roman millstones from the Mediterranean Area. *Journal of Archaeological Science,* 15(1), pp. 253-305.

Williams-Thorpe, O., 1988b. The provenance of donkey mills from Roman Britain. *Archaeometry,* 30(2), pp. 89-275.

Williams-Thorpe, O. & Thorpe, R. S., 1989. Provenancing and Archaeology of Roman Millstones from Sardinia (Italy). *Oxford Journal of Archaeology,* 8(1), pp. 89-117.

Williams-Thorpe, O. & Thorpe, R. S., 1993. Geochemistry and trade of Eastern Mediterranean millstones from the Neolithic to Roman periods. *Journal of Archaeological Science,* 20(1), pp. 263-320.

Williams-Thorpe, O., Thorpe, R. S., Elliott, C. & Xenophontos, C., 1991. Archaeology, geochemistry, and trade of igneous rock millstones in Cyprus during the Late Bronze Age to Roman periods. *Geoarchaeology,* 6(1), pp. 27-60.

Willis, S., 2007. Sea, coast, estuary, land and culture in Iron Age Britain. In: C. Haselgrove & T. Moore, eds. *The Later Iron Age in Britain and Beyond.* Oxford: Oxbow, pp. 107-129.

Wilson, A., 2007a. *Quantification of fish-salting infrastructure capacity in the Roman world.* [Online] Available at:
http://oxrep.classics.ox.ac.uk/working%20papers/quantification_fishsalting_infrastructure_capacity_roman_world/
[Accessed 23rd March 2020].

Wilson, A., 2007b. *The uptake of mechanical technology in the ancient world: the water-mill.* [Online] Available at:
http://oxrep.classics.ox.ac.uk/working%20papers/uptake_mechanical_technology_ancient_world_watermill/
[Accessed 23rd March 2020].

Wilson, A., 2010. The Roman Watermills. In: P. Bennett, I. Riddler & C. Sparey-Green, eds. *The Roman Watermills and Settlement at Ickham, Kent.* Canterbury: Cabterbury Archaeological Trust, pp. 42-67.

Wilson, A. E., 1952. Chichester Excavations 1947-1950. *Sussex Archaeological Collections,* 90(1), pp. 164-220.

Wilson, A. & Schorle, K., 2009. A Bakers Funerary Relief from Rome. *Papers of the British School at Rome ,* 77(1), pp. 101-123.

Woolf, A., 1999. Adventus, Patrocinium, and the Urban Landscape in Late Roman Britain. In: A. Leslie, ed. *Theoretical Roman Archaeology and Architecture: The Third Conference Proceedings.* Glasgow: Cruithne Press, pp. 33-47.

Woolf, G., 2007. Rethinking the Oppida. *Oxford Journal of Archaeology,* 12(2), pp. 222-234.

Xeidakis, G. S. & Varagouli, E. G., 1997. Design and Construction of Roman Roads: The Case of Via Egnatia in the Aegean Thrace, Northern Greece. *Environmental and Engineering Geoscience,* 3(1), pp. 123-132.

Young, C., 1972. The Pottery Industry of the Oxford Region. In: A. Detsicas, ed. *Current Research in Romano-British Coarse Pottery.* London: Council for British Archaeology, pp. 105-116.

Young, R. & Simmonds, T., 1995. Marginality and the nature of later prehistoric upland settlement in the north of England. *Landscape History,* 17(1), pp. 5-16.

Zaharia, A., 2013. Technical Norms and Legal Rules on the Construction and Administration of Roman Roads. *Contemporary Readings in Law and Social Justice ,* 5(2), pp. 382-387.

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