

# Borgring. Uncovering the strategy for a Viking age ring fortress in Denmark

Jonas Christensen<sup>2</sup>, Aoife Daly<sup>3</sup>, Peter Steen Henriksen<sup>1</sup>, Nanna Holm<sup>2</sup>, Catherine Jessen<sup>1</sup>, Sofie Jørgensen<sup>2</sup>, Line Olesen<sup>2</sup>, Jesper Olsen<sup>4</sup>, Maja Kildetoft Schultz<sup>2</sup>, Søren M. Sindbæk<sup>5,6</sup>, Jens Ulriksen<sup>2</sup>

<sup>1</sup> Environmental Archaeology and Materials Science, The National Museum of Denmark, I. C. Modewegsvej, Kongens Lyngby, Denmark

<sup>2</sup> Museum Southeast Denmark, Algade 97, 4760 Vordingborg, Denmark

<sup>3</sup> Saxo Institute, University of Copenhagen, Karen Blixens Plads 8, 2300 Copenhagen, Denmark

<sup>4</sup> Aarhus AMS Centre (AARAMS), Department of Physics and Astronomy, Aarhus University, Ny Munkegade 120, 8000 Aarhus C, Denmark

<sup>5</sup> Department of Archaeology and Cultural Heritage, School of Culture and Society, Aarhus University, Moesgaard Allé 20, 8270 Højbjerg, Denmark

<sup>6</sup> Corresponding author (farksms@cas.au.dk) ORCID: 0000-0002-1254-1256

## ABSTRACT

In 2014, Borgring, near Køge, Denmark, was identified as the fifth geometrical Viking age ring fortress in Denmark, complementing an exclusive group of monuments including Trelleborg. Excavations and surveys in 2016-18 allow a detailed reconstruction of the site and its history. Borgring is a fortification with the same type of geometry, construction, and location as other Trelleborg-type fortresses, though exhibiting notable differences. Finds, including beads, ornaments, and iron tools, reflect limited activities and links to other fortress sites. The dating of Borgring is established with reference to wiggle-matched <sup>14</sup>C dates.

## ARTICLE HISTORY

Received

11 September 2020;

Accepted

20 May 2021

## KEYWORDS

Viking Age; Ring fortress; Fortification; War; Monument symbolism

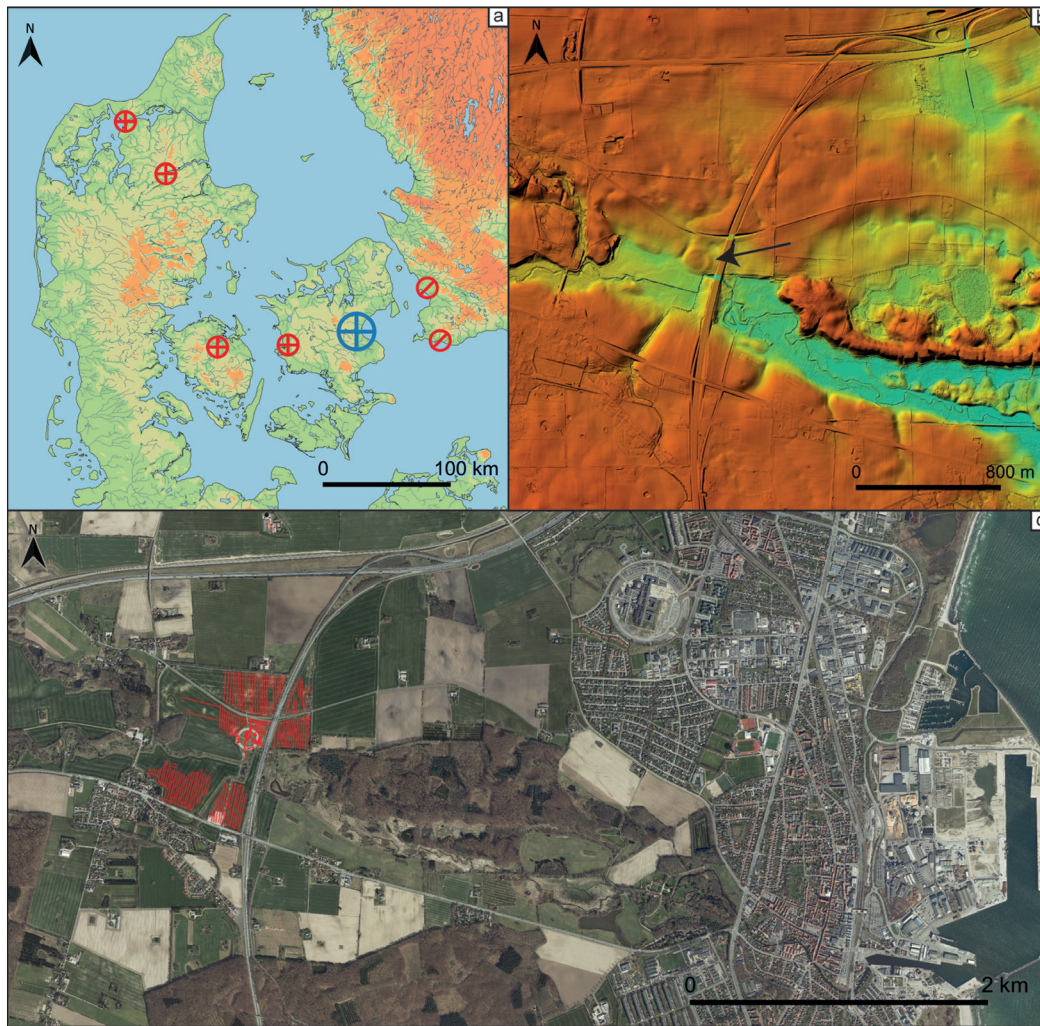
## Introduction

Major fortification works were rare in Viking Age Scandinavia. The outstanding exception is a group of large, circular fortresses built in the second half of the tenth century across modern Denmark and southern Sweden: the Trelleborg type ring fortresses (Figure 1a) (Roesdahl and Sindbæk 2014, 387). These comprise the sites Aggersborg and Fyrkat in Jutland, Nonnebakken on Funen and Trelleborg on Zealand, and probably the sites Borgeby and Trelleborg in Scania. In 2014, Borgring, which lies near Køge, south of Copenhagen, was identified as the fifth example of this group in Denmark (Goodchild, Holm and Sindbæk 2017). Apart from their substantial size (140-260 m in outer diameter), the fortresses are distinguished by their location in the landscape and by their meticulous geometric layout, consisting of circular ramparts, buildings, axial roads, and gateways laid out according to a strict and exactly surveyed plan. The data available suggests that all were constructed during a short period in the 970s and '80s, during the reign of King Harald Bluetooth, who also created the Jelling monuments (Jessen et al. 2014).

A major programme of research excavations and surveys was carried out at Borgring in 2016-18 (Christensen et al. 2018). The project applied metal-detector surveys, soil geochemical analysis, and geophysical surveys to the fortress and its nearby surroundings. Excavations were conducted in the ring fortress itself in addition to survey excavations of more than 40 ha of the surrounding area, searching for traces of contemporary activity. Together with extensive environmental and scientific analyses, the investigations now allow a detailed reconstruction of the site and its history. Furthermore, it allows a wider understanding of the Trelleborg-type fortresses as monumental statements of power and as actual instruments of defence.

## The Setting of Borgring

The landscape west of the modern city of Køge is characterised by a c.20 km-long east-west tunnel valley, through which Køge Stream flows into the sea (Figure 1c). On the northern side of the stream lies the steep ridge of Køge Ås, a glacial esker.



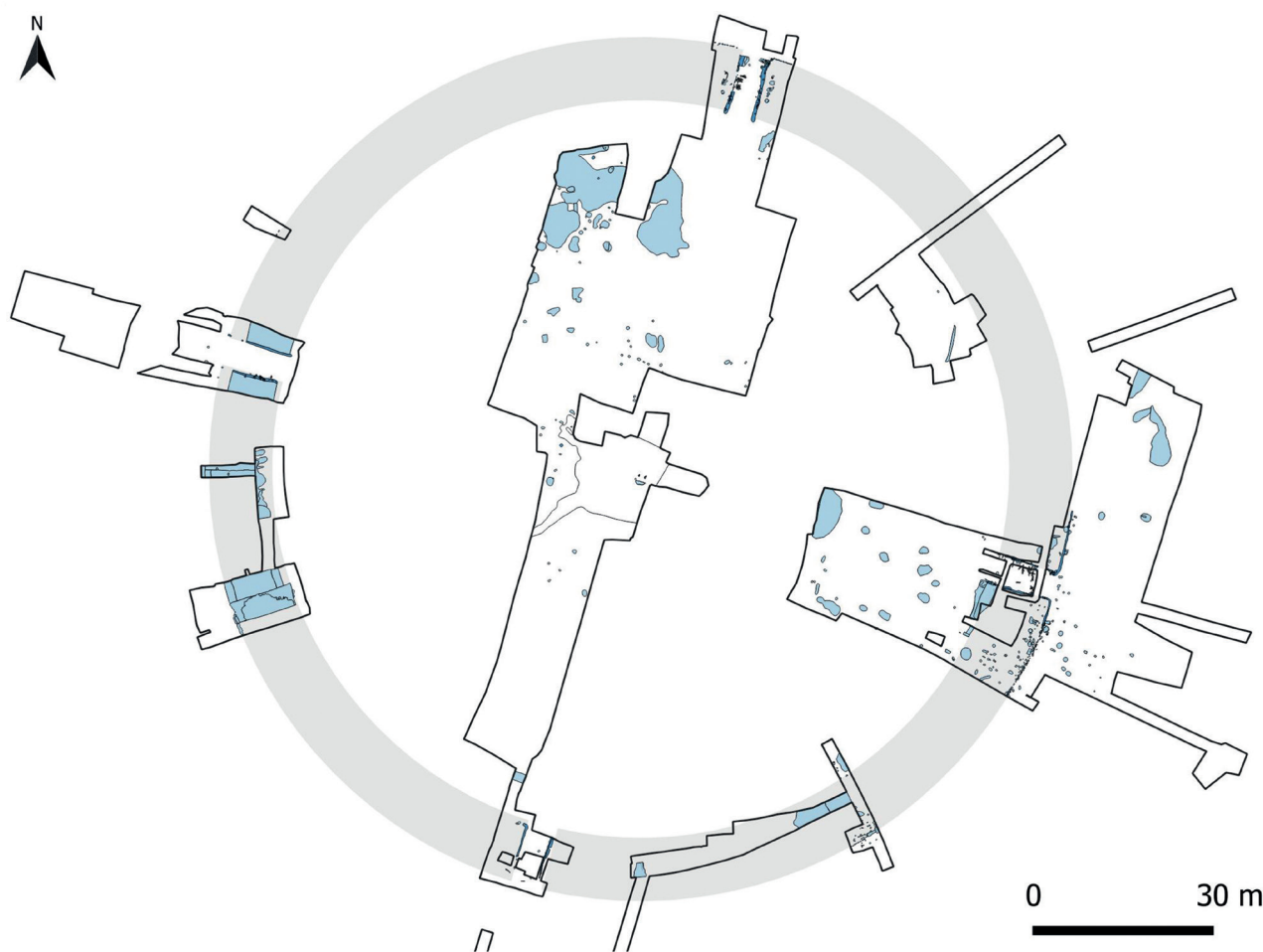
**Figure 1.** The location of Borgring: a) Map of modern Denmark and southern Sweden with Borgring (large symbol) and other Viking Age ring fortresses; the relationship between the fortresses in Denmark and the two sites in Sweden is not fully clarified; b) Lidar topography map of Køge river valley with Borgring (arrow); c) Aerial photo with overview of trial excavation trenches and survey areas (Graphics: Museum Southeast Denmark. Background map data: Danish Geodata Agency).

Borgring is located in a gap in the ridge almost 1 km wide, and positioned close to a natural crossing point where the valley is around 200 m wide (Figure 1b). The location is similar to that of other Trelleborg-type sites in that it is a dry yet well-defended site, in the proximity of major roads and crossings, near an entry point from the coast, and yet at some distance from the open sea.

The terrain where Borgring sits is surprisingly uneven. The northern area of the ring fortress is 8.5-9 m above MSL, while the southern half is characterised by a rather steep drop to around 5-6 m above MSL to the river valley. The gradient is almost 8 %. A creek in a steep gully on the western and north-western sides of Borgring, a waterlogged depression to the north-east, a valley to the east and the waterlogged Køge valley to the south

has formed natural boundaries for the building site. The only possible access on dry ground was from the north (Jessen et al. 2021, 10). The topography of other Trelleborg-type sites varies from small promontories, which required major landscaping to create a level surface, to gently sloping hillsides. Borgring shows a far stronger relief, and it could hardly have accommodated a full set of large buildings, as in the other fortresses, without major levelling works.

Prior to excavation, Borgring was practically invisible in the landscape, resembling the initial situation at Aggersborg and Fyrkat in the 1940s and 1950s (Schultz 1949, 93; Olsen and Schmidt 1977, 53). Agricultural work, probably including deliberate levelling, had eradicated most of the structures at an early date. Nineteenth-century cadastral sur-



**Figure 2.** Site plan with outline of the monument, and indication of excavation trenches (Graphics: Museum Southeast Denmark).

veys failed to note any man-made feature (Geodastyrelsen: Gl. Lellingegård), and only post-1970 aerial photography clearly reveals the presence of an earthwork (Christensen et al. 2018, 60). The excavations showed that the preserved height of the rampart varied from less than 0.25 m at the eastern gateway, where the structures were most heavily eroded, to *c.* 1.1 m in the low-lying southern and western sections, where the structures were partly buried in post-Viking Age sediments.

The inner surface of the fortress was also exposed to erosion, though probably to a lesser extent than the rampart. The surface level could be established at the inner foot of the rampart, where it was protected by fill from the levelled earthwork (cf. Goodchild, Holm and Sindbæk 2017, fig. 6). Further towards the middle of the fortress, numerous pits from an Iron Age settle-

ment demonstrate that the surface had not been heavily truncated.

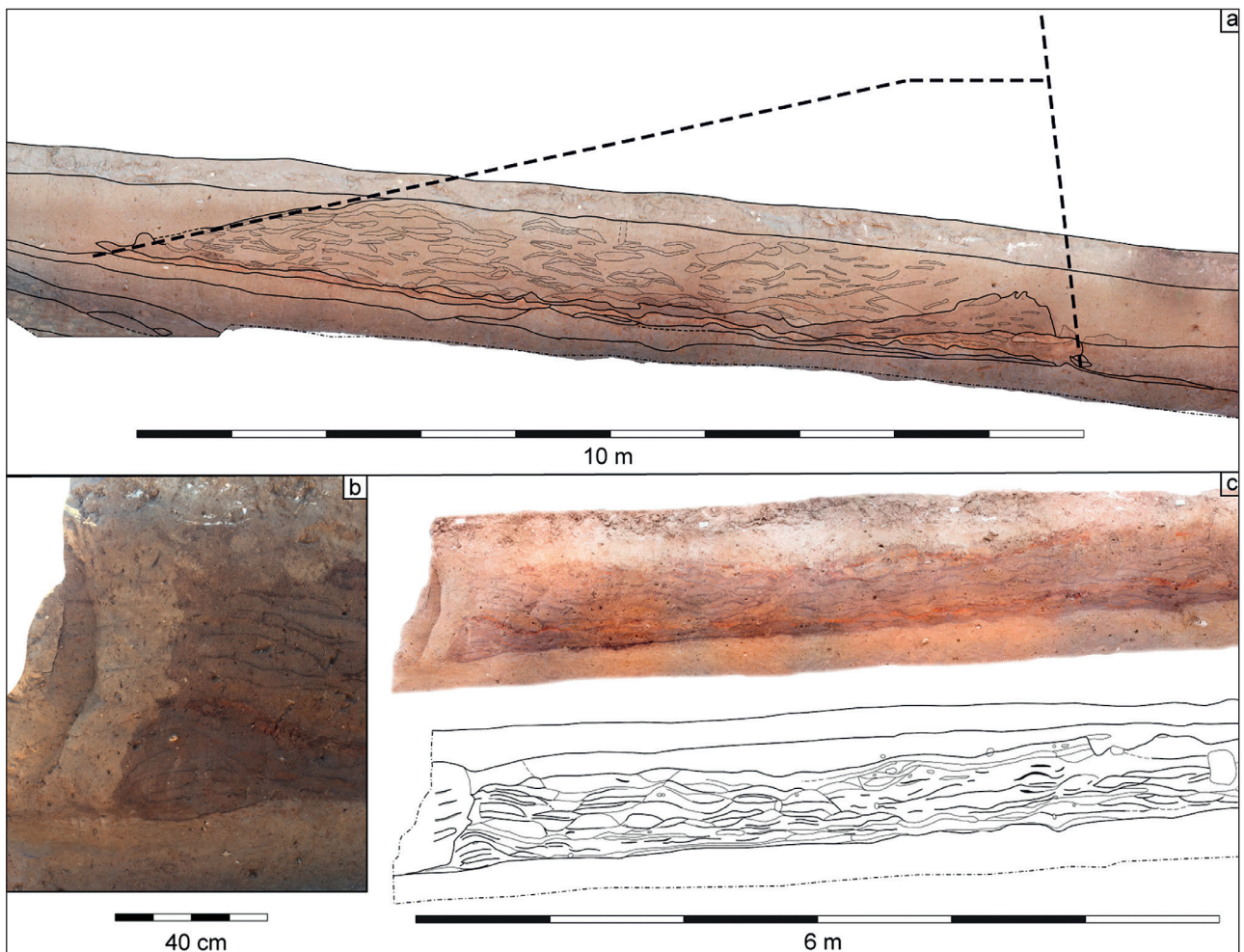
Initial gradiometer surveys had revealed the outline of the rampart, but the excavations established closer details of the plan (Figure 2). The front of the rampart was studied in four trenches to the north, east, south, and west, and it was also encountered in six other trenches. The rampart was found to be a circle with an outer diameter of 144.5 m with no apparent deviation. Two straight lines between the centres of the four gateways meet at right angles at the centre of the circle, again with little or no deviation. The precision is remarkable considering the uneven topography, and must imply that the monument was planned out using an instrument for measuring horizontal lines, such as a groma, rather than simpler techniques, such as ropes laid out on the ground.

## The construction of the Fortress

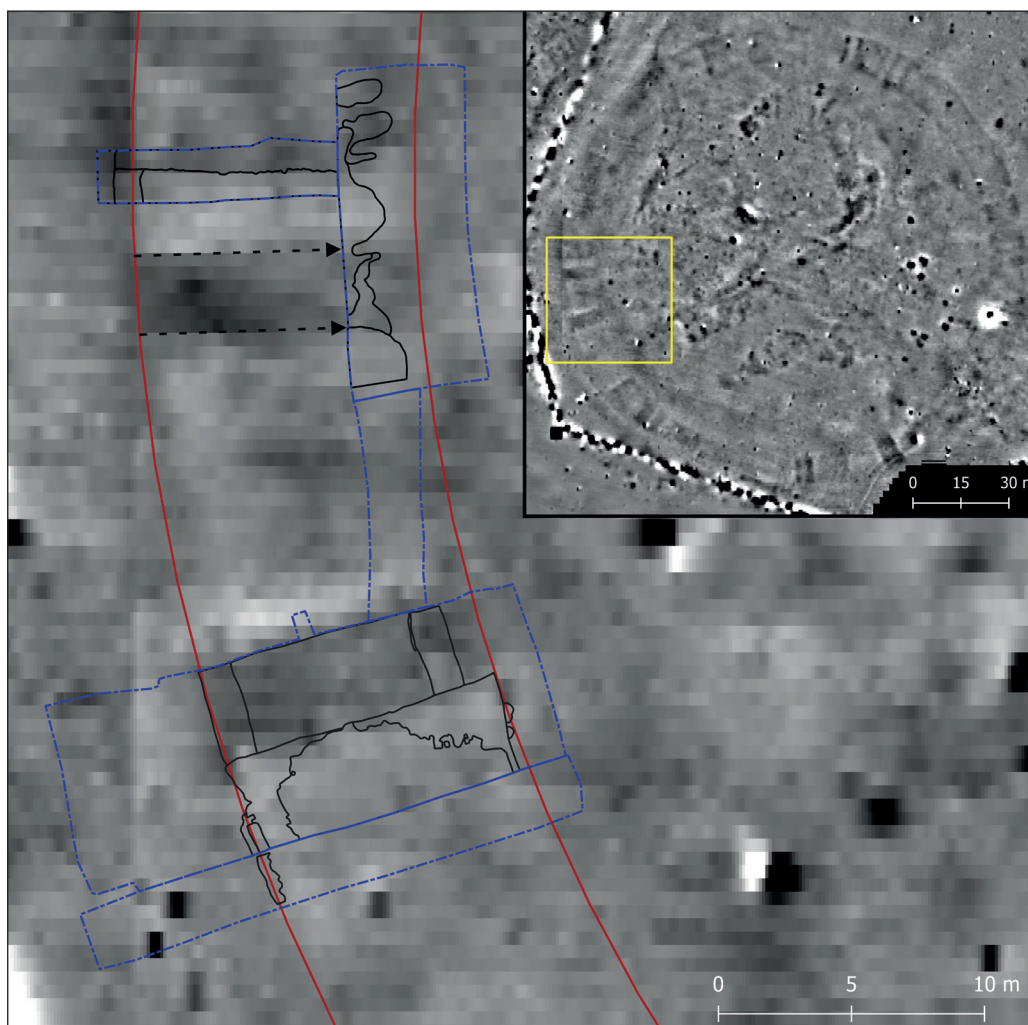
The construction site did not immediately meet the demands of the planned ring fortress, and pre-construction levelling was necessary. In order to allow for the desired diameter of the ring fortress, the construction site had to be extended into the river valley, covering the slope of the creek's gully. Consequently, more than 1900 m<sup>3</sup> of clay-rich material with inclusions of old ceramics and flint-knapping debris were transported to the side of the river valley, the gully and to other depressions in the terrain in order to create space for the rampart and gateways. Additionally, a depression to the north-east was levelled before constructing the rampart (Jessen et al. 2021, 10). The modifications did not result in an evenly levelled building site, but functioned as a solid foundation for the ramparts and gateways to the south, west, and north.

## The rampart

The rampart was constructed in four separate but identical sections. Evidence from the south-western rampart suggests that an initial 0.1-0.3 m thick layer of dark and reddish turfs marked out the ground plan. The thickness of this layer increased gradually to c.0.7 m at the front of the rampart (Figure 3a). Additionally, radial sections were marked out by low humps of turfs in the bottom layer (Figure 3b and 3c). Radial sections higher in the rampart were seen as spaces of darker turfs shifting with spaces of lighter turfs. Some sections were 6-7 m wide, while others were 3-4 m (Figure 4). The borderlines between the sequences were seen in the pre-excavation gradiometry survey (Goodchild, Holm and Sindbæk 2017). The sections may reflect the organisation of the work force. Despite differences in colour, pollen analy-



**Figure 3.** Sections of Borgring's rampart. Top: Section 75 (a). Individual layers and turfs are marked out. Note the low humps of turfs in the bottom layer. The reconstructed outline of the rampart is shown in dashed outline. Bottom: Detail (b) of section 76 (c). Note the change of texture between two building segments of the rampart (Graphics: Museum Southeast Denmark).



**Figure 4.** Plan of radial features in rampart, area 25 and 26. Red line: outline of the rampart. Blue lines: Excavation trenches. Black lines: Shifting colours of turfs in the rampart. Gradiometer map after Goodchild et al 2017 (Graphics: Museum Southeast Denmark).

sis showed that all turfs originated from dry grassland, probably cut in the immediate surroundings (Mortensen et al. 2021, 5-7).

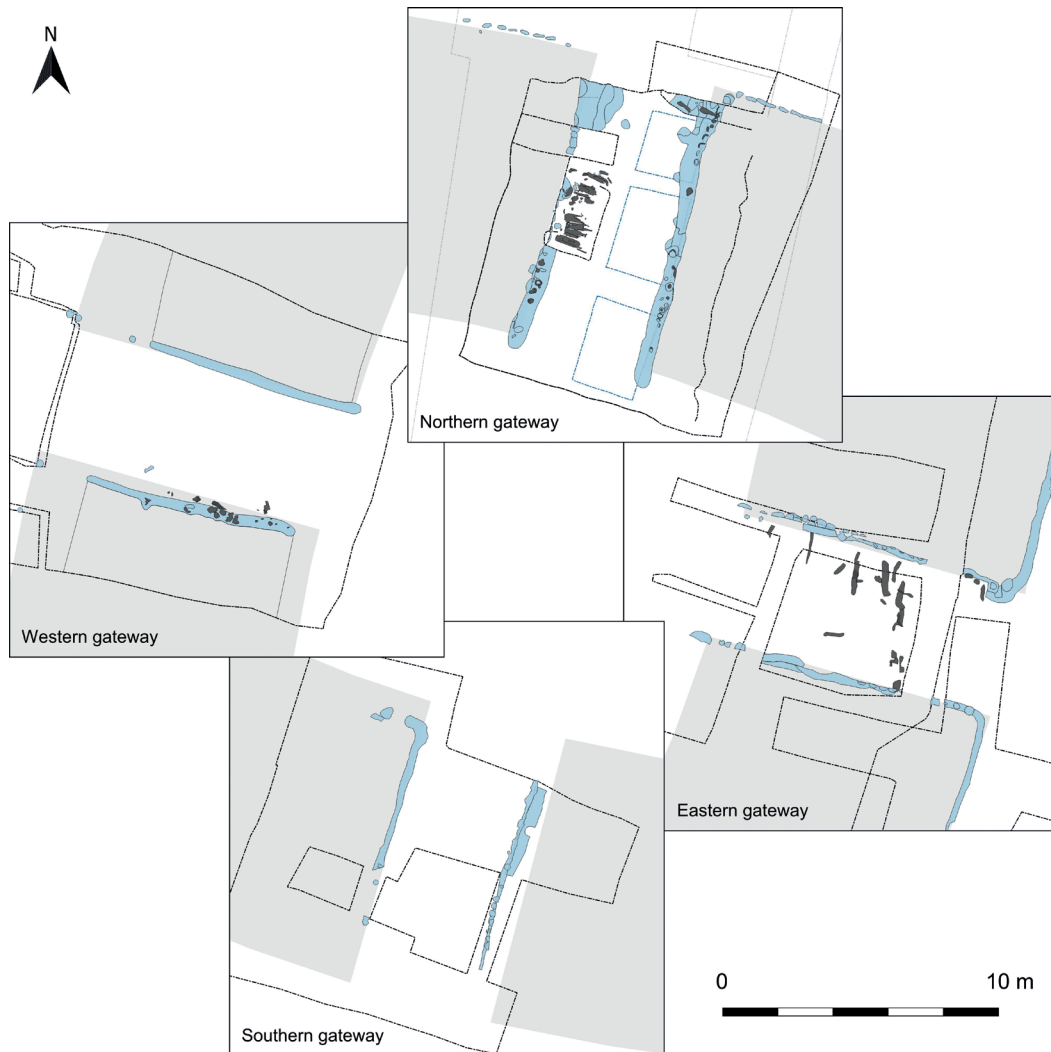
At the eastern and northern gateways, there were postholes and at some points a <0.1 m-deep slot for planking along the front of the rampart, probably a footing for a plank cover (Figure 2). There was no ditch to the south-east, but the rampart's front was marked by an irregular pattern of redox imprints the shape and size of the ends of planks. If the imprints represent the actual size of the ends of the planks, these were *c.*0.29 m wide and *c.*0.11 m thick on average (Mortensen et al. 2021, 8). In the south-western rampart, neither redox imprints nor a shallow ditch were seen.

The original height of the rampart is unknown, but may have reached *c.*3 m at the front, which inclined *c.*70° towards the inside. The substantial

amounts of soil found accumulated along the rampart were presumably part of the collapsed and/or levelled fill. There was probably a wooden palisade on the top of the ramparts extending the height by *c.*1.5-1.8 m higher (Mortensen et al. 2021, 6). The inner side of the rampart sloped to the surface of the courtyard. There were no indications of posts or planks at the inner face of the rampart, as seen at other Trelleborg-type fortresses, although observations in some areas suggest that the foot of the rampart may have been secured in some areas with a low fascine or similar.

### **The Gateways**

The four gateways were *c.*4.6-4.8 m wide, *c.*10.6-10.7 m long, and were constructed with four mas-



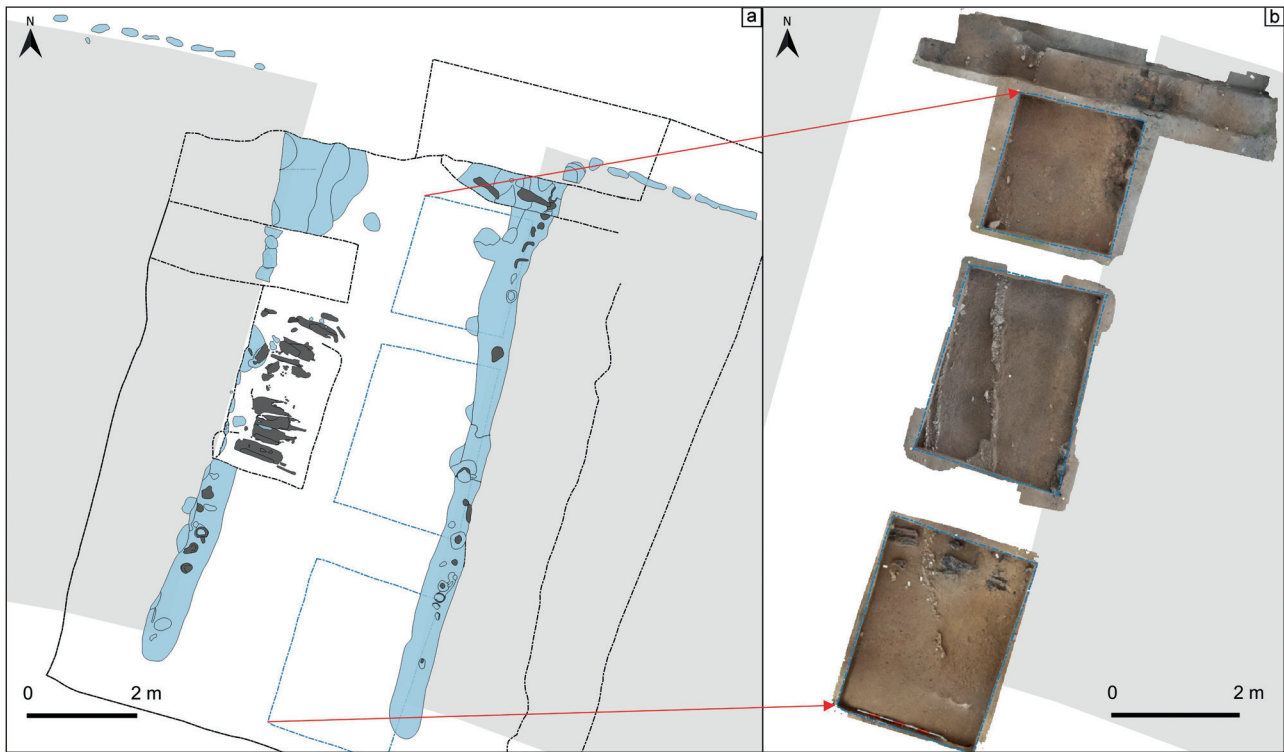
**Figure 5.** Simplified plans of the four gateways compared. Charred wood in solid black (Graphics: Museum Southeast Denmark).

sive corner posts and two parallel rows of posts along each side (Figure 5). The gateways seem to have equalled the height of the rampart and were roofed with wooden planks.

The northern gateway was constructed on a *c.*0.5 m thick layer of sediment purposely deposited in order to level out the natural terrain sloping to the east and north (Figure 6a). The western part of the gateway was left untouched by excavation except for the charred timbers already revealed in 2014. Instead, the excavation concentrated in the eastern part of the gateway, where three trenches separated by baulks were established and a trial trench from 2014 in front of the gateway was re-excavated (Figure 6b). All of the soil in the three squares was wet sieved using a 4-mm mesh. Objects were extremely rare in the tenth-century deposits, while the levelling layer contained Early Iron Age pottery.

The gateway followed a rectangular plan with a major posthole in each corner, connected by two parallel lines of smaller posts. Each posthole had a diameter of 0.2-0.3 m, and they were placed up to 0.1 m apart. The posts were dug into the 0.5 m levelling layer, from which only a few posts reached 0.1 m into the subsoil. The area of the gateway was reinforced with a *c.*0.15-0.2 m-thick layer of clayish soil laid out on top of the levelling layer. Signs of wear were absent. The clayish layer contained a fragment of a Gotlandic box-shaped brooch, a bead of blue glass, and some odd flakes of flint.

The northern gateway was most heavily affected by fire. Remains of collapsed and charred posts lay horizontally near the western side of the gateway. A number of charred timbers were found on top of the clayey layer, and reddened, heat-affected areas show that the fire must have been fierce. Most of the posts in the east wall were charred to some degree, but the



**Figure 6.** a) Plan of timber constructions; b) photogrammetry model of traces of wheel-tracks in the north gateway (Graphics: Museum Southeast Denmark).

large outermost corner-posts were unburned. In the west wall only the centre part was charred. Samples of the charred posts showed that eight were of elm (*Ulmus* sp.) and six of oak (*Quercus* sp.). The fire appears to have originated inside the gateway, since neither the corner posts nor the vertical cladding of timber on the front of the rampart was burned. Some of the timbers were only burned on one side, but in at least three areas, the timbers were completely charred and the clay around the posts had turned red from heat exposure. Several of the heavily burned timber posts had tilted towards the middle of the gateway, while the unburned and slightly charred timbers maintained a vertical position. The evidence seems to indicate that the northern gateway was heavily damaged.

After the fire, the walls of the gateway collapsed, and material from the rampart tumbled into the traffic area. At a later date, the gateway was evidently used by wagons as two *c.*0.2 m-wide and *c.*0.1 m-deep parallel depressions, 0.9-1.0 m apart, were clearly wheel-tracks reinforced with pebbles. Among the pebbles were sherds of Early Glazed Ware, dating the wheel-tracks to the first third of the eleventh century (see below). After this episode, the gateway was filled with soil that eroded from the rampart.

The eastern gateway (Figure 5) was discovered during the trial excavation in 2014, yet only a limited part was unearthed. It is situated where the terrain forms a land bridge between the river valley and the water-logged depression to the north and north-east. In 2016, the inside of the gateway was excavated except for two baulks across. The construction was 10.7 m long and 4.7-5.3 m wide – widest in the middle of the gateway. In the four corners were massive posts of up to 0.4 m in diameter; between these were two parallel post-built walls. They had been positioned in two parallel trenches and packed with soil and turfs. The excavation revealed that a fire had raged most of the northern wall. Charred remains of posts were visible as soon as the top soil was removed. A trench was excavated from the rampart-side leaving an east-west section of the outside of the gateway and therefore an overview of the charred posts and the construction. The wall posts were 0.16-0.25 m wide and 0.14-0.16 m thick, mostly of oak but elm was also present. The remains of the posts were *c.*0.45-0.55 m long and reached only 0.1-0.2 m into the subsoil. The remainder of the posts resided in Viking Age top soil and a reinforcing layer of clayey soil on the gateway floor. The majority of the posts had a

charred crust of 1-2 cm solely in their upper parts, which were above the floor level of the gateway. An exception to this were the corner posts which had no traces of fire. At this point in the excavation of the gateway, the archaeologists were joined by the National Forensic Services of the Danish National Police in order to test methods of fire investigation on an old, archaeological fire site. A detailed description of the investigation and its results is presented in Ljungkvist et al. 2021.

Charred timbers were found inside the gateway lying perpendicular to the direction of traffic, just underneath the mechanically removed topsoil. The timbers must have fallen from the sides or down from the assumed ceiling or cross-beams. The burned timbers rested on a layer of clayish soil with no traces of fire except for an isolated spot of reddish clay and charcoal in the center of the gateway. These are probably the remains of a bonfire. Further excavation revealed the original reinforcement layer from the construction phase of the gateway beneath. This layer included larger chunks and pieces of charcoal. Along the northern wall, the surface of the layer was affected by heat. In this layer, a whetstone of grey schist was found together with a small piece of iron, perhaps the remains of a nail. There is no doubt that the fire in the northern wall commenced while the original floor of the gateway was exposed and that the wall did not collapse at this point. Instead, a second reinforcement layer or floor was added. This was intact in the northern and eastern parts of the gateway. In the southern part, the layers were more fragmented due to later disturbances. Here, three glass beads were found, as well as a part of an iron key for a sliding lock, a few uncharacteristic sherds of pottery, fragments of burned bone, and flint.

The above-mentioned bonfire may indicate that the fire-stricken gateway was used for short visits before the timber construction finally collapsed. Finds of Early Glazed Ware close to the bonfire indicates that this incidence took place during the first decades of the eleventh century and is closely connected to the cart traffic through the northern gateway. A similar re-use of a gateway closed for traffic was first documented at Trelleborg (Nør-lund 1948, 60).

Very close to the bonfire, a collection of iron objects was retrieved. Originally the objects rested

in a wooden box or cache that had been buried in a shallow pit dug through both layers of gateway floors. There is no secure stratigraphy revealing whether the cache was buried before the collapse of the timber construction or after, but it is more or less the last episode that took place in the gateway before the ring fortress was abandoned for good.

The southern gateway (Figure 5) was built on top of a 1.0-1.2-m-thick layer of sediment added to provide a more stable base for the construction than the underlying soggy sediments of the river valley. The size and construction was true to the scheme of the other gateways of Borgring, including the *c.*0.1-m-thick clayish floor layer. But there had been no fire here.

Due to the damp environment, the gateway was expected to have potential preservation of its wooden construction. However, heavy draining during most of the twentieth century had desiccated the layers, and only minute pieces of the oak posts were found. The corner-posts in front of the gateway had been entirely eroded by the meandering stream (Jessen et al. 2021, 5).

No excavation was conducted of the western gateway (Figure 5) except the front corner-post facing the creek in the hope of finding wooden parts for dating. The hoped-for preserved corner-posts had, however, disintegrated. Otherwise, the western gateway was true to the layout and construction of the other three. This gateway would have opened directly into the creek. With the creek bed *c.*3-4 m below the gateway, a bridge would have been necessary. No traces of such a construction was found, however. In order to determine if the western gateway had also been affected by fire, the topsoil was removed. Charred posts were observed in the southern side of the gateway, while the northern side bore no traces of fire.

Unsurprisingly, the evidence from the gateways witness that they were of similar size and construction (Figure 5). Differences between them are found in the traces of fire. The southern gateway had not been stricken by fire at all, while the three other gateways all bore the traces of fire. The northern gateway had both walls charred and witnessed the most severe collapse of the construction. In contrast, the western gateway had the southern side burned, but there were no charred debris visible inside the gateway. In the eastern gateway, only



the northern wall had been on fire, but it clearly had not broken down immediately. A common trait is that the corner posts were unaffected by fire. Today, it is not possible to tell exactly where the fires started (Ljungkvist et al. 2021, 10). Taking all the evidence into account, though, there is nothing to indicate that the fires were related to an attack from the outside.

### The inside of the Ring Fortress

It was expected that inside the rampart of Borgring would be four blocks of houses divided by axial roads connected to the four gateways and possibly encircled by a road following the foot of the rampart. Despite the removal of the topsoil of *c.*28 % of the area, no traces of constructions from the time of the ring fortress were found.

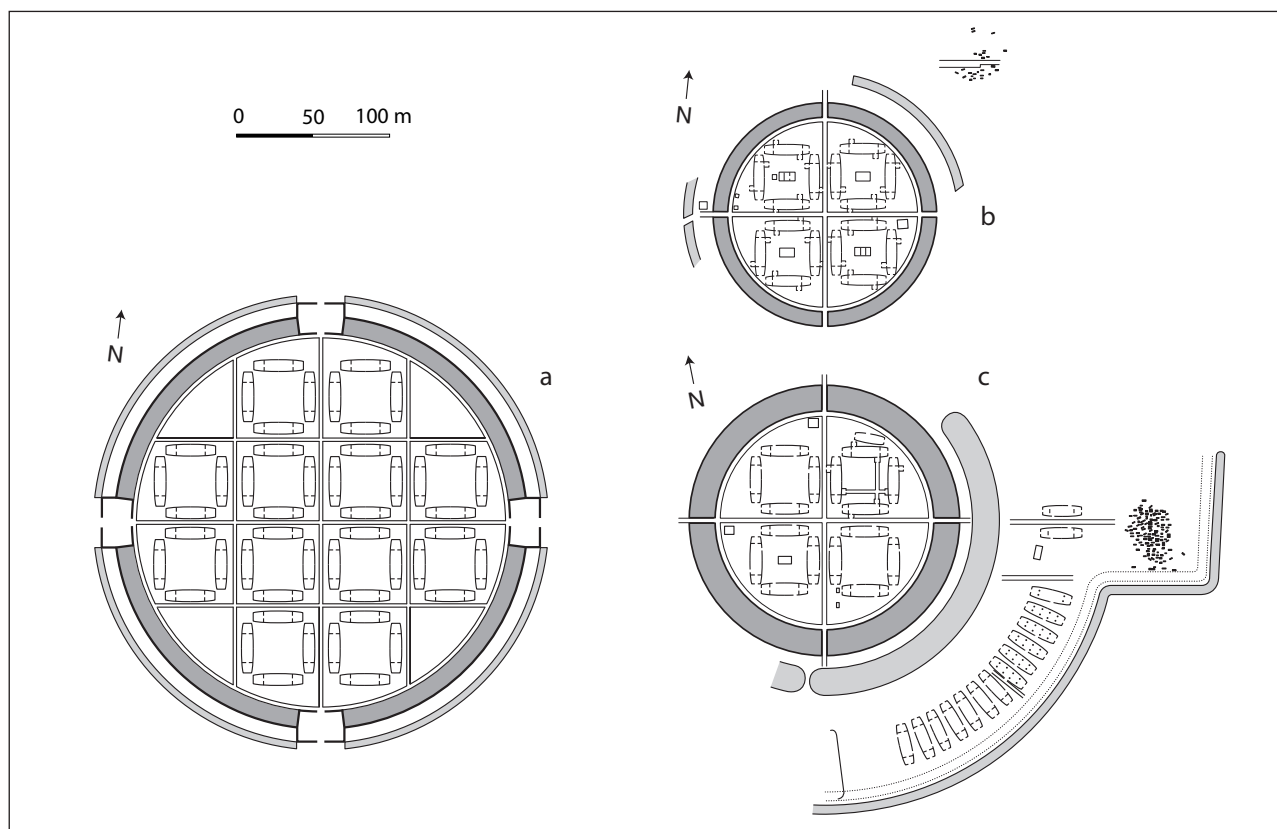
A culture layer in a shallow depression and a number of pits and postholes dating from the first century BC to the sixth century AD were registered in the level northern half of the interior of the ring fortress. Four roof-supporting posts of a three-aisled house from the Iron Age were found

when excavating the rampart close to the eastern gateway. It was partially covered by the rampart and three <sup>14</sup>C-dates on charred grain from the postholes spanned the time between the 1<sup>st</sup> century BC and the first half of the 6<sup>th</sup> century AD. Further pits and postholes dating from this period were also present east of the fortress.

### The Fortress Plan

A key objective of the investigations was to test how closely the fortress related to the previously known Trelleborg-type sites (Figure 7) (Nørlund 1948; Olsen 1977; Nielsen 1990; Dobat 2013; Roesdahl, Sindbæk and Pedersen 2014; Runge 2018).

It is widely accepted that the Trelleborg-type fortresses were built to a ‘Trelleborg foot’ (tf) of *c.*29.5 cm. In this unit, the courtyard of Fyrkat has a diameter of 400 tf/118 m; that of Aggersborg 800 tf/236 m; the rampart and ring street of both fortresses adding 40 tf/11.8 m. Without the street, the rampart of Fyrkat is 36 tf/10.6 m (Olsen and Schmidt 1977, 70; Sindbæk 2014, 180). Trelleborg, in the last of several building phases, shows



**Figure 7.** Reconstructed plans of the three most substantially excavated of the known Viking Age ring fortresses in Denmark: Aggersborg (a), Fyrkat (b), and Trelleborg (c) (Redrawn by Lars F. Thomsen after Olsen and Schmidt 1977).

a courtyard diameter of 450 tf/132.75 m, a ring street of 9 tf/2.66 m and a rampart of 60 tf/17.7 m (Nørlund 1948, 46).

How does Borgring measure up? The width of its rampart is exactly that of Fyrkat, 36 tf/10.6 m, while the mean width of its gateways is 16 tf/4.7 m (cf. below). The outer diameter corresponds to 490 tf/144.55 m. If a ring street of 9 tf was projected, as was the case at Trelleborg, the diameter of the courtyard would correspond to 400 tf/118 m, with a rampart and street of 36 + 9 tf on either side. Together with the strict geometry observed in the circular layout and the position of the gateways, these measurements strongly suggest that Borgring was planned and projected according to similar specifications, and likely by the same builder, as the previously known Trelleborg-type fortresses.

At most Trelleborg sites (possibly also at Nonnebakken, cf. Runge 2018), blocks of large houses, together with planked roads were found to complement the fortifications. Four large trenches with a combined area of 3410 m<sup>2</sup> were opened in Borgring's interior. They covered areas, where traces of as many as 12 houses and roads might have been expected, had the fortress followed the same plan as, for example, that of Fyrkat. Yet while cultural layers and pits from the earlier Iron Age settlement were preserved, no indications were seen of either houses or roads relating to the fortress. Instead, a shallow track along the rampart was found close to the eastern gateway and along part of the south-eastern rampart.

Given the strong slope in the southern half of the fortress, the absence of buildings in this area is hardly surprising. Though more appropriate space for constructions is offered in the northern half of the fortress, none were observed. While the size and layout of the fortress suggest that buildings may have been planned, and while the formation of the gateways certainly assumes axial roads, the excavation results must imply that these were never constructed.

The defensive qualities of the site were obvious: set between the river valley to the south and the gully formed by a creek to the west. To the north-east, a wetland depression stretched between the northern and eastern gateways (Jessen et al. 2021, 9). The site was thus mostly surrounded by wetlands. This resembles the situation at the fortresses of Fyr-

kat and Trelleborg, where only stretches of ditches were deemed necessary along part of the perimeter. No traces of a ditch were observed at Borgring.

Previously, the Danish ring fortresses have been associated with navigation because of their topographic location by streams or rivers (Dobat 2013, 34). In the case of Borgring, investigations in the river valley have concluded that the stream was too narrow and too shallow for Viking Age seagoing ships to navigate (Jessen et al. 2021, 12).

## The Finds

The excavations yielded a modest range of artefacts, of which many relate to the Early Iron Age settlement. The secure Viking Age artefacts include a cache of tools, a small axe, three whetstones, a fragment of a silver brooch, seven glass beads, and several sherds of Early Glazed Ceramics. In addition, several wooden objects, including a worked plank, dated to the tenth century, and a Viking Age type wheel hub were found in a test trench in the river valley.

### Glass Beads

Three round or cylindrical monochrome glass beads were found in the northern gateway (one blue, one dark red, and a small fragment of one transparent uncoloured), and two were found in the eastern gateway (yellow and blue) (Figure 8). These types are common in Scandinavia, both in the Viking Age and in earlier periods (Callmer 1977, 78). Also found in the eastern gateway is a fragment of a dark-blue cylindrical bead with a pattern of white rings formed in the mosaic technique (Callmer 1977, type G012) (Figure 8, far left). This type is common in the early Viking Age, but is also seen in later contexts (Callmer 1977, 90). Another polychrome glass bead was found at the bottom of the rampart, near the east gateway. It shows a pattern of yellow dots and white wavy lines on a black matrix (Callmer 1977, type B084). This type is most common in the tenth century. The date of the beads is thus consistent with that of the fortress, which indicates some activity at the site.



**Figure 8.** Glass beads (Photo: Jens Olsen/Museum Southeast Denmark).

### ***The Silver Plate Fragment***

A small ornamented silver fragment was found at the level of the original gateway floor, underneath the burned layer of the collapsed northern gateway (Figure 9, right). It consists of a silver fragment decorated with ornaments inlaid with niello, a small piece of a bronze fastener, and a tiny piece of gold foil. The fragment is a part of a box-shaped brooch, a type originating from the island of Gotland, Sweden (Thunmark-Nylén 1983). It belongs to Thunmark-Nylén's type 7, characterised by gold- or silver-plate decoration (Thunmark-Nylén 2006, 75-7). It is the top part of a highly ornamented side piece, of which four would have decorated the brooch. It shows a decoration of two spirals meeting, rather than the knot motif, which is more common on these brooches. Fewer than 50 finds of type-7 box brooches are known. The majority have been found in Gotland, and only two are previously recorded elsewhere: one in Grave 4 at the ring fortress Fyrkat in Jutland (Figure 9, left) and one from Öland (Thedéen 2012). When comparing the finds, it is clear that the brooch from Fyrkat provides one of the closest parallels to the Borgring fragment (Hedegaard 2016; Roesdahl 1977, 137). The ornaments on the two pieces are not identical in all details, but a comparison with other examples from the Gotland corpus shows that the individual side pieces could show considerable variation within the same brooch. The coincidence between Fyrkat and Borgring is notable, since the production date suggested for this type by Thunmark-Nylén (2006, 87) is the early tenth century. The Fyrkat brooch, which was heavily worn and repaired, was thus an antiquity by the time it was buried at the fortress around AD 980. The Borgring piece also shows substantial wear. Three of the side pieces from the Fyrkat brooch are



**Figure 9.** Silver-plate fragment from a box brooch (right) (Photo: Jens Olsen/Museum Southeast Denmark). For comparison, the box brooch from Fyrkat grave 4 (left) (Photo: CC-BY-SA, Arnold Mikkelsen, The National Museum).

missing, and it is therefore not possible to establish if the Borgring find would fit. The possibility remains that it could have belonged either to this same or to a very similar piece of jewellery.

### ***Tools and Iron Hoard***

A cache of tools and iron parts was found in a pit dug into the layer that sealed the fire horizon in the eastern gateway (Figure 10 and 11). The burial of the cache is the last incident in the gateway that can be identified before the final collapse of the construction.

When found by a metal detectorist after the removal of the topsoil, several objects of severely rusted iron formed an unmanageable conglomerate, which was consequently removed in a block in order to excavate in the laboratory. The cache was totally decomposed, but tinting from the wooden sides showed that it had measured 49 x 36 cm with 1-cm-thick sides and a 2-cm-thick bottom. The original height of the cache could not be estimat-



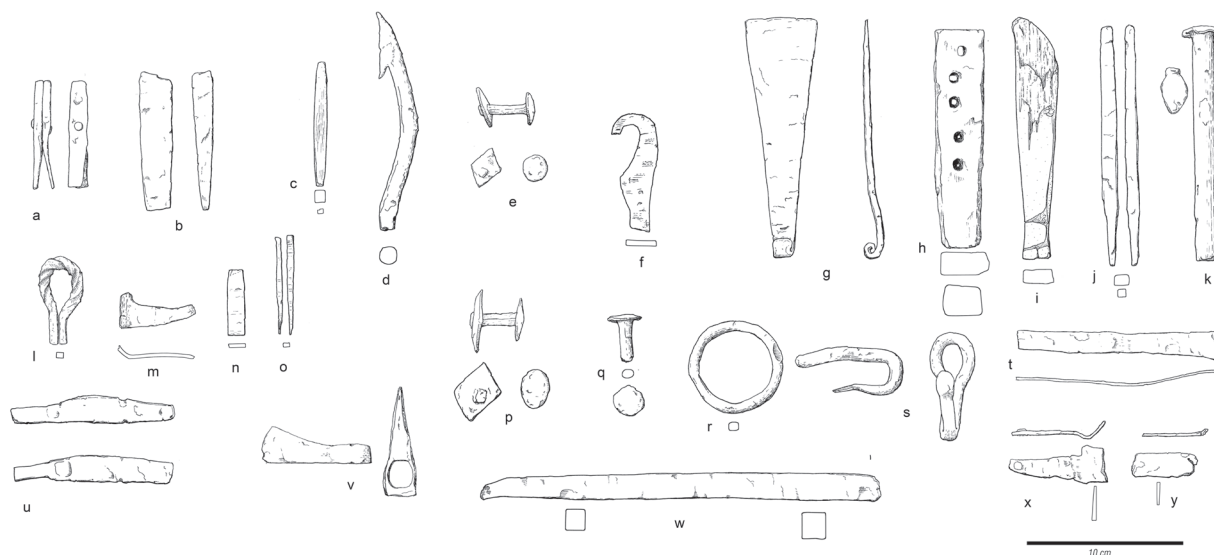
**Figure 10.** Iron hoard and whetstones (Photo: Jens Olsen/Museum Southeast Denmark).

ed, but together the iron objects measured *c.* 12 cm high. No hinges, lock parts, or fittings were found. Inside, the cache had been divided into three parts by walls less than 1 cm thick. In the middle was an 18-cm-wide partition, with a section of 14 cm on either side. Inside, the iron objects were found on different levels, and imprints of grass or hay on some of the objects indicate that they had been separated by straw. Two samples from the inside of the cache were analysed for macro fossils (Henriksen 2018). A large amount of bulky fragments of charcoal (up to 30 mm), mostly with sharp edges, suggests that it had not been exposed to traffic or redepositing. Among the charred remains were grain kernels from barley, rye, oats, and wheat, as well as different types of weeds typical for fields. There were also large lumps of organic material (up to 12 mm) fused together by heat consisting mostly or entirely of flaxseeds.

A total of 20 artefacts lay inside the cache. Some have been identified as tools, including a nail header, a plane, parts of a draw knife, a clamp, an awl, a fire steel, an oversized leister prong, a belt hook and ring, together with iron ingots, previously used clinker nails, and scrap pieces. Metallurgical analy-

ses of the assemblage show that the bog iron probably derives from southern Sweden. An exception is the draw knife made of iron from Central Europe (Jouttijärvi 2017). All of the tools and ingots were made of high-quality steel by a skilled craftsman. Nevertheless, at the time of deposition most items were either heavily worn or fragmentary. So was a chisel or mandrel with a broken-off edge or point found 20–30 cm away from the other iron objects, probably due to post-depositional disturbance by agricultural activity. The artefact was made of the same type of iron and forged in the same high quality as the other items. Furthermore, two whetstones were found 10–15 cm to the north of the iron conglomerate: one small rectangular piece made from dark, fine-grained schist, the other a larger, less regular piece made from light schist. These may also have been part of the ensemble.

At best, the contents are scrap iron, and it could be argued that a smith hid the cache with his stock intending to retrieve it later. Buried in the earth, iron and steel do not have ideal conditions for preservation, but the artefacts seem to have been wrapped in grass or hay in the cache – perhaps extending the period of time before rust



**Figure 11.** Iron hoard and whetstones. All objects of iron except c and i: schist whetstones (Drawing: Marian Frandsen).

formed. Their hiding place next to a bonfire may indicate that the gateway was used for housing by a smith, as there are no traces of a workshop. There is no other type of waste either, for instance, from cooking. As a peculiarity, the only type of pottery found near the bonfire was Early Glazed Ware. (Figure 12) This is hardly what would be expected as cooking pots in a modest residence. The typical pottery of the late tenth and eleventh centuries in Zealand is Baltic Ware, which is found in almost every excavation of farms or villages in the region dating from this period. At Borgring, however, it is absent.

Taking the contents and context of the cache into account, the find bears some of the traits of a ritual deposition of tools. According to Julie Lund (2006, 326), a tool-chest deposit typically contains hammer, anvil, and pliers, and additionally there may be a chisel, nail header, spoon drill, file, nails, or whetstone – representing the smith, the woodworker, and the shipbuilder. Furthermore, agricultural implements like blades from a scythe, sickle, or leaf knife may be present. The deposited tool chests are normally found in waterlogged areas, on the bank of a lake or a water course, or on dry land overlooking a waterlogged area, with deposits dating from the Viking Age (Lund 2009, 84-85). The Borgring cache does not match Lund's definitions perfectly. The absence of hammer and pliers especially differs from other deposits of tool

chests. Nevertheless, the content of the Borgring cache does have some similarities with tool-chest deposits and so has the context. At the ring fortress Trelleborg, a deposit of hammer, anvil, and pliers was found by the inner perimeter of the rampart to the north of the eastern gateway (Nørlund 1948, 140). According to Nørlund, a blade from a short scythe was found 'nearby', the distance being so short that Axel Steensberg subsequently suggested that the hammer and anvil had been used to sharpen the scythe (Steensberg 1943, 114). In other words, the four items may originally have been deposited together, combining the tools of a smith and an agricultural implement. The deposits from Borgring and Trelleborg were found inside or by the eastern gateway and are thus clearly connected to the monuments, which in turn are clearly connected to the banks of water courses and waterlogged areas. The Trelleborg find is dated to 980-995 AD (Lund 2006, Tab. 1), while the cache from Borgring must be from the first decades of the 11<sup>th</sup> century. Julie Lund has suggested that the tool-chest deposits are Christian rituals conducted in order to manage traditional pagan beliefs of transformation represented by the smith (Lund 2006, 336). By a ritualized burial of the smith's tools inside a truly Christian monument, pagan powers were neutralized.

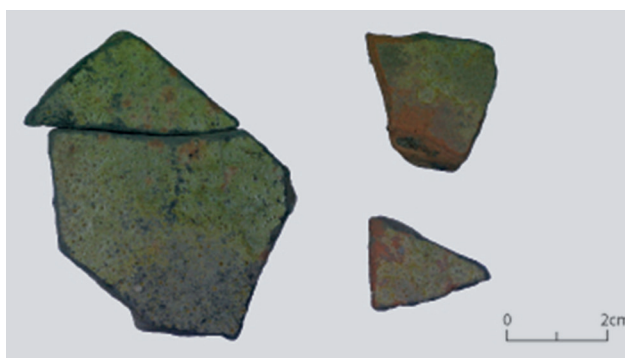
Besides the cache of iron tools, a third large whetstone of light schist was found elsewhere in

the eastern gateway, in the original floor layer. Alongside the whetstone was an iron fragment, probably part of a nail.

When the mechanical excavator removed the topsoil near the inner side of the east gateway, one very small axe was found. It is made from iron almost without any carbon, and it is peculiar by having steel present in the neck part instead of in the edge. It may have been a wedge with a haft instead of an axe (Jouttijärvi 2017, 2).

### Early Glazed Ware

Sherds of Early Glazed Ware were found in the eastern and northern gateways, in both cases in layers post-dating the fire (Figure 12). In the northern gateway, sherds were found in the wheel track; consequently, they were mostly very small and worn. The sherds from the eastern gateway were found in the youngest level of activity, beside a bonfire almost in the centre of the gateway. The sherds are fragmented and may represent just a single pot. They have a yellowish-green to bluish-green glaze on the outer surface and faint rilling marks on the inside, indicating that the vessel was wheel-thrown. Thin-section analysis of four sherds concluded that the clay derives from the Baltic littoral (Perry 2017, 4). Yet the mode of production is almost identical to that of 'Stamford ware', named after the area of production in southern England (Kilmurry 1980), suggesting that a Stamford-trained potter made the vessel (Perry 2017, 4-5). Similar Stamford-derived ware was previously identified in early-eleventh-century contexts from several sites in the region, including Roskilde (Ulriksen 2011, 107-8), Lejre, and Lund (Christensen et al.



**Figure 12.** Sherds of Early Glazed Ware from the Eastern gate (Photo: Gareth Perry).

1994). This is a rare and prestigious type of pottery in Denmark, as is Torksey-type-inspired pottery, which was also produced in Lund, Scania (Jönsson and Brorsson 2004, 171). It is suggested that it marks cultural transfer within the Anglo-Danish kingdom of Cnut (r. 1016-35) (Christensen et al. 1994, 75). At Borgring, they mark an important chronological phase, suggesting that some activity at the ruined fortress took place in the early eleventh century.

### The Date of the Fortress

The artefacts found at Borgring indicate activity in the tenth century, with finds of glazed ceramics from the early eleventh century found in layers following the destruction of the site. A worked plank (Figure 13) found in excavations in the river valley south of the fortress gave a dendrochronological date after 966 AD (no sapwood preserved), but this cannot be proven to be related to the fortress. No timber suitable for dendrochronology was found in the fortress. Two radiocarbon dates in the 2014 excavation gave an age from the late ninth to the early eleventh century (Goodchild, Holm and Sindbæk 2017).

In order to narrow down the time of the construction of the fortress, samples were taken for <sup>14</sup>C wiggle matching. Charred timbers from the northern gateway were examined to identify the wood genus and to find examples with many tree-rings. Five timbers were lifted in plaster blocks to be sub-sampled in a laboratory environment. Two charred planks from the western side in the northern gateway were selected for wiggle-match dating. Sample A901 was an oak plank with 33 identified



**Figure 13.** Plank and wheel hub found in the river valley (Photo: Jens Olsen/Museum Southeast Denmark).

growth rings. It was possible to identify the direction of growth of the original tree and to sub-sample single tree-rings. Six samples were dated from ring 1 (oldest), 3, 5, 28, 30, and 32 (youngest). Sample A905 was an oak plank with 36 identified growth rings. Again, the growth direction could be determined, and six samples were dated from ring 35 (oldest), 33, 31, 5, 3 and 1 (youngest). All charred remains are heartwood. No traces of sapwood were observed (Table 1).

The charcoal samples were processed using standard methods (Olsen et al. 2017). The results are reported as conventional radiocarbon ages BP, normalised to 25 ‰ according to international convention using online  $^{13}\text{C}/^{12}\text{C}$  ratios (Stuiver and Polach 1977), and converted to calendar age using the international calibration curve, IntCal20 (Reimer et al. 2020). Further, a wiggle-match (D\_Sequence model) is constructed using OxCal 4.4 to take into account the known age gap between the samples for each plank (Bronk Ramsey et al. 2001). The resulting calibrated age of the last ring for both planks (A901 and A905) are shown here (Figure 14). Oaks in northern Germany that have lived to be 100 years old have an average of *c.* 15-30 sapwood rings (Hollstein 1980), a result that is also applicable to Danish oaks. The two samples dated here could be from younger trees, considering the relatively few rings that the preserved tim-

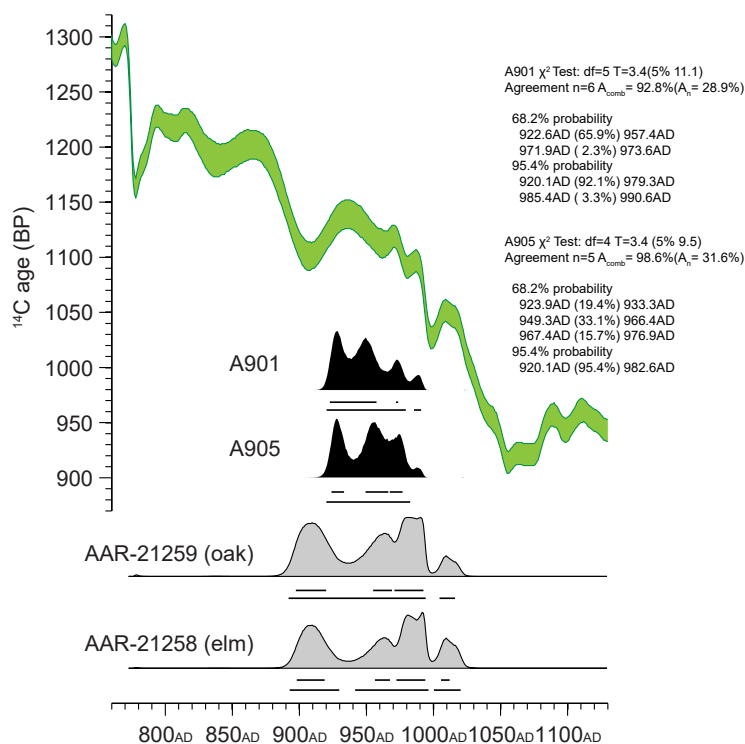
ber contained, which would mean that they might have had as few as *c.* 10 sapwood years. The results indicate that the two trees at the northern gateway were felled after *c.* 930, most likely in the second half of the tenth century.

## Outside the ring fortress

Investigating the surrounding area of Borgring was an integrated part of the project and altogether *c.* 40 ha of land on both sides of the river valley was trial excavated (Figure 15) It was important to conclude whether there had been a settlement from the tenth century in the vicinity, a burial ground like those found at Fyrkat and Trelleborg, or any other archaeological remains contemporary with the period of Borgring.

Despite the large area investigated, there were no traces of Viking Age activity whatsoever. To the east of the fortress, there were remains of scattered houses  $^{14}\text{C}$ -dated by grain samples to the Late Roman Iron Age and the Migration Period, and on the hill to the north of Borgring were found the postholes of the walls of a single house from the fourteenth or fifteenth century AD.

On the southern side of the river valley, a three-aisled house was found close to the existing village of Lellinge. Both charcoal from beech wood and



**Figure 14.** Radiocarbon wiggle-match model for the date of planks A901 and A905. The resulting calibrated age of the last ring. Below, the calibrated dates of the two previously dated samples from the 2014 excavation (AAR 21259 and AAR 21258). The new wiggle-match results constrain the date range significantly (Graphics: Jesper Olsen).



**Figure 15.** Map of trial excavations in the surrounding area of Borgring (Graphics: Museum Southeast Denmark).

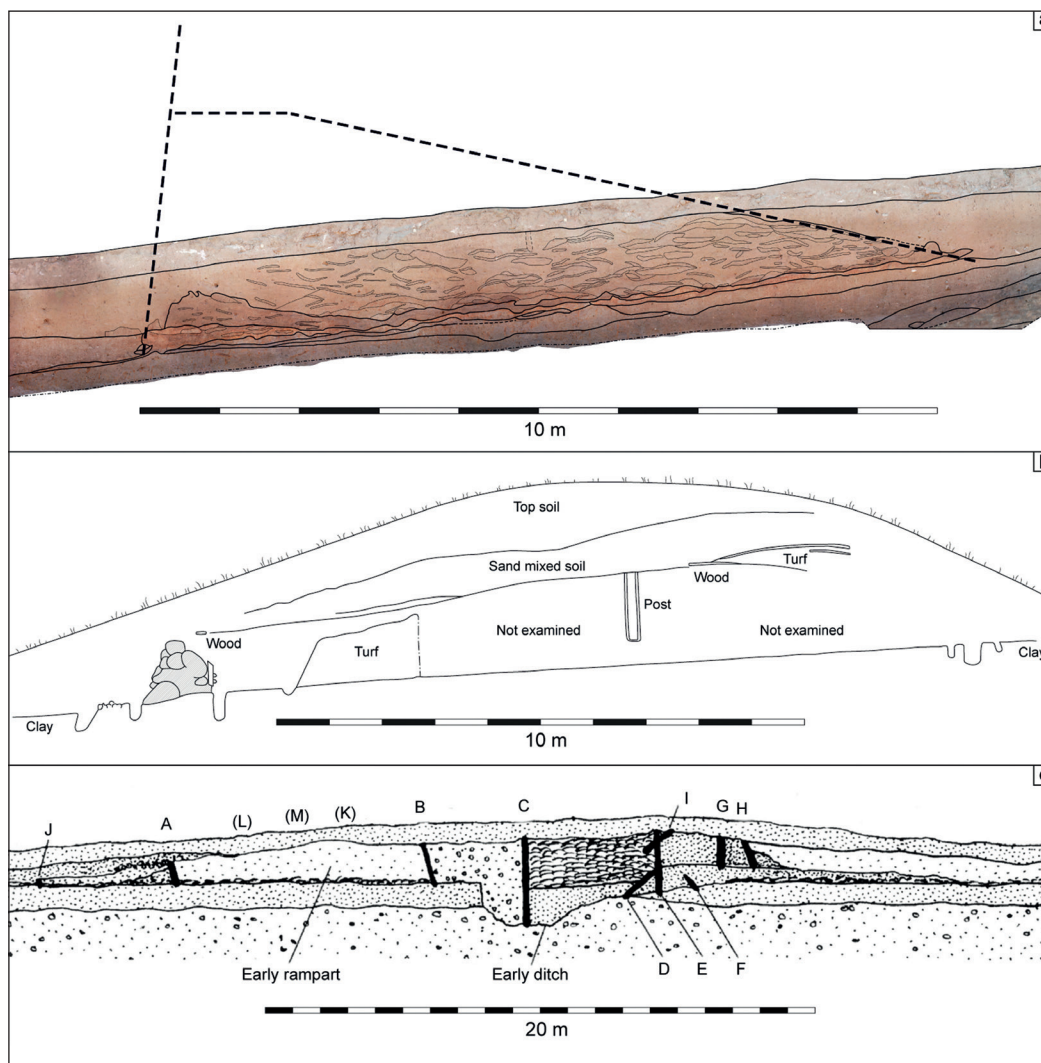
charred grain were sampled from the holes of two roof-supporting posts and  $^{14}\text{C}$ -dated the house between the mid-third century AD and the beginning of the sixth century AD. Furthermore, a pit with sherds of Baltic Ware reveals activity here during the eleventh or twelfth centuries AD. Close by, a sunken road was uncovered, leading to a ford across the stream, indicating that the opportunity to cross the river valley was a likely reason to construct Borgring at this spot.

### Discussion: Power and Defence

Borgring was built in the second half of the tenth century along a geometric outline very similar to that of other Trelleborg-type fortresses. The site saw substantial landscaping before construction of the gateways and the rampart. The gate-

ways were constructed with post-built walls like at Fyrkat and Trelleborg, and they were probably roofed. The rampart was a simple construction of turfs and soil with an outer timber cladding and no internal wooden constructions. No buildings or wood-built roads were seen within the fortress. Evidence of activity is minimal. After a short period, three of the gateways were damaged by fire, but only the northern gateway was severely affected. In each of the other two gateways, only one wall had been scorched. There are no traces of fire either on the inside or on the outside of the gateways, and this is also true for the timber cladding on the front of the rampart in the north and east. The four corner posts in each of the fire-stricken gateways were not charred at all. Put together, this indicates that the fires were not instigated by an attack on the ring fortress from people on the outside trying to get in.





**Figure 16.** Comparison of Borgring's rampart (a, reversed for comparison) with those of b) Trelleborg (Zealand) and c) Borgeby (Scania). b) redrawn after Nørlund 1948 p. 50 fig. 30; c) after Söderberg and Svanberg 1999, s 24 (Graphics: Museum Southeast Denmark).

Despite the damage caused by the fire, carts or wagons used the northern gateway as a passage-way into the ring fortress during the early eleventh century, and in the eastern gateway, a new floor layer was put in after the fire. The wheel tracks are probably contemporaneous with the use of the east gateway as temporary housing for one or more persons.

The planning of Borgring – including the choice of location, the pre-construction modification of the landscape, the layout, and the dimensions – matches other Trelleborg-type sites. These observations suggest that Borgring was indeed planned as part of the network of fortresses established across the realm of Harald Bluetooth. Excavation revealed some differences, though, indicating that Borgring was either left unfinished or was completed to an initial stage of use from which the other fortresses

progressed. Compared to Fyrkat, which has almost the same diameter and the same width of the rampart, Borgring has no blocks of houses, no roads, and no ditches to the north and east, where they would have been appropriate. There was no timber-constructed framework inside the rampart, and the cladding of the front of the rampart was documented to the north, east, and southeast, but not in the western and south-western parts. The forensic investigation of the fire in the eastern gateway suggests that there must have been a gap between the rampart and the northern wall for the fire to develop as documented (Ljungkvist et al. 2021, 8-9). This may indicate that the rampart was not completed. Furthermore, no presence of either crowds of warriors or people in general could be detected. While activities at Fyrkat and Aggersborg have left rather few artefact finds at these sites

(Roesdahl 1977; Sindbæk 2014, 178), finds at Borgring are even fewer. It is an uncertain business to conjecture a reason for the construction's abandonment before completion. It may have been the last ring fortress to be established, so during the construction phase, it may have been considered needless and therefore abandoned. This point in time could have been the mid-980s, when King Harald Bluetooth faced a rebellion led by his son, Svein Forkbeard. According to late-twelfth-century chronicles, the uproar was ignited both by 'exceptional heavy burdens' that the king laid upon the people and as a reaction to the conversion to Christianity (Saxo 2000, 435; Aggesen 1842, Ch. 4). If the 'exceptional heavy burdens' were delivering materials and manpower for the building of the king's geometric signature monuments all over the realm, the construction of Borgring might have been the last straw. Following this hypothesis, three of the four gateways could have been set on fire as a statement by the opponents of the king, resulting in the site's abandonment.

Another explanation for the absence of several component parts typical of a geometric ring fortress is that Borgring was completed to an initial, provisional stage of use. This option is supported by the fact that the rampart of Borgeby in Scania bears a strong resemblance to that of Borgring (Jacobsson et al. 1995, 54; Svanberg and Söderberg 1999, 33-34). Moreover, a similar situation is also indicated at Trelleborg in Zealand. A section of the rampart shows what the excavator called a 'first line of defence' (Nørlund 1948, 53): an initial construction with a sloping turf rampart, clad with a timber front, similar to the construction at Borgring (Figure 16). The dimensions of the two ramparts were virtually identical. At Trelleborg, this construction was subsequently covered by more substantial earthworks, which did not happen at Borgring. The early planning and constructions at both sites, however, appear to have been closely comparable.

Borgring thus shifts the balance in the pattern marked by the Trelleborg-type fortresses. What makes these distinct among the fortifications of early medieval Europe is the concerted effort to achieve a recognisable standard in visual appearance across an entire kingdom. The results from Borgring and the perspective they allow at other sites suggest that

the act of raising a fortress was more important than creating permanent lodgings for troops or a garrison. From a military and defensive point of view, the ring fortresses did not necessarily possess the most advantageous position in the vicinity where they were built (Ulriksen, Schultz and Mortensen. 2020, 9-12). Furthermore, four gateways instead of one weakens the defensive value of a stronghold. Even though some of the gateways had no practical function at Borgring, Fyrkat, and Trelleborg, because they opened into either natural or artificial obstacles, they would be the weak spots searched for by an attacking party. Instead, the effort expended in their construction may have been both symbolic and pragmatic. Contemporary sources picture initiatives such as the Wessex *Burghal Hidage* or Heinrich I's German *Burgenordnung* as an essential part of a ruler's obligation to defend his subjects (Blake and Sargent 2018, 120-154; Christie 2016, 52-67). The Trelleborg-type fortresses may signify a similar response.

In contemporary Saxon and Slavic wars, culturally and geographically close to Viking Age Denmark, large earth and timber fortresses served as refuges for the common population, especially in situations when the trained fighters left on expedition (Sindbæk 2020, 538). Crowds gathered in the fortresses were sometimes successful in holding back assaulting armies, thus avoiding being killed or enslaved. If, as sources suggest, Harald Bluetooth was challenged during the 970s, the ring fortresses may have been constructed to demonstrate vigilance to populations left vulnerable. Such a situation might fit the pattern seen at Borgring – constructed with vigour and subsequently little used.

Fortress-building, however, was certainly a show of strength in addition to providing protection. Borgring's location in relation to Zealand's landscape and communication routes was ideal to impress both locals and travellers (Ulriksen, Schultz and Mortensen 2020, 16-17). The monument stood at a crux of important land routes, virtually unmissable as a statement advertising the King's presence and power. The specific position chosen was ideally visible in relation to a major ford. The geometric design of this and other fortresses suggests the importance of the symbolism of power more than merely practical defence.

As part of the building programme of Harald Bluetooth, the construction and subsequent disuse of Borgring were gestures of power. It is tempting to relate the symbolism of the fortress buildings to the new order of society instigated by the conversion of the King to Christianity in c.AD 963, perhaps in a deliberate attempt to disrupt the older power structures in the region. The Borgring investigations thus add much to a revised understanding of the Trelleborg network and of the politics of fortification more widely.

## Acknowledgements

This work was funded by a generous grant from the A.P. Møller og Hustru Chastine Mc-Kinney Møllers Fond til almene Formaal, with additional support from Køge Municipality.

This article is one of more contributions discussing targeted aspects of the results of the Borgring Project 2016–18 published in Danish Journal of Archaeology.

Language has been revised by Taylor Grace FitzGerald.

## References

- Aggesen, S., 1842. *Danmarks Krønike*. Oversat af R. Th. Fenger. København: Bianco Lunos Bogtrykkeri. Available from: [https://heimskringla.no/wiki/Sv.\\_Aggesen\\_kap.4](https://heimskringla.no/wiki/Sv._Aggesen_kap.4). [Accessed December 2020]
- Blake, M. and Sargent, A., 2018. 'For the protection of all the people': æthelflæd and her burhs in north-west Mercia. *Midland History* 43, 120-54. <https://doi.org/10.1080/0047729x.2018.1519141>
- Bronk Ramsey, C., van der Plicht, J. and Weninger, B., 2001. 'Wiggle matching' radiocarbon dates. *Radiocarbon* 43, 381-389. <https://doi.org/10.1017/s0033822200038248>
- Callmer, J., 1977. *Trade beads and bead trade in Scandinavia ca. 800–1000 A.D.* (Acta Archaeologica Lundensia, series in 4°, 11). Bonn: Rudolf Habelt Verlag.
- Christensen, J., Holm, N., Schultz, M.K., Sindbæk, S.M. and Ulriksen, J., 2018. The Borgring Project 2016–2018. In: J. Hansen and M. Bruus, eds. *The fortified Viking Age: 36<sup>th</sup> interdisciplinary Viking symposium*: 60-68. Odense: Odense City Museums and University Press of Southern Denmark, 60-68.
- Christensen, T., Larsen, A.-C., Larsson, S. and Vince A., 1994. Early Glazed ware from medieval Denmark. *Medieval Ceramics* 18, 67-76.
- Christie, N., 2016. Creating defended communities in later Saxon Wessex. In: N. Christie and H. Herold, eds. *Fortified settlements in early medieval Europe: defended communities of the 8<sup>th</sup>-10<sup>th</sup> centuries*. Oxford: Oxbow Books, 52-67. <https://doi.org/10.2307/j.ctvh1dh3x.12>
- Dobat, A.S., 2013. *Kongens borge: rapport over undersøgelserne 2007-2010*. Højbjerg: Jutland Archaeological Society.
- Geodatastyrelsen n.d. Historiske kort på nettet. Available from: <https://hkpn.gst.dk/> [Accessed 17 April 2020]
- Goodchild, H., Holm, N. and Sindbæk, S.M., 2017. Borgring: the discovery of a Viking Age ring fortress. *Antiquity* 91, 1027-42. <https://doi.org/10.15184/aqy.2017.118>

- Hedegaard, K.R., 2016. The Gotlandic box brooch from Fyrkat grave IV: a research into the casting technique and work methods associated with multi-piece brooches. *Danish Journal of Archaeology* 5, 3-18. <https://doi.org/10.1080/21662282.2016.1199235>
- Henriksen, P.S., 2018. *Borgring, analyse af to jordprøver udtaget ved værktøjskassen i Østporten*. Rapport af 10/8 2018. Borgringprojektet. Miljøarkæologi og Materialeforskning. København: Nationalmuseet.
- Hollstein, E., 1980. *Mitteleuropäische Eichenchronologie* (Trierer Grabungen und Forschungen 11). Mainz am Rhein: Verlag Philipp von Zabern. <https://doi.org/10.1017/s0079497x00009245>
- Jacobsson, B., Arén, E., Arén, E. and Blom, K.A., 1995. *Trelleborgen: en av Harald Blåtands danska ringborgar*. Lund: Trelleborgs Kommun.
- Jessen, C., Henriksen, P.S., Hald, M.M. and Ulriksen, J., 2021. The lost landscape of Borgring: geoarchaeological investigations into the navigation to, and location of, the Danish Viking age ring fortress. *Danish Journal of Archaeology* 10, 1-14. <https://doi.org/10.7146/dja.v10i0.121917>
- Jessen, M.D., Holst, M.K., Lindblom, C., Bonde, N. and Pedersen, A., 2014. A palisade fit for a king: ideal architecture in King Harald Bluetooth's Jelling. *Norwegian Archaeological Review* 47, 42-64. <https://doi.org/10.1080/00293652.2014.921239>
- Jouttijärvi, A., 2017. *Værktøjskisten fra Borgring*. Heimdal-archaeometry Report 17-5.
- Jönsson, L. and Brorsson, T., 2004. Oxie i sydvästra Skåne. En plats med centrala funktioner. Anglert, M. and Thomasson, J., (eds). *Landskapsarkeologi och tidig medeltid – några exempel från södra Sverige. Uppåkrastudier 8. Acta Archaeologica Lundensia, Series in 80*. Lund, 147-210.
- Kilmurry, K., 1980. *The pottery industry of Stamford, Lincolnshire, c.A.D. 850–1250: its manufacture, trade and relationship with continental wares, with a classification and chronology* (BAR British Series 84). Oxford: British Archaeological Reports. <https://doi.org/10.30861/9780860541097>
- Ljungkvist, E., Thomsen, B., Sindbæk, S.M., Christensen, J., Holm, N., Schultz, M.K. and Ulriksen, J., 2021. 'The coldest case of all' – fire investigation at the Viking Age ring fortress of Borgring, Denmark. *Danish Journal of Archaeology* 10, 1-12. <https://doi.org/10.7146/dja.v10i0.121916>
- Lund, J., 2006. Vikingetidens værktøjskister i landskab og mytologi. *Fornvännen* 101, 2006, 323-341.
- Lund, J., 2009. *Åsted og vadedsted. Deponeringer, genstandsbiografier og rumlig strukturering som kilde til vikingetidens kognitive landskaber*. Doktoravhandling forsvart ved Det humanistiske fakultet, Universitetet i Oslo. No. 389.
- Mortensen, M.F., Baittinger, C., Christensen, J., Nielsen, A.B., Nielsen, S., Pihl, A., Prøsch-Danielsen, L., Ravn, M., Sindbæk, S.M. and Ulriksen, J., 2021. Turfs and timbers – resource use in the construction of a Viking Age ring fortress. *Danish Journal of Archaeology* 10, 1-18, <https://doi.org/10.7146/dja.v10i0.121918>
- Nielsen, L.C., 1990. Trelleborg. *Aarbøger for nordisk Oldkyndighed og Historie* 1990, 105-178.

- Nørlund, P., 1948. *Trelleborg*. København: Gyldendal.
- Olsen, J., Tikhomirov, D., Grosen, C., Heinemeier, J. and Klein, M., 2017. Radiocarbon analysis on the new Aarams 1MV Tandetron. *Radiocarbon* 59, 905-13. <https://doi.org/10.1017/rdc.2016.85>
- Olsen, O. and Schmidt, H., 1977. *Fyrkat: en jysk vikingeborg. 1: borgen og bebyggelsen*. Copenhagen: Det Kgl. Nordiske Oldskriftsselskab.
- Perry, G., 2017. *Early Glazed Wares from Borgring, Denmark*. Unpublished report, University of Sheffield.
- Reimer, P., Austin, W.E., Bard, E., Bayliss, A., Blackwell, P.G., Bronk Ramsey, C., Butzin, M., Cheng, H., Edwards, R.L., Friedrich, M. and Grootes, P.M., 2020. The IntCal20 Northern Hemisphere radiocarbon age calibration curve (0-55 kcal BP). *Radiocarbon*, 779-820. <https://doi.org/10.1017/rdc.2020.68>
- Roesdahl, E., 1977. *Fyrkat: en jysk vikingeborg. 2: oldsagerne og gravpladsen*. Copenhagen: Det Kgl. Nordiske Oldskriftsselskab.
- Roesdahl, E. and Sindbæk, S.M., 2014. The purpose of the fortress. In: E. Roesdahl, S.M. Sindbæk and A. Pedersen, eds. *Aggersborg: The Viking-Age settlement and fortress*: 383-414. Højbjerg: Jysk Arkæologisk Selskab.
- Roesdahl, E., S.M. Sindbæk and A. Pedersen (eds.) 2014. *Aggersborg. The Viking-Age settlement and fortress*. Højbjerg: Jysk Arkæologisk Selskab. <https://doi.org/10.1080/00665983.2015.1112671>
- Runge, M., 2018. New archaeological investigations at Nonnebakken, a Viking age fortress in Odense. In: J. Hansen and M. Bruus, eds. *The fortified Viking Age: the 36<sup>th</sup> interdisciplinary Viking age seminar, Odense 2017*. Odense: Odense City Museums and University Press of Southern Denmark, 44-59. <https://doi.org/10.2307/j.ctv4t7z9h.8>
- Saxo, 2000. *Saxos Danmarkshistorie*. Oversat af Peter Zeeberg. Viborg: Det Danske Sprog- og Litteraturselskab and Gads Forlag.
- Schultz, C.G., 1949. Aggersborg. Vikingelejren ved Limfjorden. *Nationalmuseets Arbejdsmark* 1949, 91108.
- Sindbæk, S.M., 2014. The fortress. In: E. Roesdahl, S.M. Sindbæk and A. Pedersen, eds. *Aggersborg: the Viking-age settlement and fortress*: 139-208. Højbjerg: Jysk Arkæologisk Selskab. <https://doi.org/10.1093/ehr/cew194>
- Sindbæk, S.M., 2020. Borgring and Harald Bluetooth's Burgenpolitik. In: A. Pedersen and S.M. Sindbæk, eds. *Viking encounters: proceedings of the 18<sup>th</sup> Viking Congress*: 529-543. Aarhus: Aarhus University Press.
- Steensberg, A., 1943. *Ancient Harvesting Implements*. Nationalmuseets Skrifter, Arkæologisk-Historisk Række, Vol. I. København: Gyldendal.

- Stuiver, M. and Polach, H.A., 1977. Reporting of C-14 data. *Radiocarbon* 19, 355-63.
- Svanberg, F. and Söderberg, B., 1999. *Den vikingatida borgen i Borgeby*. Arkeologiska Studier kring Borgeby och Löddeköpinge 1. Lund: Riksantikvarieämbetet.
- Thedéen, S., 2012. Box brooches beyond the border: Female Viking Age identities of intersectionality. In: I.M. Back Danielsson and S. Thedéen, eds. *To tender gender: The pasts and futures of gender research in archaeology*: 61-81. Stockholm: Stockholm University.
- Thunmark-Nylén, L., 1983. *Vikingatida dosspännen, teknisk stratigrafi och verkstadsgruppering*, Archaeological studies 4. Uppsala: Uppsala University Institute of North European Archaeology.
- Thunmark-Nylén, L., 2006. *Die Wikingerzeit Gotlands III:2. Text*. Stockholm: Kungliga Vitterhets Historie och Antikvitets Akademien.
- Ulriksen, J., 2011. Fremmed indflydelse i vikingetid og tidlig middelalder (700-1150 e.Kr.). *Historisk Årbog for Roskilde Amt* 2011: 79-120.
- Ulriksen, J., Schultz, M.K. and Mortensen, M.F., 2020. Dominating the landscape: the emblematic setting of Borgring and the Viking age ring fortresses of Denmark. *Danish Journal of Archaeology* 9, 1-22. <https://doi.org/10.7146/dja.v9i0.116110>

## Supplementary

**Table 1.** Radiocarbon wiggle match of the A901 and A905 charred wood pieces.

see pdf-attachment