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Archaeological and ground penetrating radar investigations around Valjala, Pöide and Kaarma hill forts in Saaremaa

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Foundation Osiliana and Tallinn University started archaeological excavations around Valjala hill fort in Saaremaa in summer 2021, focusing on the areas outside the presently visible walls of the hill fort. By 2022, eight trenches were opened in various structures, including a sector of the outer main wall in the south-eastern part of the hill fort.

The new investigation of Valjala hill fort combined modern methods including GIS-systems, LiDAR data and high-quality aerial imagery provided by the Estonian Land Board, and ground penetrating radar, the latter in cooperation with OÜ Elermo. The program for investigating the mighty late prehistoric (the 11th–12th centuries) and early medieval (in Estonia the 13th–14th centuries) hill forts of Saaremaa was launched in May 2022 at three selected fortifications – Valjala, Kaarma and Pöide. Only part of the collected material has been analyzed by now, and combined with the results from earlier and ongoing archaeological excavations at Valjala hill fort. The first overview presented here focuses on defensive structures outside the presently visible hill forts.

RESEARCH BACKGROUND

Although the big hill forts in Saaremaa have raised attention among amateur archaeologists as early as in the 19th century, it has mostly been the central fortification that has been described and studied. Less attention was paid to the area around the hill forts. Still, drawings of Saaremaa hill forts published in *Necrolivonica* by Friedrich Kruse (1842, Tab. 62) depict the main hill forts with their nearest vicinity (Fig. 1). A clearly marked stone fence or low stone wall around the hill forts of Muhu and Pöide strikes the eye on these pictures.

No such wall around Valjala hill fort was described by Kruse, neither was it mentioned by Jean Baptiste Holzmayer, who studied the hill fort in the 1860s. On the other hand, Holzmayer

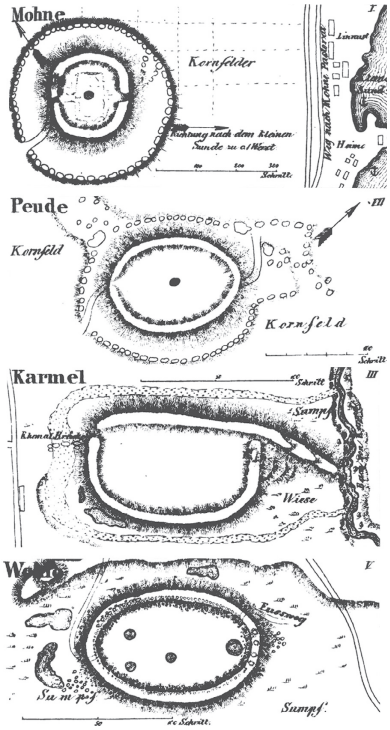

Fig. 1. *Some hill forts of Saaremaa in 'Necrolivonica'.*
Jn 1. *Mõned Saaremaa maalinnad „Necrolivonicas".*
Source / allikas: Kruse 1842, Tab. 62.

mentioned a 10–11 m wide dry moat around the rampart (Holzmayer 1868, 46–48). The outer wall was first described by Sergei Bogojavlenski and Reinhold Stackelberg in the end of the 19th century (Trudy, 27). According to them, a 0.5–0.75 m high additional wall surrounded the hill fort 30–35 m from the main wall. The same outer wall was mentioned by Alice Karu in 1924, with the remark that it was 0.5 m high by then and only visible in the northern side of the hill fort (SMM, 123). Aita Kustin, who excavated the hill fort in 1962 and 1964, focused entirely on the inner yard and partly on the inside of the main wall of the hill fort (Kustin 1963; 1966). After that, the area around Valjala hill fort has been overgrown by bushes and trees, and the outer wall was not observable until the late 2010s, when LiDAR maps were made available by the Land Board.

Holzmayer, who studied Kaarma hill fort in 1860, also noticed some presumably man-made structures outside it. He interpreted wet spots at the foot of the hill fort as remains of a moat that was once filled with water from a nearby river (Holzmayer 1868, 52–53). Some of these spots can also be seen on Kruse's drawing (Fig. 1). On the banks of the river, 35 m east from the hill fort, Holzmayer reported big stones on both sides, according to him probable supporters of a wooden bridge. A sandy plateau east of the river, with two sandy ridges and a gap or an entrance between them, could, according to Holzmayer, be interpreted as outer fortifications of the site (Holzmayer 1868, 54). Since the area east of the hill fort has unfortunately strongly been modified in the 20th century and is forested by now, no clear structures can be observed there in our time. Evald Tõnisson made some trial pits at the flat area west of the hill fort and reported a cultural layer from historical and possibly also prehistoric periods (Tõnisson 2008, 243). A surface survey trip to the same area in 2021 did not confirm the suggestion, and the cultural layer can just be connected with an inn that had been at the same place 100–200 years ago, or perhaps earlier.

In 1990, two trenches were opened outside the northeastern entrance of the Pöide hill fort: excavations A (40 × 1 m) and B (6 × 8 m) (Lõugas 1991). In one of them, remains of a building were detected, with some pottery sherds and a ring brooch from the 13th–14th century. Excavation leader Vello Lõugas dated the potsherds to the Pre-Roman Iron Age and the 8th–9th century (Lõugas & Mägi-Lõugas 1994b). A cultural layer and some remains of probable houses have also been recorded outside Valjala hill fort during test-pitting in 2008 and archaeological excavations in 2021 and 2022 (Fig. 2; Mägi 2008). Excavations B, C (2021) and H (2022) were trenches cutting the outer wall 1. ^{14}C analyses suggested that some activity had taken place outside the present Valjala hill fort as early as in the 5th–7th century, while most of the cultural layer in this area is dated to the 11th–13th century (Fig. 3).

The LiDAR images reveal a regular circular wall around the main rampart of two Saaremaa hill forts – Valjala and Kaarma (Figs 2, 4). The circular outer wall of Valjala hill fort has an outer diameter of about 193 m and the inner area of about 2.5 ha. The construction can still be seen, although it is not as high as described in the 19th century. A large part of its stones has probably been removed during the last century. The low outer wall around Kaarma hill fort is much less preserved and almost not visible on the terrain. It has been oval, with outer measurements approximately 193 (E–W) × 163 m, surrounding an area of ca. 2 ha.

No outer wall can be seen in LiDAR images around the hill forts of Pöide and Muhu. However, the local people remembered as late as in 1949 that there had been another wall around Pöide hill fort, which was removed around the year 1900 (Jaanits & Metsar 1949). It should be noted that the areas around these two hill forts have been subject to intensive cultivation and land improvement processes in the 20th century that may have levelled the remains of the walls. The surroundings of Valjala and Kaarma hill forts are uncultivated lands historically only used as pastures, meaning that no damage caused by land cultivation can be presumed.

LiDAR images of the Valjala and Pöide hill forts reveal that another lower and probably earlier ring-wall is partly visible under the latest hill fort walls. Both in Pöide and Valjala it can be seen right outside the northeastern part of the present hill fort, while a great part of the ring-walls must have remained under the last fortifications.

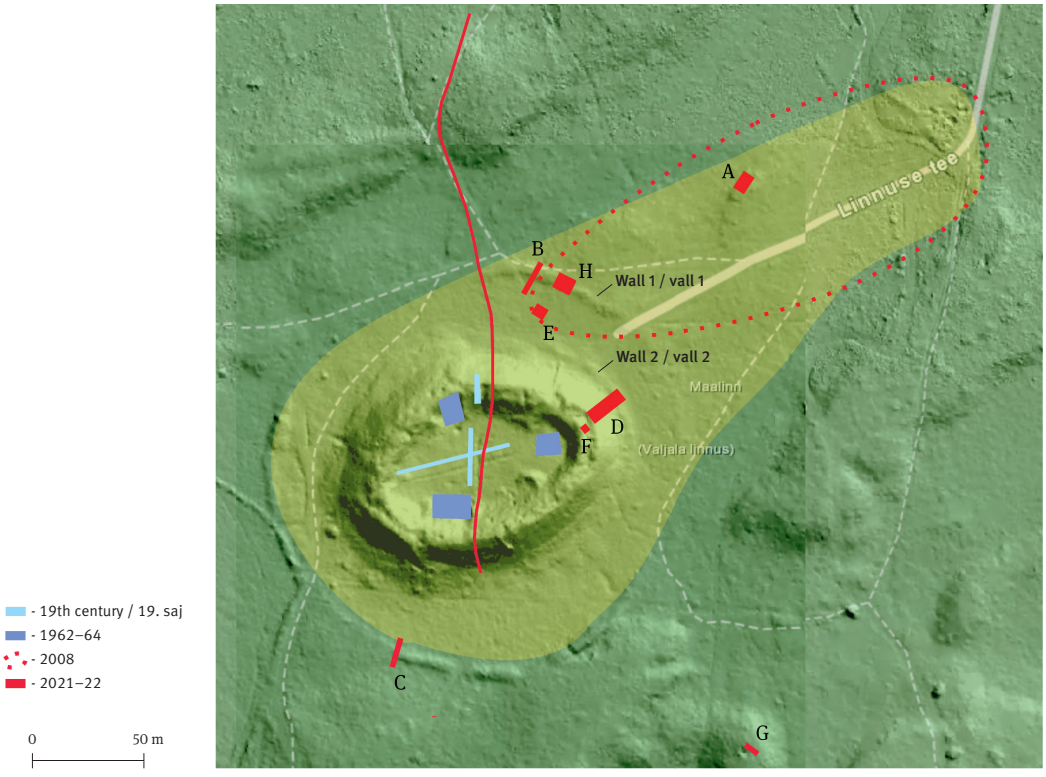

Fig. 2. *Archaeological excavations and test-pitting at Valjala hill fort and surroundings. The red line indicates GPR profile, yellow marks the area with a cultural layer, detected in 2008.*

Jn 2. *Arheoloogilised uuringud ja eeluuringud Valjala maalinnal ja ümbruses. Punase joonega on märgitud georadari profiil, kollasega 2008. aastal tuvastatud kultuurkihiga ala.*

Relief map by Estonian Land Board / Reljeefkaart Maa-amet, drawing / joonis: Marika Mägi

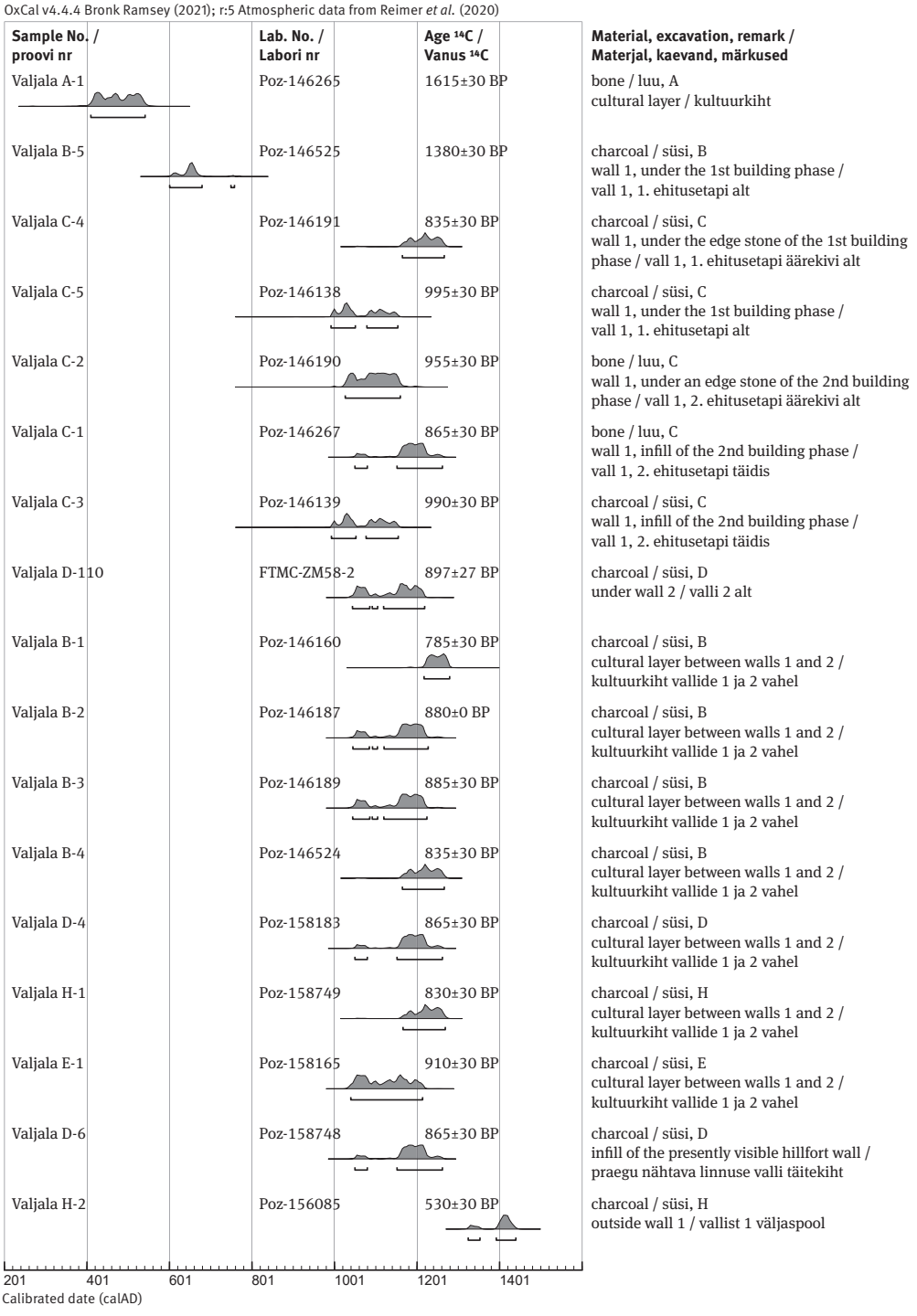

Fig. 3. *¹⁴C dates from outside Valjala hill fort.*
Jn 3. *¹⁴C dateeringud Valjala maalinna ümbrusest.*
Poznan Radiocarbon Laboratory and Vilnius Radiocarbon Laboratory / Poznani radiosüsiniku laboratoorium ja Vilniuse radiosüsiniku laboratoorium

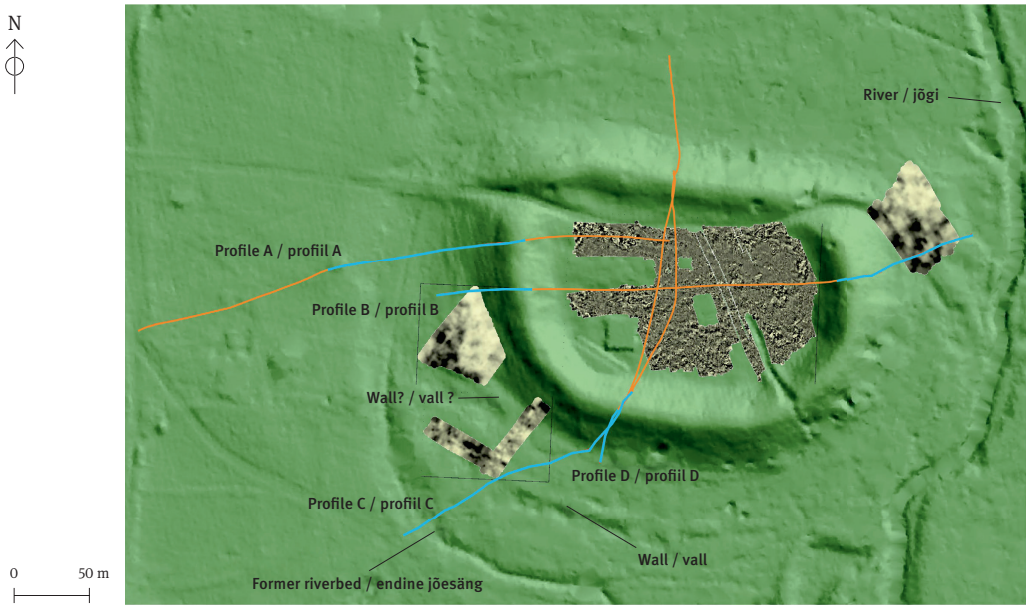

Fig. 4. *GPR investigations at Kaarma hill fort, profiles and slab images. The sections of profiles treated in the article are marked in blue.*
Jn 4. *Georadari uuringud Kaarma maalinnal, profiilid ja horisontaallõiked. Artiklis käsitletud profiilide osad on näidatud sinisega.*
Relief map by Estonian Land Board / Reljeefkaart Maa-amet, drawing / joonis: Marika Mägi

SELECTION OF AREAS AND METHODOLOGY FOR GROUND PENETRATING RADAR (GPR) SURVEY

The selection of areas for the investigation with non-destructive methods was based on the research history and observations described. Especially around Valjala and Kaarma hill forts the research areas were also greatly defined by the surface structure and vegetation, meaning that flat terrain without bushes, trees and high grass was preferred.

Two areas investigated by GPR outside Valjala hill fort (631 m² and 1239 m²) embraced two lower outer walls visible on the LiDAR images and the area between them in the northern and northeastern side of the big hill fort. It covered partly the excavation B from 2021. Two additional excavations, E and H, were opened in the same area in 2022.

The area outside Pöide hill fort, surveyed with ground-penetrating radar, covered 832 m² in the east-northeast of the big hill fort, immediately south of the excavations in 1990. The western part of the area embraced possible low wall remains right outside the hill fort that could be surmised from the LiDAR image.

At Kaarma hill fort, three separated areas outside the main fortification were chosen for the survey. One of those (601 m²) east-northeast of the main hill fort, right outside the north-eastern gate embraced some structures probably connected with the gate. Two survey areas were chosen west and southwest of the main hill fort. One of them (518 m²) covered the area between the rampart of the big hill fort and the possible outer wall. Another, an L-shaped survey area (343 m²) south of the latter touched the outer low wall visible on the LiDAR image and the area between it and the big hill fort. No archaeological excavations outside Kaarma hill fort have been conducted so far.

Various single beam and array GPR systems by *ImpulseRadar* were used for the survey. For deeper penetration, the uneven surface and generalization CrossOver730 antenna was used. It incorporates two channels with ultra-wideband frequencies centered around 70 MHz and 300 MHz. An internal GPS antenna was used for this radar (horizontal accuracy mostly ±0.5 m). Additionally, we also used PinPointR Dual channel operation 400 MHz (LF) and 800 MHz (HF) for detailed survey on more uneven surface sections. A more detailed survey covering a smoother surface was carried out by Raptor 8-channel 3D GPR Array with the 450 MHz frequency antenna. RTK-GPS system was used to position detailed GPR surveys with Raptor and Pinpoint systems (more detailed descriptions Tõnisson *et al.* 2022).

ViewPoint App for ImpulseRadar was used during field-surveys. ViewPoint is an Android-based data acquisition application that controls ImpulseRadar CrossOver and PinPointR antennas. Data analyses was carried out in GPR-Slice software (for Crossover and PinPointR radaras) and Talon 2 3D GPR Data Acquisition Software for Raptor.

For topocorrecting CrossOver radar profiles, we used LiDAR data by Estonian Land Board. Basically, we used the track file created by CrossOver730 radar, extracted LiDAR elevations from elevation model and replaced elevation values in the initial CrossOver730 track file. There was no need to use topocorrections for PinPointR and Raptor data as these were measured on almost smooth surface and original elevation data was collected by RTK-GPS system (accuracy 1–2 cm).

Accurate depths (for depressions, walls, undisturbed layer, etc.) for long GPR profiles were not given as there was not enough hyperbolas in critical locations. Some depths are described in text, when these were verified with previous excavations or simple coring. It needs further investigations (detailed coring, trenches) to give reliable depth values for all features described in the paper (Vilumaa *et al.* 2017).

ArcGisPro, Q-Gis and Mapinfo Professional were used to support GIS-data analyses.

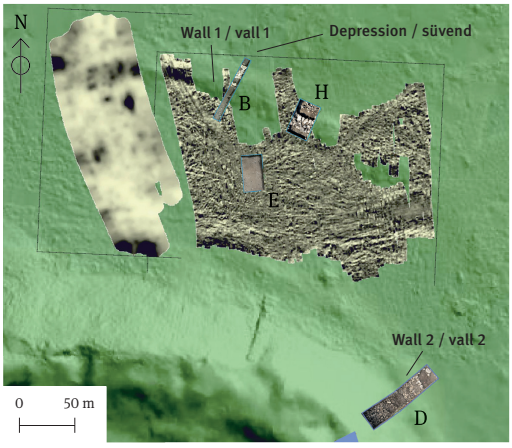

Fig. 5. *Excavations in 2021–2022 and GPR slabs outside Valjala hill fort.*

Jn 5. *2021.–2022. aasta kaevamised ja georadari horisontaallõiked Valjala maalinnast väljaspool.*

Relief map by Estonian Land Board / Reljeefkaart Maaamet, drawing / joonis: Marika Mägi, photos / fotod: Indrek Teppan, Janek Ojasaar

OUTER RING-WALLS AND OTHER STRUCTURES OUTSIDE THE HILL FORTS

Valjala

The ground-penetrating radar survey demonstrated two concentric outer wall remains (walls 1 and 2) northeast of Valjala hill fort (Fig. 5). The outer walls are 35–38 m and 7 m from the foot of the big rampart respectively, and 2–3 m wide.

The outermost wall (**wall 1**) has been archaeologically excavated in three places. Trenches B and H were opened right next to or at the same place as the GPR-survey. Trench B (11.6 × 1 m) cut the wall that was built of bigger stones, packed with clay (Fig. 6). The 3-m-wide wall had been intentionally demolished, as indicated by empty places of one-time boulders in the upper side of the clay. The foundation of the wall actually consisted of two parts, probably indicating

different stages of construction: an about 1.8 m wide stone foundation and another line of big stones 70–80 cm from it (Fig. 7). A layer of clay covered all the stones.

A similar picture opened in excavation C of wall 1 south-southwest from the big hill fort. The trench measured 7 × 1.1 m. The clay wall was 3 m wide, and its base consisted of big stones in two zones, one about 150–170 cm wide, and another line of boulders 60–70 cm from it (Fig. 8).

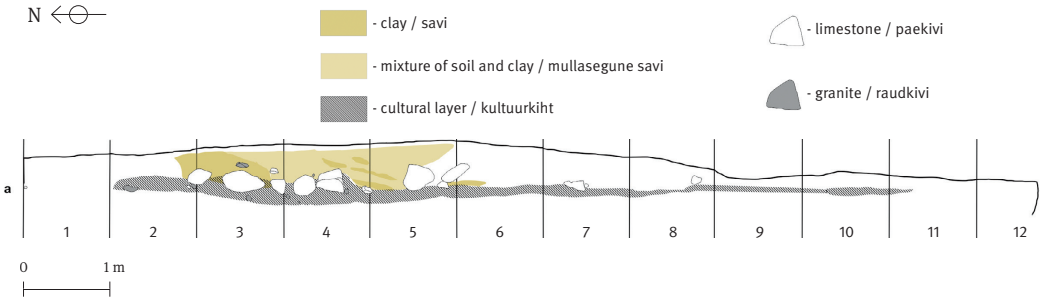

Fig. 6. *The eastern profile of excavation B at Valjala.*
Jn 6. *Valjala kaevandi B idaprofiil.*
Drawing / Joonis: Marika Mägi

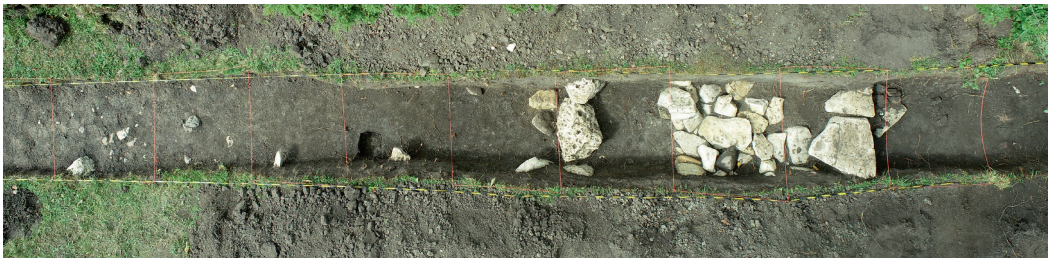

Fig. 7. *Wall 1 in excavation B at Valjala.*
Jn 7. *Vall 1 Valjala kaevandis B.*
Photo / Foto: Janek Ojasaar

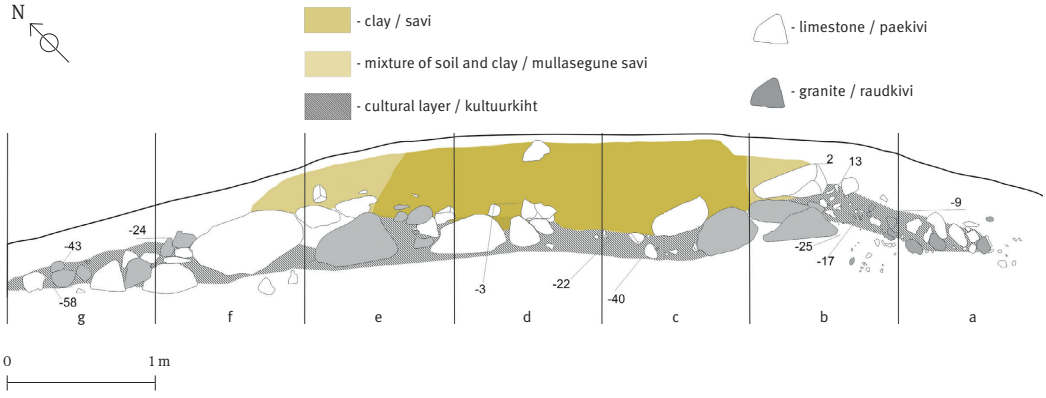

Fig. 8. *The eastern profile of excavation C at Valjala.*
Jn 8. *Valjala kaevandi C idaprofiil.*
Drawing / Joonis: Marika Mägi

Fig. 9. *Wall 1 in excavation H at Valjala.*
Jn 9. *Vall 1 Valjala kaevandis H.*
Photo / Foto: Indrek Teppan

Excavation H was opened in 2022 12 m east-southeast from B, and measured 4 × 3 m along wall 1. Surprisingly, a clay layer was missing here, and the well-preserved wall foundation was only 2 m wide (Fig. 9). It seems that wall 1 lacked later fortifications here, perhaps because the cultural layer continued further north-east in this section. Excavation H was close to a probable entrance in wall 1, visible both on LiDAR and ground-penetrating radar survey images. The gap in wall 1, about 6 m broad, remained 6 m east-southeast from H.

All trenches opening wall 1 revealed an intensive cultural layer underneath the wall itself as well as between the wall and the hill fort. Finds and ^{14}C analyses dated the cultural layer to the 11th–12th century, in one case to the 7th century (Fig. 3). In B and C, the cultural layer did not continue outside the wall, but excavation H also cut a corner of a probable building outside the ring-wall. ^{14}C analysis from it dated the building, however, to the early 15th century. Archaeological test-pitting in 2008 had indicated spots with a clear cultural layer at least up to 200 m north-eastward of the main hill fort, dated by a few finds mainly from the 11th–13th centuries (Mägi 2008).

The area outside wall 1 in excavation B was low and wet, suggesting that the clay used for building the walls may have been taken from there. It was confirmed by the long profile created with the GPR (Figs 2, 10). The profile indicated a man-made depression right outside the remains of wall 1. The outer bank of the depression had ca. 45 degree slope while the inner bank had an almost vertical slope, nearly like a wall. However, one coring indicated clay in the same location where GPR showed the depression. Clay was characterized by natural lamination, therefore, further investigation might be needed here.

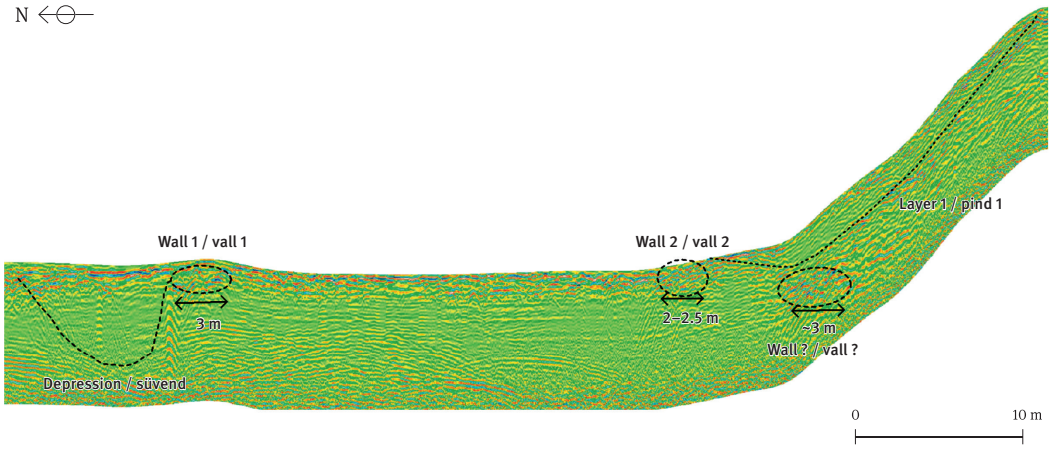

Fig. 10. *The northern part of GPR profile at Valjala hill fort.*
Jn 10. *Georadari profiili põhjapoolne osa Valjala maalinnal.*
Drawing / Joonis: Hannes Tõnisson, Olav Harjo

Both in the profile and on GPR slab images another wall, **wall 2**, can also be seen near the foot of the big hill fort. In the north-eastern and eastern side of the hill fort, it is also visible on LiDAR images, and was revealed in excavation D in 2022. As indicated by the excavations, it was 2.2 m wide (Fig. 11). It is possible that wall 2 has partly remained under the later walls of the hill fort, especially in the western part of it. The GPR profile suggests that the structure of wall 2 may have been very similar to wall 1. It seems that wall 2 indicated by GPR was approximately 2–2.5 m wide (Fig. 10).

Finally, another feature resembling a stone wall was visible on the GPR profile, 5 metres towards the centre of the fortification (Fig. 10), measured from the inner edge of wall 2. This wall is currently buried under the foot of the main rampart (approximately 1 m under the surface). Its dimensions (approximately 3 m wide) and pattern in GPR were very similar to walls 1 and 2. Another wall under the foot of the present hill fort, wall 3, was also opened in excavation D, but was only partly uncovered and will be treated closer after the excavations of 2023 will be finished.

Several rectangular anomalies between walls 1 and 2 were also observable on GPR images, suggesting probable buildings. Excavation E was opened at a place where there seemed to be a rectangular anomaly on the GPR image. As it was demonstrated by the excavation at a corner section of this anomaly, clayish soil really formed a right-angled zone there. Some potsherds and charcoal dated the structure, probable remains of a house, to the 11th–12th centuries (Fig. 3).

Other building remains were found in excavation A about 80 m northeast from H (Fig. 12), dated by ^{14}C to the 5th–6th centuries and by part of the find material to the 12th–13th centuries (Figs 3, 13). A small trial excavation G (3 × 1 m) was also made on an elevation ca. 110 m southeast of the big hill fort, but no cultural layer was detected there.

Fig. 11. *Wall 2 in excavation D at Valjala.*
Jn 11. *Vall 2 Valjala kaevandis D.*
Photo / Foto: Marika Mägi

Fig. 12. *Excavation A outside Valjala hill fort. Orange dots mark finds, mainly ceramic.*
Jn 12. *Kaevand A väljaspool Valjala maalinna. Oranžid täpid tähistavad leide, peamiselt keraamikat.*
Photo / Foto: Indrek Teppan, drawing / joonis: Marika Mägi

Fig. 13. *Finds from the excavations outside Valjala hill fort. Items 4 and 5 were found under wall 1.*
Jn 13. *Leide Valjala linnusest väljaspool olevatest kaevanditest. 4 ja 5 leiti valli 1 alt.*
1 – 2 – A, 3 – E, 4 – C, 5 – B.
(SM 10890: 119, 33, 215, 196, 182.)
Photo / Foto: Marika Mägi

Kaarma

The outer ring-wall around the Kaarma hill fort is hardly visible on LiDAR images, and the same is true for GPR images (Fig. 4). Four long profiles (A–D) were drawn over the walls of the hill fort, all of them also covering the area around the hill fort.

A former riverbed or a part of it can be seen in all profiles, except the northern part of profile C. GPR slab images suggest that there have probably been some constructions or buildings between the main wall and the former river distributary – possible stone walls or wooden fences. According to some data, long beams were found in 1917 when a ditch was dug for draining the former riverbed in the south-western side of the hill fort (SMM, 29).

GPR profile (Fig. 14) indicates that the initial fortification had a much steeper slope and maybe even some kind of moat or depression at the foot of the steep slope. It is likely that surface erosion over the centuries has smoothened the slope. The depression is, according to the GPR profile, approximately 5 m wide. When moving further towards the river-bed (to the west), several hyperbolas can be seen, usually indicating stones, a stone wall or sometimes pieces of wood (Tõnisson *et al.* 2022). This formation is 2.5–3 m wide. A few metres further west, an approximately 28 m wide section of the river-bed can be seen. The riverbed seems to have a 1–1.5 m thick layer of sediments. It looks heterogeneous with a number of hyperbolas visible. Assuming that the riverbed is filled with organic material, the hyperbolas are likely signs of buried pieces of wood.

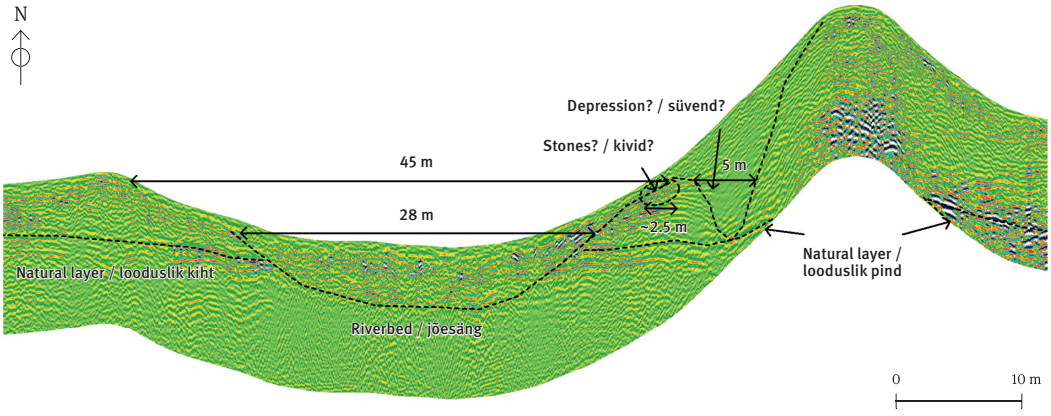

Fig. 14. *The western part of GPR profile A at Kaarma.*
Jn 14. *Georadari profiili A lääneosa Kaarmal.*
Drawing / Joonis: Hannes Tõnisson, Olav Harjo

The eastern bank of the riverbed seems to have a slightly stronger signal, perhaps indicating remains of the outer ring-wall.

In almost all profiles, a natural undisturbed layer can be observed. That kind of continuous layers sometimes indicate the ground-water level, but here it is obvious that the riverbed is quite clearly cutting into the layer. It suggests that the layer is undisturbed.

Profile C ran through the southwestern area outside the hill fort (Fig. 15). Here the riverbed remained slightly further from the hill fort, but many other features were similar with the ones in profile A. The same natural layer can be observed below the present surface, and stones, a stone wall or wooden logs (covering up to a 5 m wide area) can be suggested close to the hill fort foot. Another wall seems to have been further away from the hill fort and is also visible on LiDAR images. It is ca. 9 m wide and its internal structure looks very different. Features that characterize the possible outer wall on the GPR image normally indicate very compacted silt or clay (Tõnisson *et al.* 2020). It is possible that the outer wall was built of clay or silt. Between the two walls there has possibly been a small depression, just at the outer side of the inner wall. Outside the outer ring-wall the old riverbed is visible.

There are two more GPR profiles in the western and south-western side of Kaarma hill fort (profiles B and D). A similar pattern of features as in profiles A and C can be seen in profiles B and D as well. The outside slope of the big hill fort wall had been steeper, and under the steep slope, in one case a small depression and remains of an additional wall can be observed, in another case the depression is not visible, but remains of a wall are very clear (Fig. 16). The wall at the foot of the hill fort seems, in profiles B and D, have been 3–5 m wide, and can be surmised from the LiDAR image as well. In profile B it looks more like a clay wall, while in profile D it looks more like a wall made of stones or logs, or perhaps clay. The outer ring-wall can be seen in profile B.

The eastern part of profile B (Fig. 17) indicated a second wall along the eastern entrance that is also depicted on Kruse's drawing. It is partly removed, but still visible on LiDAR images, and has once reached down the river, to the place where Holzmayer reported of bridge remains and where a bridge stands also in our days. Unfortunately, the signal of GPR was not clear here, perhaps because the compact silty/clay part of the wall had been removed.

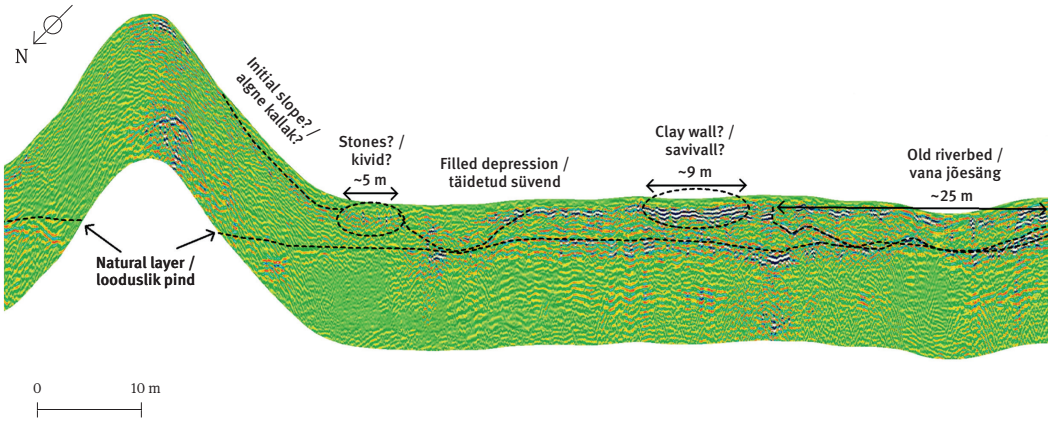

Fig. 15. *The south-western part of GPR profile C at Kaarma.*
Jn 15. *Georadari profiili C edelaosa Kaarmal.*
Drawing / Joonis: Hannes Tõnisson, Olav Harjo

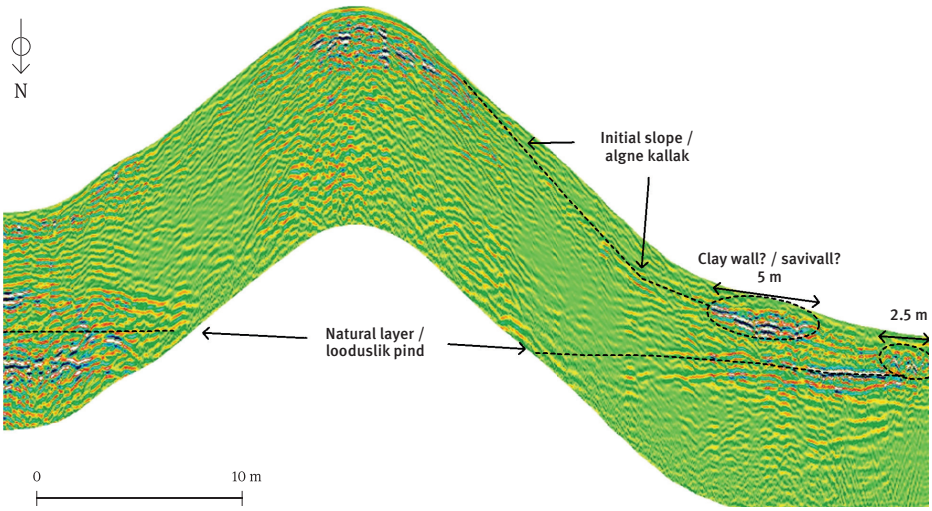

Fig. 16. *The western part of GPR profile B at Kaarma.*
Jn 16. *Georadari profiili B lääneosa Kaarmal.*
Drawing / Joonis: Hannes Tõnisson, Olav Harjo

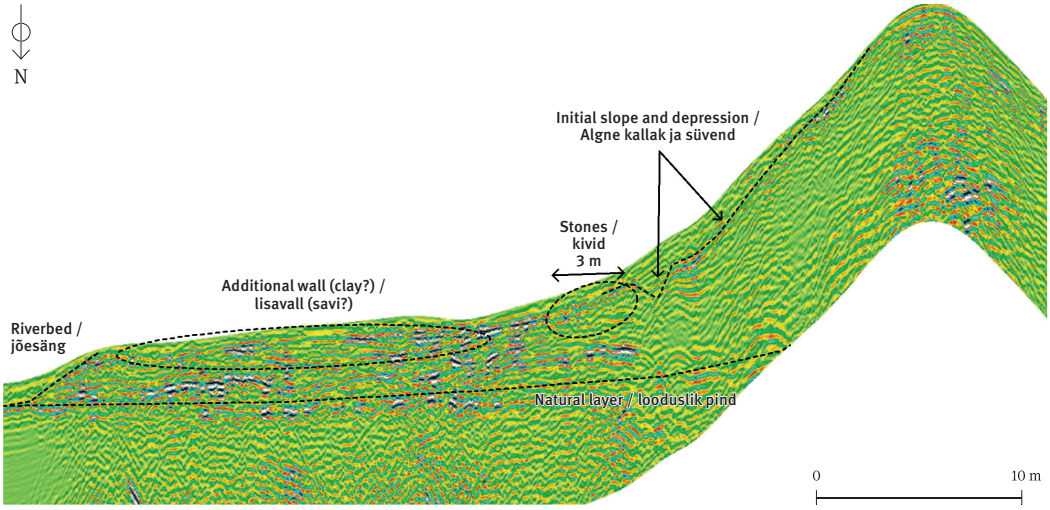

Fig. 17. *The eastern part of GPR profile B at Kaarma.*
Jn 17. *Georadari profiili B idaosa Kaarmal.*
Drawing / Joonis: Hannes Tõnisson, Olav Harjo

It is also a much wider formation compared with the walls presumed in the western and south-western side of the hill fort. It is possible that the top of the additional wall between the northeastern entrance of the hill fort and the river had been artificially smoothened.

Pöide

At Pöide, where no outer ring-wall can be seen on LiDAR images, the long profile with radar revealed that it may still have been there. What is more, the location of about a 2-m-wide anomaly visible in the GPR profile (probable stone wall) fits very well with the wall or stone

fence marked on the drawing of Pöide hill fort by Kruse in 1842 (Fig. 18). On the GPR slab image outside the hill fort, a rectangular structure is visible and fits well with the house foundation recorded during the excavations in 1990 (Fig. 19).

One can see from the north-eastern part of the GPR profile (Fig. 20) that there have probably been two about 2-m wide stone walls outside Pöide hill fort, one close to the foot of the big hill fort (wall 2) and another about 13 m further away (wall 1). Both can also be observed on GPR slab images (Figs 18–20).

The GPR profile (Fig. 20) also indicates that right outside wall 1 remains in the north-eastern side of the hill fort a ca. 7 m broad depression or ditch can be located. Similar to the signal in Valjala, the depression's gentler slope was further away from the hill fort and its steeper slope was just at the edge of wall 1.

On the long GPR profile, walls 1 and 2 were 3–4 m wide. That is slightly wider compared to GPR slab images. It might be the effect of just one profile (a slab image consists of a number of profiles) or some deeper reflections. These deeper reflections are not visible on the slab image as slab images show the layer only from a fixed (chosen) depth.

Walls 1 and 2 can be detected at the south-western side of Pöide hill fort as well (Fig. 21). Here the signal was not so clear due to the intensive land-use of the area. Some stronger GPR signals suggesting remains of stone walls were found at similar distances from the hill fort as in the north-eastern part of the profile. However, it was not possible to detect any depressions outside wall 1, while there was a very weak signal suggesting a possible depression just outside wall 2. In terms of dimensions, the width of the possible ring-walls is very similar on both sides of the hill fort.

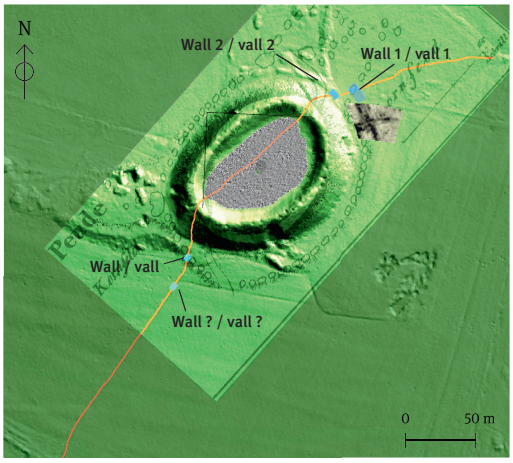

Fig. 18. *The hill fort of Pöide with Kruse's drawing, GPS profile and slab images. Possible wall remains indicated in the profile are marked in blue.*
Jn 18. *Pöide maalinn koos Kruse joonisega, georadari profiili ja horisontaallõigetega. Sinisega on märgitud profiilis näha olevad võimalikud vallikohad.*
Relief map by Estonian Land Board / Reljeefkaart Maaamet, drawing / joonis: Marika Mägi

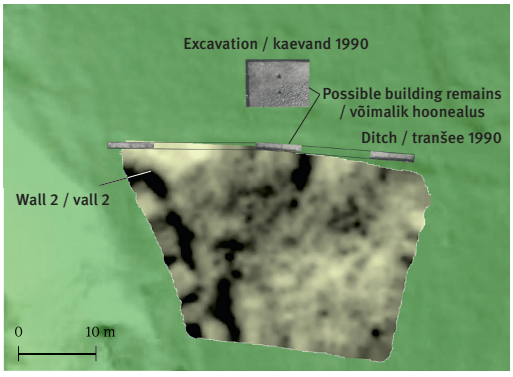

Fig. 19. *Photos of excavations in 1990 and GPR slab images north-east from Pöide hill fort.*
Jn 19. *1990. aasta kaevamiste fotod ja georadari horisontaallõige Pöide maalinnast kirde pool.*
Relief map by Estonian Land Board / Reljeefkaart Maaamet, drawing / joonis: Marika Mägi, photos / fotod: Rein Kärner

The GPR slab image north-east from the hill fort demonstrated some additional structures under the foot of the presently visible hill fort (Fig. 19). 3–4 m wide regular rectangular structures probably formed an earlier wall construction. It may be wall 2 near the foot of the presently visible hill fort that could also be observed in the GPR profile.

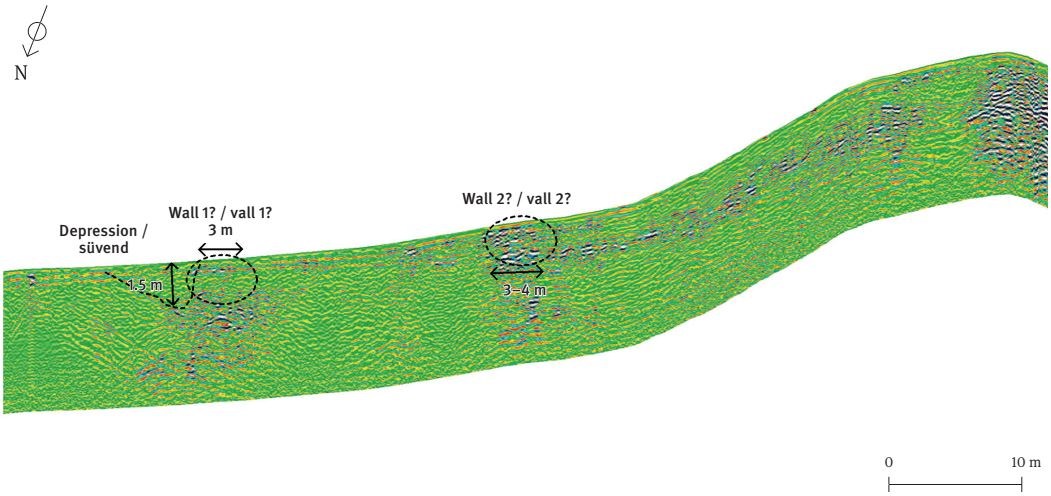

Fig. 20. *The northeastern part of GPR profile at Pöide hill fort.*
Jn 20. *Georadari profiili kirdepoolne osa Pöide maalinnal.*
Drawing / Joonis: Hannes Tõnisson, Olav Harjo

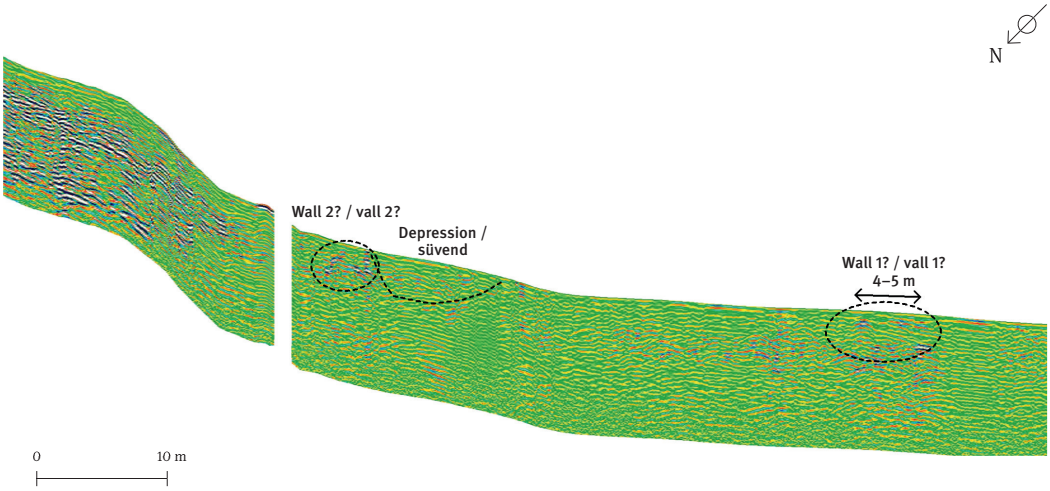

Fig. 21. *The southwestern part of GPR profile at Pöide hill fort.*
Jn 21. *Georadari profiili edelapoolne osa Pöide maalinnal.*
Drawing / Joonis: Hannes Tõnisson, Olav Harjo

DISCUSSION

Simultaneous investigations at three big late prehistoric – early medieval hill forts in Saaremaa enabled to draw several parallels between these sites, especially when combining different non-destructive methods and the knowledge of both earlier and ongoing archaeological excavations. All three hill forts appeared to be similar in several aspects, revealing regular features that can potentially characterize not only the three selected sites but other similar hill forts in Estonia.

The massive circular ramparts presently visible proved to be only the latest stage in the development of the hill forts at Valjala, Kaarma and Pöide. At least two earlier concentric stone walls outside the hill fort itself were archaeologically detected in Valjala and were observable on GPR images at Pöide. Walls 1 and 2 of both Valjala and Pöide were 2–3 m wide stone walls with probable timber construction on top of them.

The trenches at Valjala demonstrated two building phases of wall 1 in excavations B and C, where the originally about 2 m wide wall had been rebuilt as a 3 m wide clay and stone wall, probably in the 13th century. The width of the wall from the latest phase suggested the height of about 3 m as well. The later phase was missing in excavation H, perhaps because the section of wall 1 where excavation H was opened was in higher ground where remains of buildings were revealed in both sides of the wall. Test-pitting from 2008 had indicated that spots of a cultural layer can be found along the higher ground as far as 200 m from the main hill fort (Mägi 2008). The area further north-east has not been studied yet.

A similar wall 1 at Pöide has not been excavated, but it appeared to be 3–5 m wide on GPR images. Whether the fortification was built in different phases is not known. In any case, considering the character of the soil at Pöide, the possible fortifications could hardly have been of clay. At Kaarma, similar walls seem to have been partly built of clay or silt from the very beginning, although probable stone walls were also detected by GPR. The soil around Kaarma hill fort contains clearly less stones than can be found around the other two hill forts. At the present stage of investigation, it seems, however, that concentric ring-walls similar to those in Valjala and Pöide had also existed in Kaarma, but were erected of available material, that is, mainly of clay or silt.

When stone constructions normally appeared quite clear on GPR images, it was much more problematic to interpret other features visible in the recordings of the ground penetrating radar. The possible ring-wall remains at Kaarma must, therefore, be considered less certain constructions and need to be confirmed by further archaeological excavations.

The uncertainty in interpreting the GPR results is also valid for depressions that were recorded in the GPR profiles at all the hill forts. It is difficult to decide whether a depression outside walls 1 at Valjala and partly Pöide indicated regular moats or these were places where material was gathered for erecting the walls on or around the hill forts. It can still be noted that at Valjala the area outside excavation B had very steep sides, indicating that it was artificially deepened. The construction of the last great walls at Valjala needed massive soil material that was presumably dug out as close to the hill fort as possible. Excavations B, C and D demonstrated that the walls of clay or clayish soil had been mostly built of soil forming the cultural layer with a lot of charcoal and some artefacts in it. Quite clearly the soil from an area with former human activity had been collected to the walls.

The earliest finds or ^{14}C analyses from Valjala trenches are from the 5th–6th centuries (Fig. 3); the lack of proper excavations at Kaarma does not allow us to decide whether the situation is the same there or not. Finds and analyses[1] inside and outside Pöide hill fort indicate human activity there in the 7th–8th centuries, but it is not known whether fortifications existed there in the earliest period of inhabitation. In Valjala, such early activities have only been recorded outside the big hill fort, mainly in excavation A.

A cultural layer was detected under walls 1 and 2 at Valjala, as well as outside and between the walls. It is almost entirely dated to the 11th–13th centuries, that is, to the same period as the infill material used for building the latest walls of the hill fort. At least one ^{14}C sample

[1] Poz-135553, 1300±30 BP, calibrated with OxCal v.4.4.4 using intCal20 calibration curve 660–774 AD (95.4% probability).

(Valjala B-1) indicated activity between walls 1 and 2 probably in the middle or second half of the 13th century (Fig. 4). The majority of the finds at Pöide belong to the 11th–13th century as well, as do the two known finds from Kaarma hill fort (Lõugas & Mägi-Lõugas 1994a; 1994b; Tõnisson 2008, 242–243). It is clear that the first outer ring-walls 1 and 2 at Valjala were built not before the 12th century, most likely in the second half of it. The fortifications were then rebuilt at least once in the 13th century. Considering the similarity of the outer fortification systems at Pöide and Kaarma, the same can be suggested for these hill forts.

Valjala in the 13th century thus consisted of different parts: a very strong hill fort in the middle and buildings around it surrounded by a weaker wall, covering an area of at least 2.5 ha. Buildings were also outside the outmost wall in the eastern and north-eastern side. Buildings and a cultural layer have also been registered outside Pöide hill fort (Lõugas 1991), and can potentially have existed outside Kaarma hill fort as well.

Evidence of weaker fortifications surrounding an area with buildings outside the big hill forts, as well as cultural layers outside these fortifications fits very well with some remarks in the 13th-century chronicles, notably the Chronicle of Henry the Livonian and the Older Rhymed Chronicle of Livonia. It is only for hill forts in Saaremaa and the lower reaches of the Daugava River where Henry the Chronicler uses the Latin term *urbs*, roughly meaning 'town'. Particularly in Saaremaa there had been, according to the chronicler, many *urbi*. The biggest of them was apparently Valjala, but in Muhu there was an *urbs* as well (HCL XXX: 4, 5). It has been suggested so far that the chronicler for some unknown reason used the term *urbs* parallel with the term *castrum* (hill fort), although he never used the *urbs* word for hill forts in other areas but Saaremaa and the lower reaches of the Daugava.

Reading the Chronicle of Henry of Livonia with the knowledge acquired by the latest investigations at Saaremaa hill forts, it can be noted that the terms *castrum* and *urbs* need not necessarily be synonyms, but can also refer to two different phenomena connected to each other. *Urbs* at Muhu and Valjala may have denoted the whole complex, where *castrum* was the central hill fort, or may have only denoted the built-up area partly surrounded by smaller fortifications near or around the big hill forts. The same may be true for Kaarma, mentioned in the Older Rhymed Chronicle that was written in Low German. The fortification conquered and plundered in 1261 was called *hagen*, a term normally used for somewhat weaker fortifications of wood (LVR, 6170–6314). However, closer interpretation of Kaarma hill fort and its surrounding remains a subject for future studies.

CONCLUSIONS

LiDAR images compiled with ground-penetrating radar survey are innovative tools that have only occasionally been utilized for investigating prehistoric hill forts in Estonia so far. GPR images of archaeological sites are always characterized by specific features slightly different in different areas. The methodology can thus improve with every new study and has potential to enhance abruptly our knowledge of prehistoric sites.

The presently visible hill forts in Pöide, Valjala and Kaarma are comparable in size and date. All of them were predominantly used in the 12th–13th centuries, there are similarities in their location in cultural landscape and in the main fortifications. Combination of non-destructive methods and archaeological excavations demonstrated that similarities also existed in other features characterizing these fortifications, e. g. in buildings and other constructions around the main hill forts. The new interpretations are also in better correlations with the way how some of these sites have been described in written sources.

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ARHEOLOOGILISED JA GEORADARI UURINGUD VALJALA, PÖIDE JA KAARMA MAALINNA ÜMBRUSES SAAREMAAL

Marika Mägi, Hannes Tõnisson ja Olav Harjo

Saaremaa suured maalinnad on pälvinud tähelepanu eeskätt seoses võimsate kindlustistega, mis on nähtavad tänapäevani. Hoopis vähem, kui üldse, on uuritud maalinnade lähiümbrust.

Esimesed kaevamised Valjala maalinnal toimusid juba 19. sajandi teisel poolel ning seejärel uuriti muistist 1960. aastatel. Alates 2021. aastast viib linnuse ümbruses ja osalt ka linnuse suure valli välisküljel arheoloogilisi kaevamisi läbi SA Osiliana koostöös Tallinna Ülikooliga. Üheaegselt kaevamistega Valjalas algasid georadariuuringud nii sellel kui ka kahel teisel, Pöide ja Kaarma, maalinnal. Käesolev artikkel on esimene ülevaatlik kokkuvõte nende uuringute käigus kogutud materjalist, keskendudes hetkel üksnes linnustest väljapoole jäävatele struktuuridele.

1842. aastal ilmunud raamatus Necrolivonica on toodud ära Saaremaa peamiste maalinnade plaanid (jn 1). Muhu ja Pöide linnuste ümber on märgitud kiviaed või vall, mis tänapäeval pole enam nähtav. Sarnast madalat valli ümber Valjala maalinna on

mainitud 19. sajandi lõpul ja 20. sajandi esimestel kümnenditel. Reljeefkaartide laiemal kasutuselevõtul ilmnes, et vall on Valjala maalinna ümber hästi jälgitav (jn 2). Sarnane moodustis näib olevat olnud ka Kaarma maalinna ümber (jn 4).

Georadariuuringuteks valitigi välja lisaks linnuste õuealadele mõned paigad linnuste ümbruses. Kasutati erinevaid ImpulseRadari süsteeme ning programme, mis võimaldasid luua eri kõrguste horisontaallõikeid ning 2D profiile. Andmete analüüsiks kasutati programme ArcGisPro, Q-Gis ja Mapinfo Professional.

Valjala maalinna ümbruses osutas georadar kahele praegusest maalinnast väljapoole jäävale ringvallile (vall 1 ja 2), mis mõlemad on näha ka Maaameti reljeefikaartidel (jn 2). Vallide vahelisel alal võis kohati tõdeda ebamääraseid anomaaliaid, võimalike hoonete jäänuseid (jn 5). Neid andmeid toetasid ka arheoloogiliste uuringute tulemused. Valli 1 lõikasid 2021.–2022. aasta kaevandid B, C ja H. Selgus, et see on algselt rajatud u 2 m laiuse kivivallina, mille peal on tõenäoliselt olnud puittara (jn 6–8). Hiljem on valli pea meetri jagu laiendatud ja seega ilmselt ka kõrgendatud. Uus vall püstitati peamiselt savist, mille sees leidus suuremaid kive. Täiendav savivall puudus kaevandis H. Vallilõik, kus kaevand H avati, paiknes kõrgemal alal, kus kultuurkiht hoonete jäänustega jäi vallist mõlemale poole (jn 9). 2008. aasta arheoloogiliste eeluuringute käigus oli juba varem tuvastatud mitmeid kultuurkihi laike vähemalt kuni 200 m suurest linnusest kirde ja ida suunas.

Vall 2 paljandus kaevandis D. See on nähtav ka nii reljeefkaardil kui ka georadari horisontaallõigetel (jn 10–11). Georadari profiilis ilmneb u 3 m laiune kivikiht või vall ka linnuse suure valli all. Umbes samast kohast tuli kaevandis D välja vall 3.

Vallide 1 ja 2 vahel oli kõikjal uuritud alal tegemist kultuurkihiga. Selles alas avati kaevand E, kust saadi tõenäolise hoone jäänused ning mõned savinõukillud. Kaevandis A linnusest mõnekümne meetri kaugusel puhastati samuti välja tõenäoline hoone alus, kus oli silmatorkavalt rohkesti leide, peamiselt erinevatest sajanditest pärinevat keraamikat (jn 12–13).

Kultuurkiht ulatus ka vallide 1 ja 2 alla. Sellest saadi nii söeproove kui ka esemeleide, mis enamasti dateeriti 11.–13. sajandisse, ühel juhul ka 7. sajandisse (jn 3).

Kaarma linnust ümbritsevad vallid on reljeefkaardil hoopis halvemini jälgitavad ega ilmnenud selgelt ka georadari uuringutes (jn 4). Linnuse jalamil võis georadari profiilidel siiski näha tõenäolist alumist kivivalli ning praegu näha olevast linnusevallist veidi eemal arvatava savist valli jäänuseid (jn 14–17). Kahel profiilil joonistus selgelt välja mattunud jõesäng Kaarma linnusest läänes ja edelas – rajamisajal on linnus paiknenud jõesaarel. Kaarma linnust ei ole kaasaegsete meetoditega arheoloogiliselt kaevatud ning mitmed georadariuuringute tulemused vajavad seetõttu täiendavat testimist.

Linnust ümbritsevad ringvallid ilmnesid georadariuuringutel ka Pöidel. Linnusest väljapoole jääval alal tuli horisontaallõigetel välja ühe valli alus vahetult praeguse valli jalamil ning teine sellest mõnevõrra väljapool. Mõlemad olid jälgitavad ka georadari profiilis (jn 18–21). Horisontaallõikel nähtav nelinurkne anomaalia liitus 1990. aastal linnusest väljaspool avatud kaevandis paljandunud hoonealusega (jn 19).

Georadari uuringud osutasid, et Valjala, Kaarma ja Pöide linnused on olnud ehitatud võrdlemisi sarnaselt. Kõikidel juhtudel on praegu näha oleva valli ümber nõrgemini kindlustatud ringvallid, mis osalt on olnud kasutuses linnuste hiliseima järguga üheaegselt. Kultuurkiht ja hoonejäänused nende ümbritsevate vallide vahel Valjalas ja Pöidel lubavad oletada sama ka Kaarma kohta.

Saaremaa linnused koosnesid hiljemalt 13. sajandil seega nii kesksest tugevast linnusest kui ka seda ümbritsevast või selle kõrval paiknenud hoonestatud alast, mis oli osaliselt samuti ümbritsetud ringvalliga. Sellisele jaotusele viitavad ka kirjalikud allikad, eriti Läti Henriku kroonika, kus Saaremaa ja Väina jõe alamjooksu linnuseid nimetatakse erandlikult nii linnuseks (*castrum*) kui ka linnaks (*urbs*). Ilmselt pidaski kroonik silmas eri asju, mis küll paiknesid koos või lähestikku.