SUPPLYING THE ROMAN EMPIRE

HARRY **VAN ENCKEVORT**, MARK **DRIESSEN**, ERIK **GRAAFSTAL**,
TOM **HAZENBERG**, TATIANA **IVLEVA** AND CAROL **VAN DRIEL-MURRAY** (EDS)

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The newly excavated brick and tile kiln in the *Vindolanda* North Field

Craig A. Harvey and Elizabeth M. Greene

Located on the northern frontier of Roman Britain, the archaeological site of *Vindolanda* is one of the most intensely studied and well-understood forts in the region (fig. 1). Occupied between the 1st and 6th centuries AD, this site comprised a multi-phased auxiliary fort and its associated extramural settlement (R. Birley 2009). Continued archaeological exploration of this site has brought to light new and exciting insights into the daily lives of those living at *Vindolanda* (R. Birley 1994; 2009; A. Birley & Blake 2005; 2007; A. Birley 2013; Blake 2014; A. Birley & Alberti 2021). Between 2009 and 2014, five seasons of excavation were carried out in the *Vindolanda* North Field, located northwest of the fort and its adjacent settlement (Greene & Meyer 2017). Directed by the Vindolanda Trust along with a small team from the University of Western Ontario, these excavations uncovered an industrial area of the site featuring two ceramic kilns, one of which has been identified as a brick and tile kiln (Greene & Meyer 2017, 220-221). This newly discovered brickyard at *Vindolanda* is only the third to be found along this frontier and has provided new insights into the regional production and distribution of ceramic building materials. It has also presented several interesting challenges to its interpretation. The primary aim of this short contribution is to introduce these kilns and comment briefly on their construction and use. The final publication of these kilns is currently in preparation (Greene & Harvey in preparation).

Excavation of the kilns

The North Field at *Vindolanda* is a large open area that follows the same topographical slope of the main *Vindolanda* site, but it is now bisected and cut off from the fort and extramural settlement by the modern Stanegate Road (fig. 2). The field drops off steeply on its northern edge, culminating in the Chinley Burn, which wraps around the current plateau on which the *Vindolanda* fort and settlement sit on the north and east sides. A magnetometer survey that had been conducted in 2007 on the flat area of the slope, in conjunction with fortuitous aerial photography from the 1976 drought, showed interesting potential for excavations in this field (Greene & Meyer 2017, 201, fig. 4).

The excavation of the area under discussion in this paper took place over the course of two seasons in 2013 and 2014. The location was selected for excavation based on a heavy anomaly present in the magnetometer survey from 2007. A large trench first opened in this area in 2013 revealed a network of defensive ditches and hydraulic infrastructure that included channels and wells. On the northern edge of the trench, excavation also uncovered

Craig A. Harvey
University of Western Ontario/University of Alberta, Canada,
caharvey@ualberta.ca

Elizabeth M. Greene
Department of Classical Studies, University of Western Ontario, Canada,
egreene2@uwo.ca

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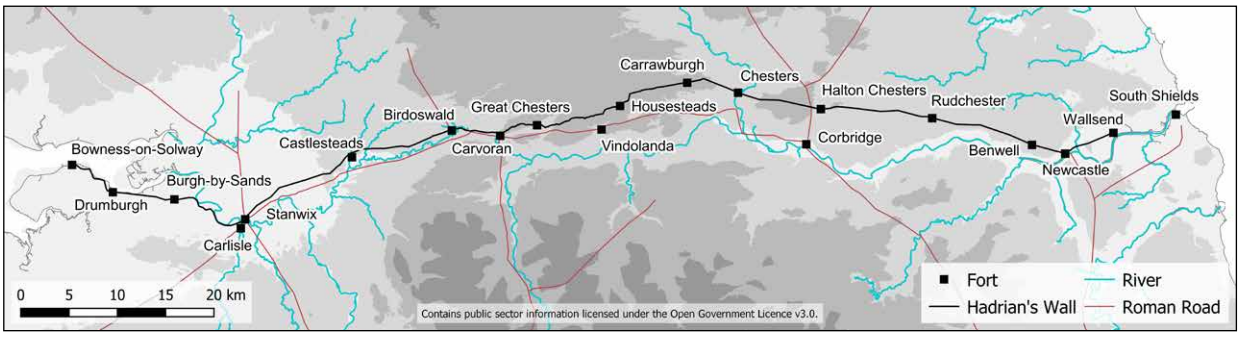

Figure 1. The northern frontier of Britain with *Vindolanda* at the centre and the lines of the Stanegate and Hadrian's Wall shown (The Vindolanda Trust/Andrew Birley).

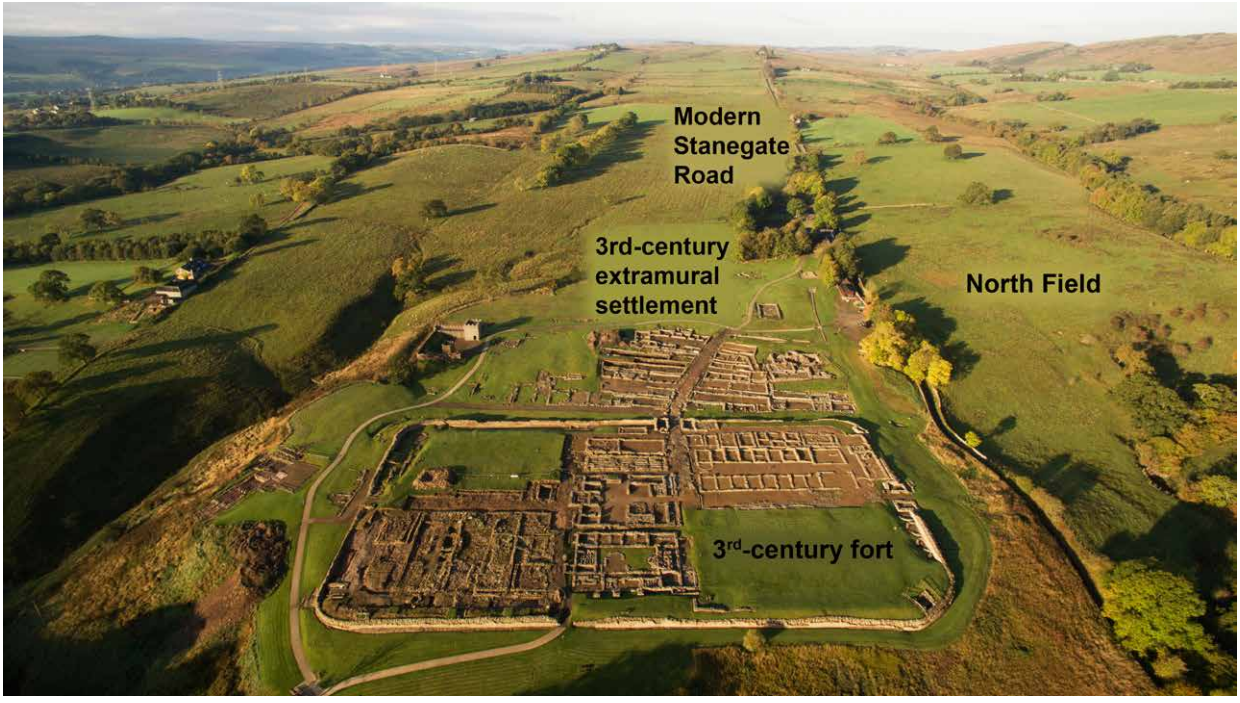

Figure 2. Aerial view of *Vindolanda* and the surrounding countryside, looking west (The Vindolanda Trust/Adam Stanford).

an interesting concentration of ash with a spread of tiles on its eastern edge and a rectangular patch of heavily oxidized clay to its west. Further work in this northern part of the trench revealed the edge of a large rectangular kiln, which was partially excavated to determine the basic components of this structure. At the end of the 2013 season, this area was left with most of its features still covered in thick boulder clay to protect it for the winter.

At the start of the 2014 season, the excavation trench was extended to the north in order to explore the full extent of the rectangular kiln and the details of its construction style. This extended excavation area also allowed for a more complete understanding of the entire industrial complex, including how all the constituent parts worked together (figs. 3-4). Immediately south of the large rectangular kiln (the aperture of which faces roughly southeast), a smaller kiln was found in the area of the heavily oxidized clay. This smaller kiln sits at a ninety-degree angle to the larger kiln, with its aperture facing roughly northeast. The apertures (or flues) of both these kilns face the large concentration of ash, which was eventually revealed to be a large stokehole shared by the two kilns. By the end of the season, excavation had exposed the entirety of the large kiln, the interior of the smaller kiln, and their shared stokehole. The trench was subsequently backfilled to preserve the uncovered remains, but enough of both kilns was excavated to conduct a detailed study of their construction and place them into their typological context.

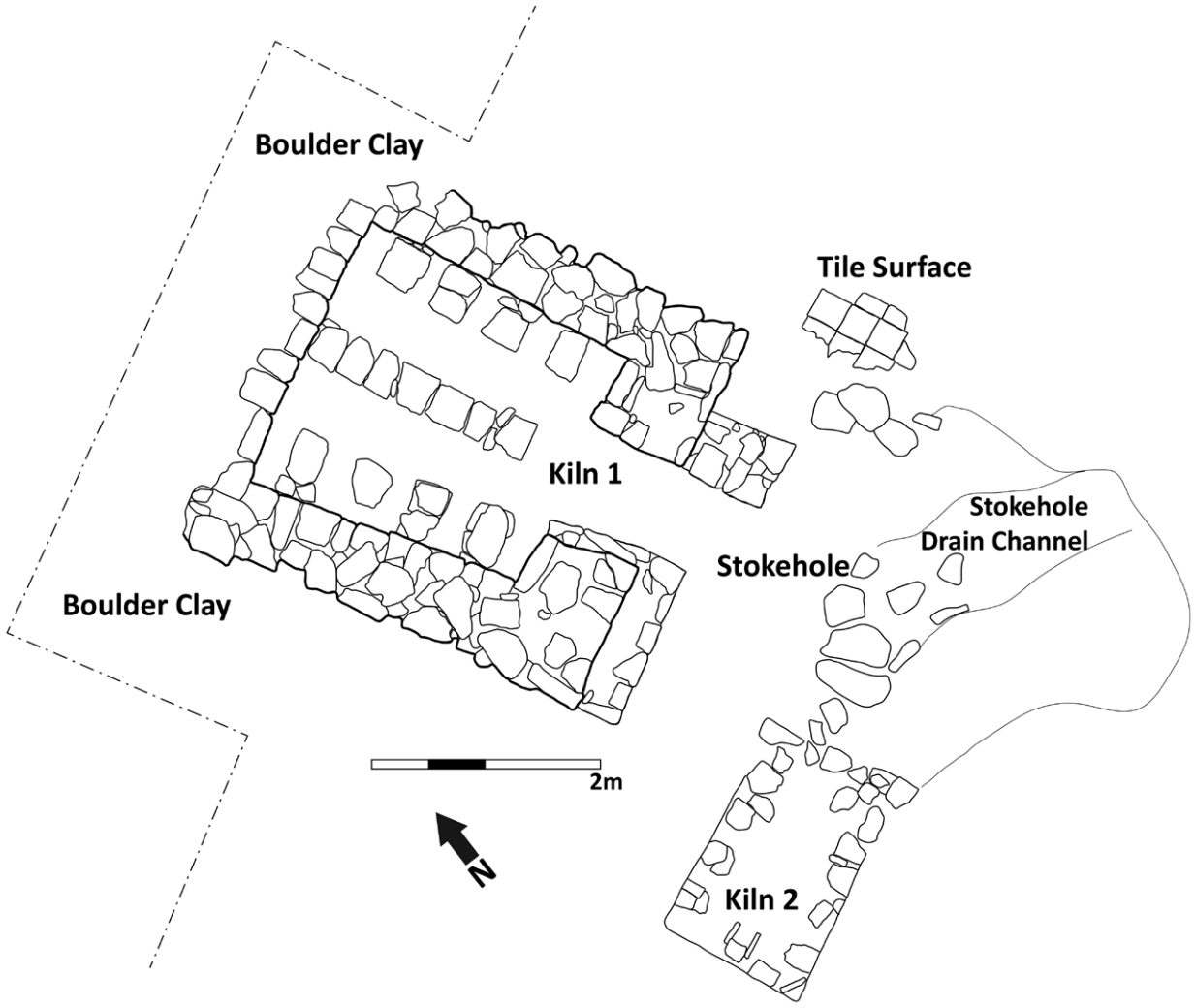

Figure 3. Plan of the industrial complex with the large and small kilns, stokehole, and surrounding features (Alexander Meyer/ Craig Harvey/The Vindolanda Trust).

Description of the kilns

The larger of the two kilns uncovered in the North Field is rectilinear in shape and has exterior dimensions of roughly 3.75 m (northeast-southwest) and 4.0 m (northwest-southeast) (fig. 4; for plan fig. 3). Nothing of this kiln's superstructure was found preserved, but the extant remains of its firing chamber, fire box (or flue), and support system were constructed of roughly cut blocks of local sandstone. Notably, the back (or northwest) wall of the kiln does not have an exterior face, suggesting that this kiln was constructed into the side of a low-lying hill, which was a common building practice for such kilns (McWhirr 1979, 99). Within the firing chamber, excavation uncovered the remains of the support system comprising four stone-built cross walls and a central tongue-support. These supports once held the oven floor, of which nothing survives intact, but the discovery of large amounts of 'crushed brick' during excavation of this area may reflect the remains of this oven floor or the kiln superstructure.

The configuration of supports and the rectangular form of this kiln is characteristic of brick and tile kilns associated with the Roman military in Britain, particularly those dated to the Claudian and Flavian Periods (Swan 1984, 83-85). A similar use of stone-built cross walls and a central tongue-support is seen at the undated (but possibly 2nd century AD) tile kilns at Muncaster, in Cumbria (Bellhouse 1960, 6-8; 1961, 51). The supports of the Muncaster kilns comprised granite piers with brick corbelling, and it is possible that the supports of the *Vindolanda* kiln also contained corbelling to help support the oven floor. Although stone-built kilns like the large kiln at *Vindolanda* are relatively uncommon in Roman Britain (Swan 1984, 32), it is notable that local sandstone was also used in the construction of the two other known tile kilns along this frontier, namely the auxiliary tile kilns at

Figure 4. Oblique aerial view of the kiln complex looking west/northwest with the large kiln on the right and the smaller kiln at a ninety-degree angle on the left with the shared stokehole on the bottom left (The Vindolanda Trust/Adam Stanford).

Brampton (Hogg 1965, 139-146 and 151-158; McWhirr 1979, 111-116) and those at South Shields (McWhirr 1979, 171). These parallels, combined with the recovery of misfired bricks and tiles of local clay from the excavation trench, support the conclusion that this large kiln was primarily used to produce ceramic building materials.

Directly to the south of the large rectangular kiln is a much smaller kiln measuring roughly 1.5 by 2 m (fig. 5; for plan fig. 3). This kiln is also rectangular in shape, but rather than having stone walls, its firing chamber appears to have been built using the more typical technique of digging a hole in a natural hill slope and plastering its sides with clay (Swan 1984, 32). The heavy use of this smaller kiln is attested by the large quantity of ash that was found within its firing chamber and the striking appearance of the surrounding clay into which it was dug, which was baked to an orangey-red colour. Although this kiln may also have produced bricks and tiles, its small size and the kiln waste recovered suggest that it primarily produced ceramic vessels.

The shared stokehole of the two North Field kilns is notable, as it is rare in Britain to find two kilns sharing a single stoking pit. Nevertheless, parallels do exist. Examples include the nearby auxiliary tile kilns at Brampton (Hogg 1965, 154, fig. 6), as well as the tile kilns much further south at Arbury (McWhirr 1979, 175, fig. 6.30).

A full assessment of the date and phasing of these kilns will appear in the forthcoming publication of this industrial site (Greene & Harvey in preparation). Provisionally, the ceramics recovered from these installations suggest that the initial use of the large kiln dates to the late 1st century (*c*. AD 85-100). This date is corroborated by both the shape of the kiln and the configuration of its supports, which are paralleled in brick and tile kilns elsewhere in Britain that date to the Flavian period (Swan 1984, 83-85).

Despite the existence of these parallels for the large kiln at *Vindolanda*, several of its features present challenges to interpreting its construction and use. One such point of uncertainty is the fact that this kiln displays very little sign of operation. The friable sandstone walls and supports of this kiln show no evidence of heat damage, and its firing chamber and firebox did not produce large amounts of ash as one would expect from a heavily used kiln. Furthermore, the boulder clay surrounding the kiln was not baked to an orangey-red colour as was the case with the smaller kiln.

Figure 5. View of the smaller kiln excavated, facing west.

Another point of curiosity is the asymmetrical form of the kiln's fire box (or flue channel) and the fact that it appears to have been subsequently added to the kiln proper (fig. 3). On its eastern side, the construction of the fire box comprises a simple masonry wall extending into the stokehole, but on its western side, it appears to be little more than a facing of stones built up against the exterior of the firing chamber's wall. This facing wraps around the flue opening, thereby decreasing its aperture. It may be that the addition of a fire box was an attempt to convert the brick kiln into one for producing pottery, as longer fire boxes allowed for better control of temperatures, which was needed for the manufacture of thinner vessels. This theory, however, does not explain the apparent minimal use of this kiln.

One possible explanation for these alterations to the flue opening and the little sign of use is that this kiln is an example of a failed kiln that was never used, resulting perhaps from a faulty design. This theory is not entirely convincing, however, because the care with which this kiln was built and the investment represented by its stone construction suggest that it was constructed by experienced individuals. Furthermore, the presence of misfired bricks and tiles of local clay from the excavation trench suggests that this kiln was used to produce this material, even if for only a short period of time. An alternative explanation for the apparent lack of use may be that this kiln was only used for a very short period and possibly only to produce the ceramic building material for the baths associated with one of the early forts at the site. Analysis remains ongoing, but the possibility that this kiln saw only limited use for bath construction will be discussed in greater detail below.

Implications / significance of the kilns

The location of the kilns in the North Field provides new insight into the use of this area of the site, which seems to have been dedicated to industrial activity (Greene & Meyer 2017, 236-244). The area directly around the kilns appears to have been intentionally left open and free of stone-built structures for the duration of their use, perhaps designating it as an industrial zone beyond the periphery of the main settlement. Excavation in the area to the east of the kiln complex revealed several wells, channels, and holding pits that may be associated with the processing of clay for the kilns, but the date of these features is currently uncertain (Greene & Meyer 2017, 240-244).

A good deal more work needs to be done on this aspect of the North Field, but the discovery and analysis of the kiln complex will be a central component to

understanding how and where industrial activity took place at *Vindolanda*, a topic which has been understudied up to now. In particular, the identification of the brick kiln in the North Field has the potential to contribute to the study of several aspects of the local and regional brick industry, including:

1. Brick production and bathhouse construction at *Vindolanda*.
2. Resource use at the site through quantification studies.
3. Brick production and supply along the frontier zone of Roman Britain.

Brick production and bathhouse construction at *Vindolanda*

Long before the discovery of these kilns, excavators at *Vindolanda* recognized the likelihood for brick production on site. This need for local brick and tile production was especially evident after the excavation of the pre-Hadrianic baths in 2000 (A. Birley 2001, 15-34). Located to the south of the fort, this structure contains the greatest concentration of ceramic building materials thus far found at *Vindolanda*. In addition to the ceramic hypocaust tiles and *tubuli* (or box-tiles) used in the heating system, the presence of relatively light-weight tiles in the fill of the baths suggested that the vaulted roof of the heated rooms was also partially built of ceramic building materials (A. Birley 2001, 27). The extensive amount of ceramic brick and tile required for the construction of this bathing facility convinced its excavators that a tile kiln was most likely established nearby, either in the Dow Sike, below the bathhouse to the south, or in the North Field, where the kiln presented here would be found 15 years later (A. Birley 2001, 11, 34).

It is not possible to say with certainty that the North Field tile kiln was the one used to produce the ceramic building material for the pre-Hadrianic baths, but the provisional date of the earliest phase of this kiln does align with the late 1st-century construction of this bathing facility. Notably, this date also roughly corresponds to the date of TV 155, which comes from a pre-Hadrianic context dating to the late 1st or early 2nd century AD (Bowman & Thomas 1983, no. 1; 1994, no. 155; 2003, 155-156). This tablet records a duty roster and lists men working in what was probably a ceramic kiln (*ad furnaces*). While it is possible that the kiln mentioned in this tablet was used for lime, this possibility seems less likely, as a lime kiln is more explicitly referenced with different terminology in a separate duty roster (TV 156; Bowman & Thomas 1994, no. 156), which refers to men burning stone (*ad lapidem flammandum*). Regardless of whether the kiln in TV 155 was used for brick or lime, it is perhaps no coincidence that this same tablet also lists 18 builders sent to work in the baths (*ad balneum*). While it may be tempting to interpret the contemporary initial use of the North Field brick and tile kiln, the construction of the pre-Hadrianic baths, and the date of TV 155 (which lists men working in both kilns in baths) as clear proof that the North Field kiln was used for the construction of the pre-Hadrianic baths, there is still no way to definitely prove this connection.

An alternative possibility is that the North Field brick kiln was constructed to produce brick for an even earlier bathhouse that has yet to be found, but which has been hypothesised to exist for the earliest phase of Roman occupation at *Vindolanda* (A. Birley 2001, 34-35). Although not yet located, this anticipated bathhouse would likely have used ceramic building materials in its heating system, as the use of stone for hypocaust construction along this frontier appears to be a later development. The heating system of the 3rd-century baths at *Vindolanda*, for example, was primarily stone-built, with the exception of the *praefurnium* (the furnace), which employed ceramic bricks. About 24 of these bricks contain the stamp of *Legio* VI *Victrix*, and it was hypothesised by the excavators that these bricks were brought to the site from a legionary tilery, possibly in the vicinity of Corbridge (A. Birley 2001, 5).

Resource use at the site through quantification studies

Assuming that the large kiln uncovered in the North Field was indeed used to produce brick and tiles for the construction of the early baths at *Vindolanda*, its excavation offers a unique opportunity to conduct a quantification study to determine the materials and resources required for this building project. Although the pre-Hadrianic baths at *Vindolanda* underwent several phases of repair and renovations and were subsequently robbed of building material for use elsewhere on site, enough of the hypocaust remains extant to allow for an accurate calculation of the number of bricks required for its construction. For example, it is estimated that roughly 2000 *bessales* (bricks measuring ⅔ of a Roman foot wide) would have been required for the hypocaust supports in the *caldarium* and *tepidarium* alone.

By calculating the total number of bricks, tiles, and *tubuli* required (while also allowing for accidental breakage) and by determining the capacity of the tile kiln (with the aid of comparative studies and experimental archaeology) it will be possible to estimate the number of firings required to produce the ceramic building materials needed for the construction of the bathhouse. This planned study may help clarify why the large kiln exhibits such limited use, especially if only a few firings were required to produce the material for the building project. For example, Warry (2006, 119-120) suggests that a kiln with a firing chamber 2 m by 3 m could hold *c.* 1440 roof tiles. Given the larger size of the tile kiln in

the North Field and the smaller size of the *bessales* used in the hypocaust supports of the pre-Hadrianic baths at *Vindolanda*, it seems possible that all of the bricks used in the hypocaust supports could have been produced with a single firing of the kiln. In addition to advancing the study of the North Field tile kiln, this quantification study should also provide a better understanding of resource use and industry at *Vindolanda* and along this frontier.

Brick production and supply along the frontier zone of Roman Britain

Beyond the implications for the site of *Vindolanda*, the discovery of this brick kiln represents an important contribution to our understanding of industry and supply in this frontier zone. To date, brickyards have been identified at only two other locations along the Stanegate/Hadrian's Wall. *C*. 24 km to the west of *Vindolanda*, auxiliary tile kilns have been discovered at Brampton, which likely date to the early 2nd century and are thus roughly contemporaneous with the one presented here (Hogg 1965; McWhirr 1979, 111-119). Auxiliary tile kilns have also been found at South Shields, which date much later to the 4th century (McWhirr 1979, 1970-1971). In addition, bricks from the later baths at *Vindolanda*, with stamps of *Legio* VI *Victrix*, suggest that another brick kiln may have existed in the vicinity of Corbridge (22 km west of *Vindolanda*) in the mid-2nd to 3rd centuries (A. Birley 2001, 5).

Peter Warry's extensive work on *tegulae* in Roman Britain has shown that roof tiles were regularly transported up to 40 km and occasionally as far as 80 km (Warry 2006, 124). The fact that the roughly contemporaneous auxiliary tile kilns at *Vindolanda* and Brampton were only 24 km apart demonstrates the extent to which the supply of ceramic building materials along this frontier relied on truly local sources. This local supply benefited from the availability of sufficient clay, fuel, and water resources at the site, but it also avoided the need to transport bricks and tiles overland by cart, which the *Vindolanda* tablets reveal could be damaging to both the cargo and draught animals (TV 343.20-21 and 890.ii.1). We should, therefore, not be surprised if additional tile kilns are found elsewhere in this frontier zone, especially in locations where ceramic building materials were needed in large quantities.

In the economic context of a military frontier in a conquered province like *Britannia*, this very local production is particularly interesting. Despite the extensive resources and centralized industrial capacity of the Roman army, it seems that out here on the northwestern edge of the Roman Empire, with the full-time occupation in the hands of auxiliary military units, each settlement may have been responsible for its own resources and building materials. In this light, the short-lived use of the large kiln makes some sense if it only really needed to produce the brick and tile for a single bathhouse.

Conclusion

The newly excavated kilns in the *Vindolanda* North Field represent a significant finding for the study of industry, construction, and supply at this site and along the wider frontier zone. There are areas of localized industrial activity elsewhere at *Vindolanda* that should be brought into a comprehensive study to investigate these trends through time and across the settlement. The North Field complex is the most significant locus of industrial activity so far discovered at *Vindolanda* and, on current evidence, appears to have been the primary location of industry and manufacturing at the site. The next step in this research is to place *Vindolanda* into a broader regional picture of manufacturing and supply along the northern frontier of *Britannia*. There is a distinct lack of synthesized work on manufacturing and industrial supply in the military zone or at individual sites on this frontier, which must have been a significant and constant component of daily life and work in the region. This ongoing research hopes to fill some of these gaps. A comprehensive analysis of these kilns is in preparation (Greene & Harvey in preparation), but this preliminary report has demonstrated some of the potential avenues for further research.

Abbreviation

TV: *Tabulae Vindolandenses*

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