DISSERTATIONES ARCHAEOLOGICAE

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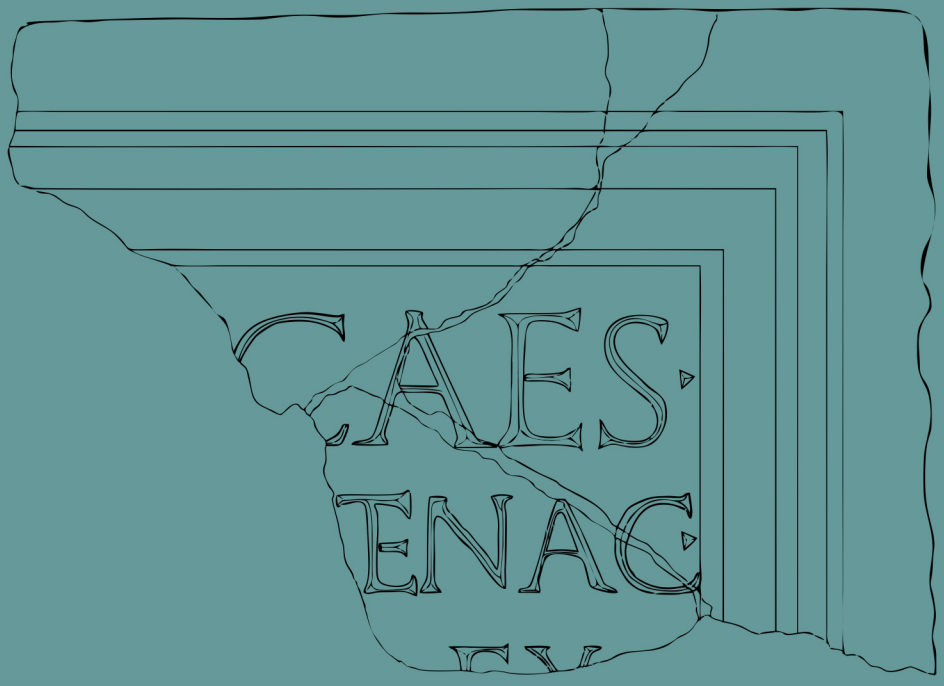

FIRKáK IV.

Fiatal Római Koros Kutatók IV. Konferenciakötete

Proceedings of the 4th Conference for Young Researchers of Roman Age

Supplementum 1. | 2018

Dissertationes Archaeologicae
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Proceedings of the Conference for Young Researchers of Roman Age

Pécs, 26.11.2010 – 28.11.2010

Visegrád, 10.11.2011 – 11.11.2011

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Dávid Bartus and Katalin Boruzs

Budapest – Visegrád 2018

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Előszó – Foreword

Idén immár 12. alkalommal került megrendezésre a Fiatal Római Koros Kutatók Konferenciája, de az elhangzott előadások írott (hagyományos, papír alapú) formában történő megjelenése még sok esetben várat magára. Az első, 2006-ban tartott konferencia óta, melynek előadásai könyv formában már 2007-ben megjelentek, az utóbbi időben az aktuális konferencia és a kéziratok nyomdába kerülése között igen hosszú idő telt el. Ez több szempontból is hátrányos: egyrészt elmarad az új kutatási eredmények közzététele, amik a technika gyors fejlődésének köszönhetően gyakran már 1–2 év távlatából is elavultnak, túlhaladottnak számítanak. Másrészt csökkenhet a publikálási kedv, ami a konferencián elhangzottak szűk körben maradását vonja maga után, esetleg színvonalcsökkenést is.

A 2006-ban indult kezdeményezés, miszerint a római korral foglalkozó, kezdő kutatóknak is szükségük van saját fórumra, bebizonyította, hogy életképes. Az elnöki tisztséget betöltő egyetemi oktatók, elismert szakemberek biztosítják a rendezvények színvonalát, a „fiatalok" gyakorlatot szereznek az előadások készítése és prezentálása valamint a publikálás terén is. Éppen ezért is kifogásolható, hogy az elhangzottak nem „napra készen" jelennek meg. Ezt a „hibát" igyekszünk most kiköszörülni: jelen kötet nyomdába kerülésével a FIROKONF-on elhangzottak 2012-ig terjedően (az I–VII. konferenciáig) nyomtatott verzióban is elérhetőek. Célunk kivitelezéséhez hozzájárultak azok a kutatók, akik ennyi év eltelte után is bíztak a pozitív végkifejletben és rendelkezésünkre bocsátották kéziratait.

Reméljük, hogy a 2014 óta tartott konferenciák szervezői is optimistán állnak a manapság mostohagyerekként kezelt könyvkiadáshoz és minél hamarabb megtalálják a módját a publikációk megjelentetésének.

A FiRKÁK IV. kötete két rendezvény eddig nem publikált tanulmányait adja közre, emellett színesíti egy korábbi konferenciakötetből kimaradt kézirat, valamint Patay Pál Soproni Sándorra emlékező rövid írása, amivel Visegrád római korának jeles kutatója előtt szeretnénk tisztelegni.

Visegrád, 2018 áprilisában

Boruzs Katalin

Papers presented at the conferences

5th Conference for Young Researchers of Roman Age

26.11.2010–28.11.2010
Organizer: University of Pécs, Faculty of Humanities
Venue: Pécsi Kulturális Központ, Dominikánus Ház

Hoppál Krisztina: Minden út Kínába vezet? Avagy a Római Birodalommal kapcsolatba hozható régészeti leletek problematikája

Gábli Cecília: Plinius a gemmákról

Tóth István Zsolt: Beszámoló a Pécs Janus Pannonius u. 10. (Rózsakert) területén végzett 2010. évi régészeti kutatásokról

Borhy László – Számadó Emese – Dévai Kata – Bózsa Anikó: Brigetio polgárvárosának II. számú temetője (Komárom, Mártírok útja, Lidl)

Szabó Ernő: A collegiumok temetkezési hozzájárulása Pannoniában

Nagy Levente: Római lelőhelyek védetté nyilvánítása 2001 és 2009 között

Lassányi Gábor: Pannonia kifosztása

Wilhelm Gábor – Sóskúti Kornél: A Kiskundorozsma-Nagyszék lelőhelyen előkerült szarmata települések (2-5. század) római készítésű kerámiaanyaga

Vámos Péter: Észak-afrikai applikált díszű edények Aquincumban

H. Harsányi Eszter: Fehér a feketén – avagy hogyan kerül az ige a pohárra?

Szabó Ádám: Silvanus a sötét Pan

Bíró Szilvia: Földbe mélyített házak Pannoniában önálló településtípus vagy helyi jellegzetesség?

Csapláros Andrea – Neuhauser Tina: „Határok nélküli kultúra Noricum és Pannonia között"

Csiki József Attila: Környe község topográfiája archív légifotók alapján

Fehér Bence: Germanus, Respectus, Adiutor és a többi

Agócs Nándor: Augustalis testületek a Duna-vidéki tartományokban

Szabó András: Auxiliaris centuriok és decuriok

Farkas István Gergő: Újabb adatok a pannoniai auxiliaris csapatok titulatúrájának vizsgálatához

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Szabó Máté – Pánczél Szilamér: Rómaiak a Székelyföldön

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Bartus Dávid: Bronzszobrok Brigetióból

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Merczi Mónika: Újabb sírok a nyergesújfalui tábor késő római temetőjéből

Hullám Dénes: Római tárgyak a Kárpát-medencei Barbaricum északkeleti részéről

6th Conference for Young Researchers of Roman Age

10.11.2011–11.11.2011
Organizer: King Mathias Museum of Hungarian National Museum
Venue: Visegrád, Királyi Palota lovagterme

Buzás Gergely: Római kövek a középkorban

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Prohászka Péter: A Vértesketheli 4. századi éremlelet: lehetőségek a rekonstrukcióra

Torbágyi Melinda: Pénzforgalmi kutatások a római kori Magyarországon

Geophysical investigations of Roman rural sites in the vicinity of Pécs (Baranya County, Hungary)

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Abstract

In our study, we want to present the methodological background and the results of geophysical investigations of the Roman rural sites at Bakonya-Csucsa-dűlő, Cserdi-Horgas-dűlő and Szabadszentkirály-Gerdei-árok partja near Pécs (Baranya County, Hungary), conducted in recent years.

Introduction

The Roman sites at Bakonya, Cserdi and Szabadszentkirály were known from different sources, therefore their research level also differs, however all three places have been defined by field survey or aerial archaeology as a Roman villa site *(Fig. 1)*.[1] In addition to better understanding these sites,

1 In summary, see Szabó 2014

recent researches, using especially non-invasive archaeological methods focused on analysing the role they played in the region, as well as their impact on the landscape and environment. In this respect, besides aerial archaeology,[2] geophysical survey provides information.

Various geophysical methods were used at the presented sites in the researches carried out between 2012 and 2015. Beyond the archaeological data-extraction, understanding of methodological issues also drove our researches. In our study, we present these results site by site.

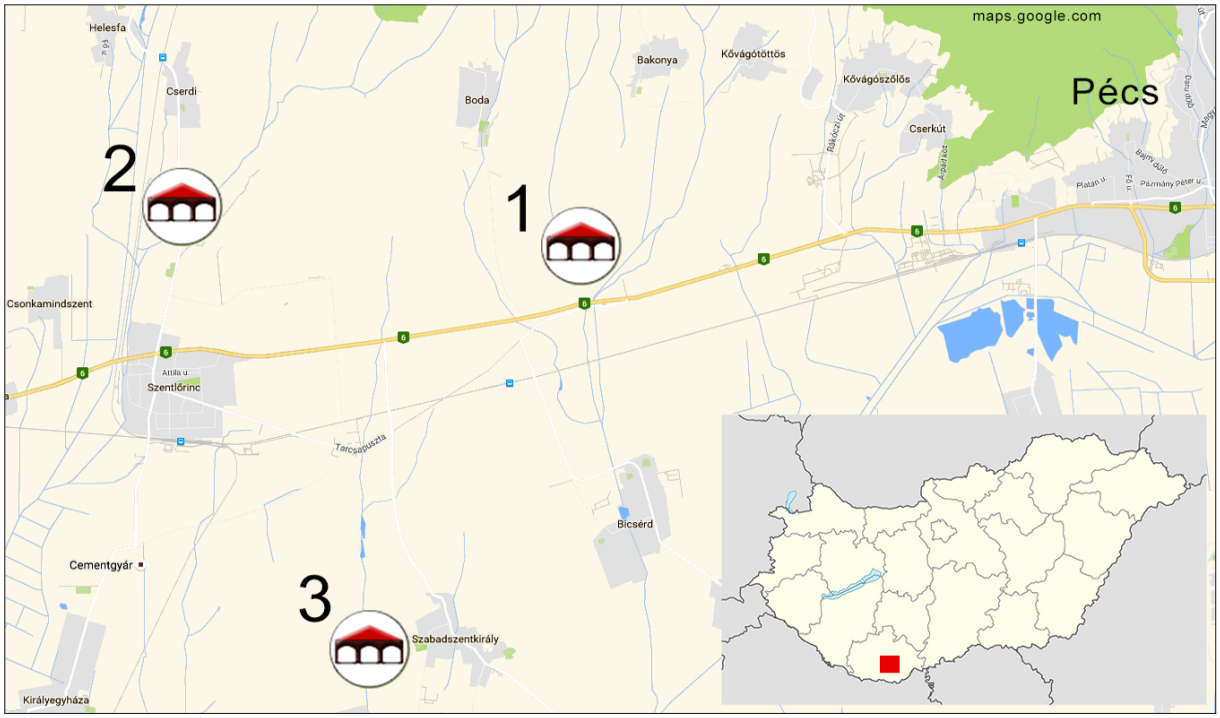

Fig. 1. The map of the investigated sites (mapped by Máté Szabó).

Bakonya – Csucsa-dűlő *(Fig. 1.1)*

The villa site lies west from Pécs and south from the village of Bakonya, between the so-called Kaposi-út (Kaposi route) and the main road 6. Streams run on its western field-boundary and on the eastern and southern part of the site too, but we have no information about the ancient hydrological conditions. The site has long been known to the research[3], and many finds show its importance. In addition to decorative building elements and high-quality trim or paving stones, inscribed fragments enrich the collection of the Janus Pannonius Museum, Pécs.[4] Fragments of a copper-alloy casket mount, decorated with early Christian imagery[5] was also found here and provides a glimpse to the late Roman history of the site and the region. Before its aerial survey only Roman small-finds, building materials and residuals of an excavated underground water channel[6] leading to the villa indicated the importance of the site. Its structure was unknown, but the stratigraphy and history of the buildings, without any excavation, still remains.

2 Bertók – Gáti 2014, 138–143; Szabó 2015
3 Fülep – Burger 1979, 281.
4 Gábor 2002; Bertók – Kovaliczky 2007.
5 Visy 2010, 38.
6 Bertók – Kovaliczky 2007, 348.

The first photographs taken in 2006 only revealed the debris of the buildings.[7] These phenomena confirmed the former field observations, but still did not provide a suitable site-plan. Two years later, in 2008, much clearer patterns emerged from above. The villa was photographed by the experts of the Janus Pannonius Museum and the Aerial Archaeological Archive of Pécs too,[8] and its detailed interpretation also took place[9].

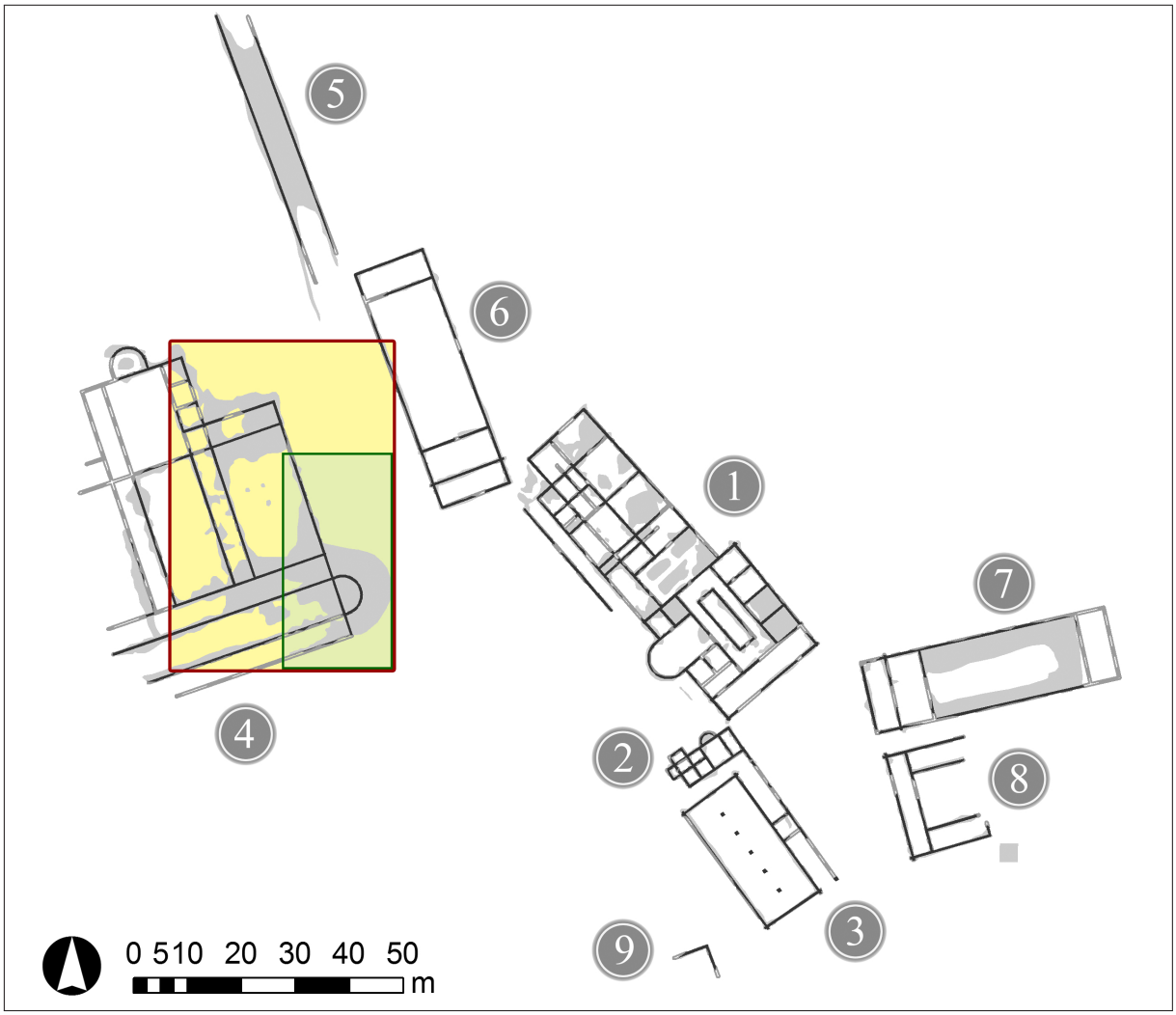

Fig. 2. Identified buildings from the air at the villa site of Bakonya with the area of the geophysical survey. 1 – latter main building; 2 – bathhouse; 3 – store building (granary?); 4 – former main building; 5 – road; 6–9 – outbuildings; yellow area with red frame – magnetometer survey; green area with green frame – GPR survey (mapped by Máté Szabó).

The accurate crop-mark mapping of the remains visible from the air[10] gave a proper background for other researches. The relative chronological differences, based on the *intensity data*[11] of crop-marks[12] and field-survey was the basis for geophysical investigations. In 2013, within

7 Bertók – Kovaliczky 2007.
8 Bertók – Gáti 2014, 138–143; Szabó 2015, 90–97.
9 Szabó 2015, 107–111.
10 Szabó 2015, 93.
11 Vegetation growth differences observed in visible wavelength on the aerial photographs.
12 Szabó 2013, 83; Szabó 2015, 96.

the framework of ArcLand international project, the Janus Pannonius Museum organised a Non-invasive Archaeology Training School (NATS),[13] and the eastern half of a less visible building of the villa site was designated as a sample area. This building, beyond its state and structure, could also give an insight about methodological issues *(Fig. 2.4)*.

Fortunately, only sprouting maize was on the field at the time of the survey, which did not trouble our work, in fact, we could use their lines as a guide. During the survey, Ground Penetrating Radar (GPR), two types of magnetometer, ground resistivity and magnetic susceptibility measurements were performed, of which we wish to elaborate the results of the Overhauser magnetometer and Ground Penetrating Radar below.[14]

Magnetic surveying over the buildings that are faintly visible on the aerial photos[15]

An area of 60×40 meter was surveyed by Overhauser magnetometer over the western part of the Roman age villa site near Bakonya, which was faintly visible on the aerial photos. The resolution of the instrument (0.01 nT) is much less than the magnitude of the magnetic anomalies of the archaeological objects (in general, 1–100 nT), thus we expected the results would help us to better interpret the traces shown from the air. We made the survey along lines separated by a distance of 0.75 meter *(Fig. 3–4)*.

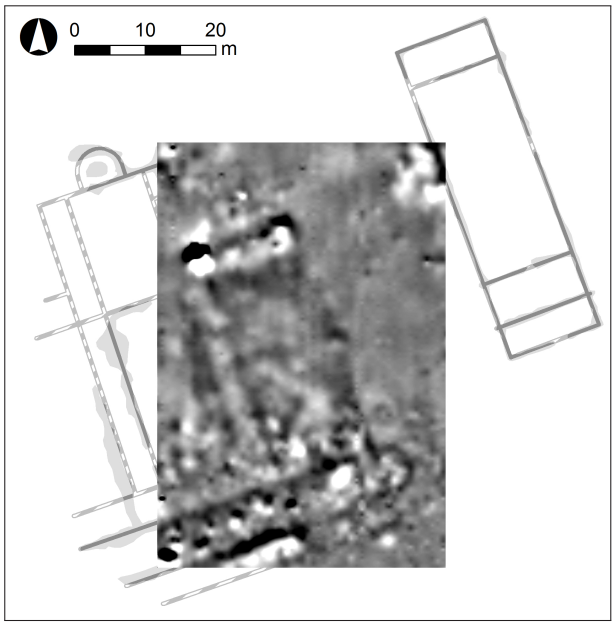

Fig. 3. Results of the magnetometer survey with the traces of the buildings visible from the air (mapped by Gábor Bertók – Máté Szabó).

The traces of the building shown on the aerial photos were revealed in larger details in the results of the magnetic surveying. Besides the foundations of the walls the southern part and the northern wing located 30 meters from it are characterized by strong anomalies. It suggests that in these places underfloor heating system (*hypocaustum*) or burnt structures can be found. The two wings are separated by a corridor-like structure in the western side as also shown on the aerial surveys. Perpendicular to it in the middle another zone with 4.5 meters width runs until the eastern wall of the building. It is not clear whether two large halls (12×12 meter) covered by roof and separated by a corridor, or courtyards (*peristylia*) or gardens (*horti*) rimmed with *portico* were located between the southern and northern wings. The question might be resolved by an excavation based on the magnetic results. In the same survey area another building with two sections(?) oriented in NW-SE direction is traceable. In its south-eastern part an apse can be

13 Kostyrko – Lokś 2013.

14 Geophysical surveys were performed with the contribution of Kevin Barton in the framework of the NATS. These results will present later.

15 See also: Bertók – Gáti 2014, 138–143.

seen. It cannot be separated from the host building neither based on the demolished materials on the surface and findings nor on the aerial photos. Further research is necessary to determine its age and function.

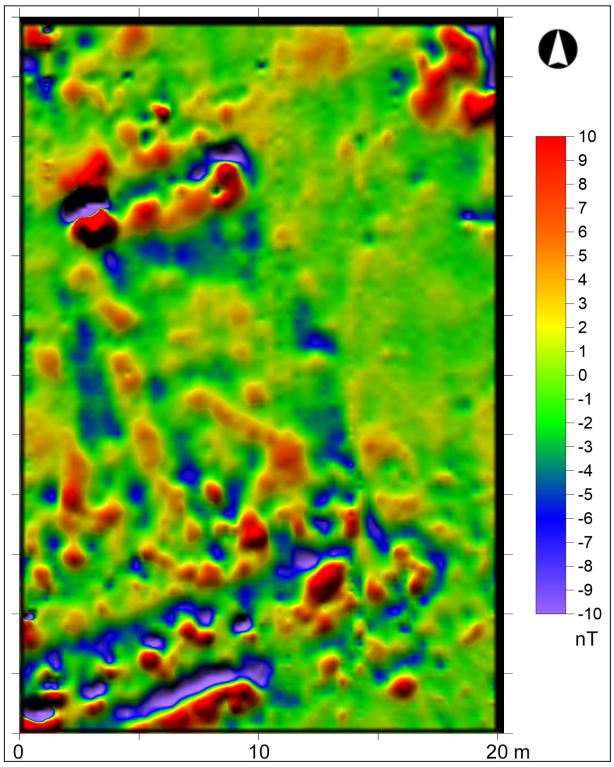

Fig. 4. Coloured and shaded image of the magnetometer survey (mapped by Gábor Bertók).

The edge of an outbuilding, which was identified on the aerial photos *(Fig. 2.6)*, is shown by strong anomalies in the north-eastern part of the survey area suggesting that the walls still have a solid base (foundation). Some anomalies might be attributed to a road running parallel to the building *(Fig. 2.5)*. Surveying a larger area can clarify this hypothesis. The magnetic surveying supplemented the results of the aerial surveying with valuable data. The structure of the building located in the western part of the survey area is imaged with larger details in the magnetic anomaly map compared to the aerial photos, and it became clear that faint traces on the aerial photos might belong to solid wall foundations in the subsurface. Additionally, a new trace (structure?) with different orientation of the building was also discovered.

Ground Penetrating Radar (GPR) survey to better understand the structure of the building[16]

The GPR[17] works with electromagnetic radiation (radar waves) in different wavelengths and measures the reflection of emitted signals. Its applications highlighted in built structures, walls, wall foundations, floor levels, cellar or hole detection.[18] Since the radar antenna has to be moved close and parallel to the surface, site coverage is important. We should not forget that only harrowed or sown plots can be measured effectively, and debris covered fields will give a special task for the measurers. Similarly, attention should be paid in addition to the building material (stone types, brick, etc.) the soil type as well. Certain soils (e.g. clay) preventing penetration of the radar waves make it impossible to measure. Besides the type of the GPR device, the frequency of its antenna and the survey area with the target, measuring costs also play an important role in our decision. In cases when we need a high-detailed data for answering certain research questions or for designating excavation trenches, as the international examples provide, GPR measurement with its 3D maps will give an extraordinary opportunity.[19]

16 The results of GPR survey was previously published as illustration: Bertók – Gáti 2014, 14.
17 In summary, see Schmidt et al. 76–88.
18 Schmidt et al. 2015, 76.
19 Neubauer et al. 2014

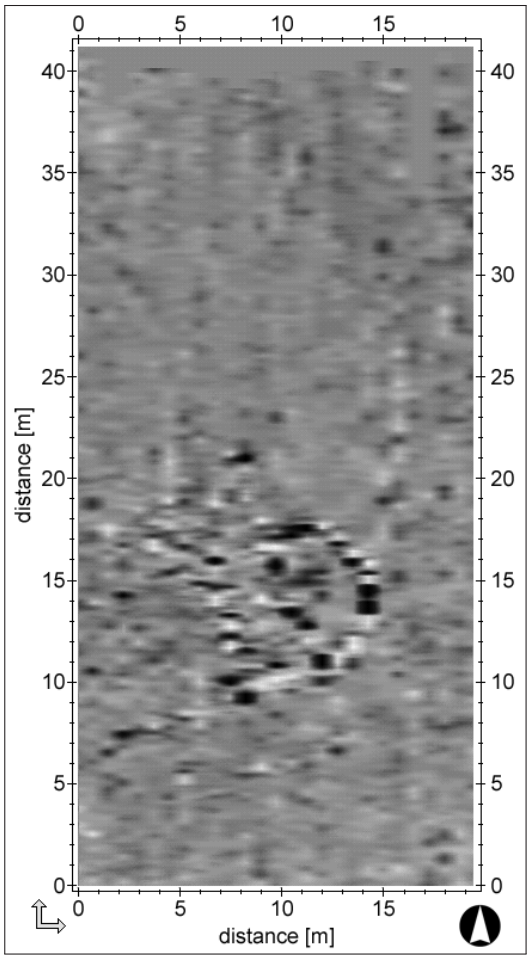

Fig. 5. Results of the GPR survey in 120 cm depth (mapped by Gábor Bertók).

At Bakonya, we utilized a Mala Geoscience GPR mounted with Ramac monitor, XV11 control unit and 250MHz shielded antenna and a 0.75 meter measuring space was used. Our survey covered a 20×40 meter area on the eastern half of the magnetometer investigation *(Fig. 5)*.

Our results are well comparable with the magnetometer measurement's map. The apse and its environment are clearly outlined. According to the survey the apse foundation's depth reaches some 1.5 meters, suggesting underfloor heating system (hypocaustum), but it is conceivable that in this area (primarily on the eastern part of the apse, which is the edge of the main wing) they constructed the foundations so deep due to a second floor. The depth map indicates rubble between the apse's walls, but undisturbed subsoil outside them. It also refers to the remains of a hypocaust (a 'hole' in the sense of measuring) filled with the remnant of debris *(Fig. 6–7)*.

Foundations of the rooms next to the apse penetrate to 1–1.3 meters deep which is deeper than external walls usually needed (˜0.8 meter) also refer to underfloor heating systems. Sudden changes in the depth of the wall-foundations indicated by the 3D data confirm that intensive building material extraction continued after the abandonment of this part of the building, but without excavation it is uncertain that this section was still standing simultaneously with the "latest" main building *(Fig. 2.1)* or it has been destroyed already in the Roman period, possibly during the construction of the latter.

According to the aerial photographs and magnetometer survey, an area can be found with uncertain construction and function in the northern foreground of the apsidal room closing the southeast wing of the building. The GPR survey provided very similar results and showed no traces. As an external or load-bearing wall needs proper foundation, the lack of its anomalies or the missing remains of material extraction also assumes that this area was an outer part of the building, probably a courtyard (*peristylium*) or a garden (*hortus*).

Cserdi-Horgas-dűlő *(Fig. 1.2)*

The first aerial photographs of the archaeological site were taken during overflights in the framework of FRE Central Europe Danube Limes UNESCO WHS project in 2008.[20] The remains of the Roman villa buildings lie on a low hill south from the village Cserdi, between the streams

20 Szabó 2014a, 350.

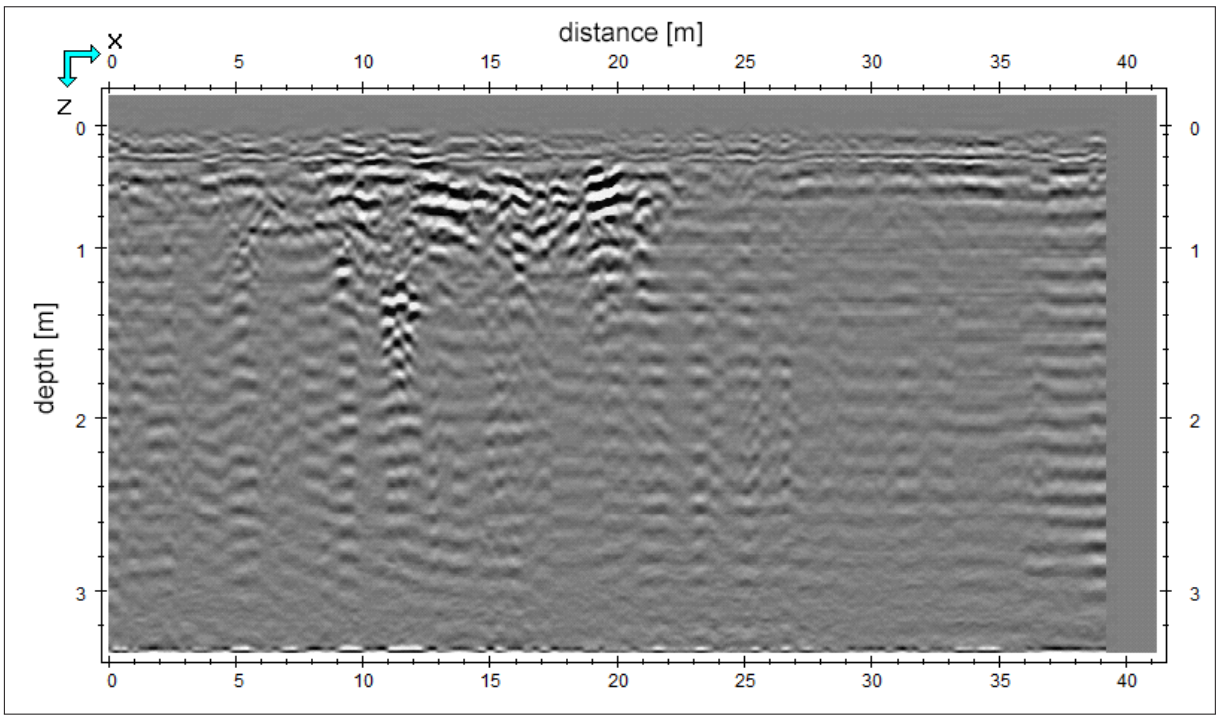

Fig. 6. South-North (left to right) profile graph of the GPR survey at 8 m. The picture indicates the wall-foundations and the debris or the remains of the *hypocaustum* in between (mapped by Gábor Bertók).

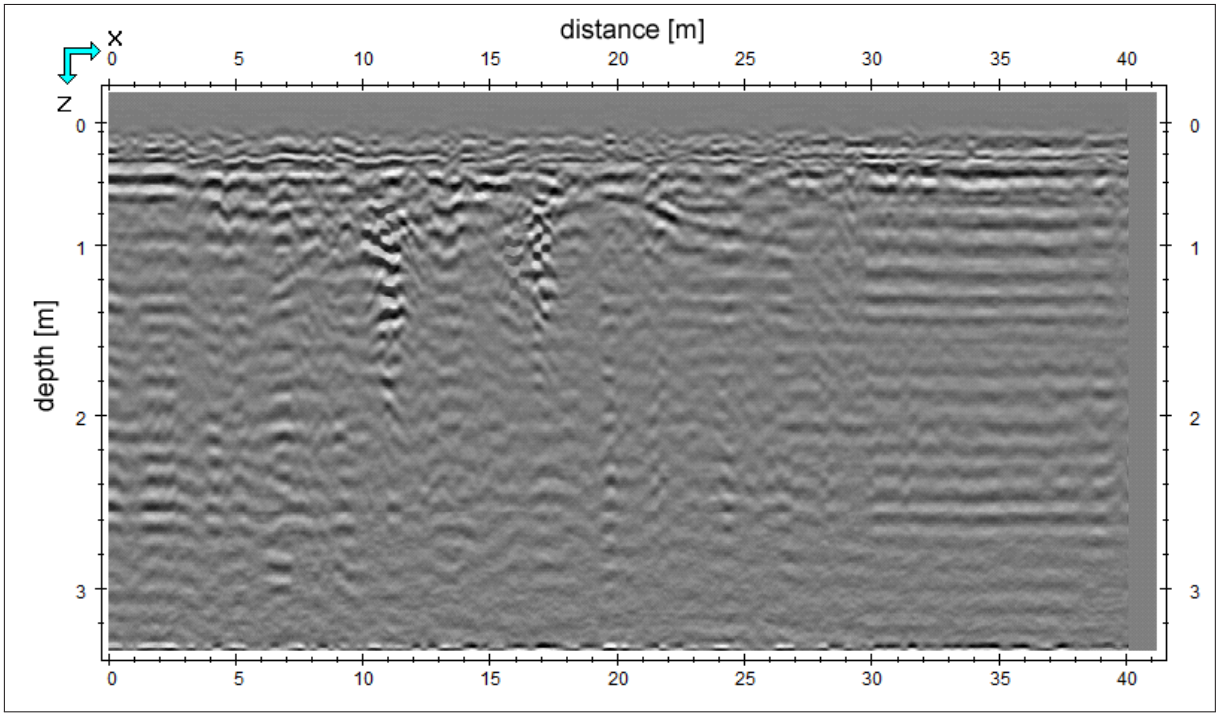

Fig. 7. South-North (left to right) profile graph of the GPR survey at 13 m. The picture indicates the deep wall-foundations of the apsidal room (mapped by Gábor Bertók).

of two valleys (Bükkösdi-víz and Bodai-völgyi-rét), but farther away from the former wetland of Bükkösdi-víz. Before the aerial reconnaissance flights we did not have any proper information about the site, and the Roman period history of the village and its environs was also known only by the related small-finds.[21]

In recent years (except 2010) systematic aerial surveys provided information about the archaeological site. Traditional methods and RPAS (Remotely Piloted Aircraft Systems) devices were also used[22] in these researches. In parallel, field surveys, metal detecting and some small-scale excavations (2012, 2014–15) took place at the site.[23]

Negative anomalies of cereal crops highlighted the traces of the villa buildings, but in some cases soil-marks could also reveal faint signals or landscape information. Except the landscape data, in each case only the remains of the building-complex were visible in an approximately 1.5 hectares large land from the air. Field surveys, metal detecting and excavations provide contradictory results and showed a much larger, some 20 hectares area of Roman presence and additional built up structures.

Walls and other traces visible from the air had been measured by crop-marks with geodetic accuracy[24] and gave a proper background for the excavation in 2012 and the GPR survey of the main buildings. The other geophysical investigations based on the artefact-pattern of field surveys or the excavation data from 2014.

Using Ground Penetrating Radar (GPR) in the research of the main buildings

Similarly to Bakonya, two large main buildings could be identified at the Cserdi site on the aerial photographs *(Fig. 8.1–2)*. Both are oriented northwest to southeast and lie almost entirely in parallel to each other. The latter's maximum length exceeds 55 meters and its width is about 45 meters *(Fig. 8.1)*. Traces of several reconstructions can be seen on its layout from the air, but the details and chronology is almost completely unknown to us and trial-trenching have not provided clear information in 2012 too.[25] The inner part of the building is only hardly identifiable, according to our researches partly the existence of the floor stood behind it.[26] Since aerial reconnaissance failed to get accurate data about this building part, parallel to the excavation, a 30×30 meter area which mostly covered this section was measured by GPR in 2012.

We utilized a Mala Geoscience GPR mounted with Ramac monitor, XV11 control unit and 250MHz shielded antenna and a 0.5 meter measuring space was used *(Fig. 9)*.

Archaeological phenomena (wall-foundations) became differentiated from their surroundings around 50 cm depth in the map of the GPR measures and to the depth of approximately 1 meter the signals have become increasingly clearer, which is basically consistent with the excavation

21 JPM Archaeological Repository 99–75; 100–75; Fülep – Burger 1979, 281.

22 The research assistance provided by Aeroart Ltd. (András Balogh, Norbert Sandó and Tamás Schnur) and DeltaHF (Péter Szalánczay) is gratefully acknowledged.

23 Szabó 2012a, 2012b, 2013, 2014, 2015; Szabó et al. 2014.

24 Szabó 2015, 93.

25 Szabó et al. 2014, 258.

26 Szabó 2013, 83.

experience. Northwest-southeast direction and perpendicular traces, aligned to walls can be seen from the air are visible on the images. Between the remains, best detected around a depth of 65–90 cm, structures can barely be discovered and can be explained by the results of the excavations. In our excavation trench 'D', located near the GPR survey, the intact Roman floor level was found in a depth about 65–70 cm from today's surface and the foundation of the observed partition walls were also hardly built beneath it.[27] In contrast, the load-bearing wall was penetrated below the supposed hypocaust floor level with an approximately 1 meter in trench 'A'.[28] Compared with the results of the GPR survey, this suggests that the near-surface layers (approx. 0–50 cm) perceived 'slurred' picture above the Roman floor level refers to the demolish of agricultural cultivation and shows hardly interpretable the remains of walls and debris together, while below the floor level higher contrast of the subsoil and the wall foundations can be observed.

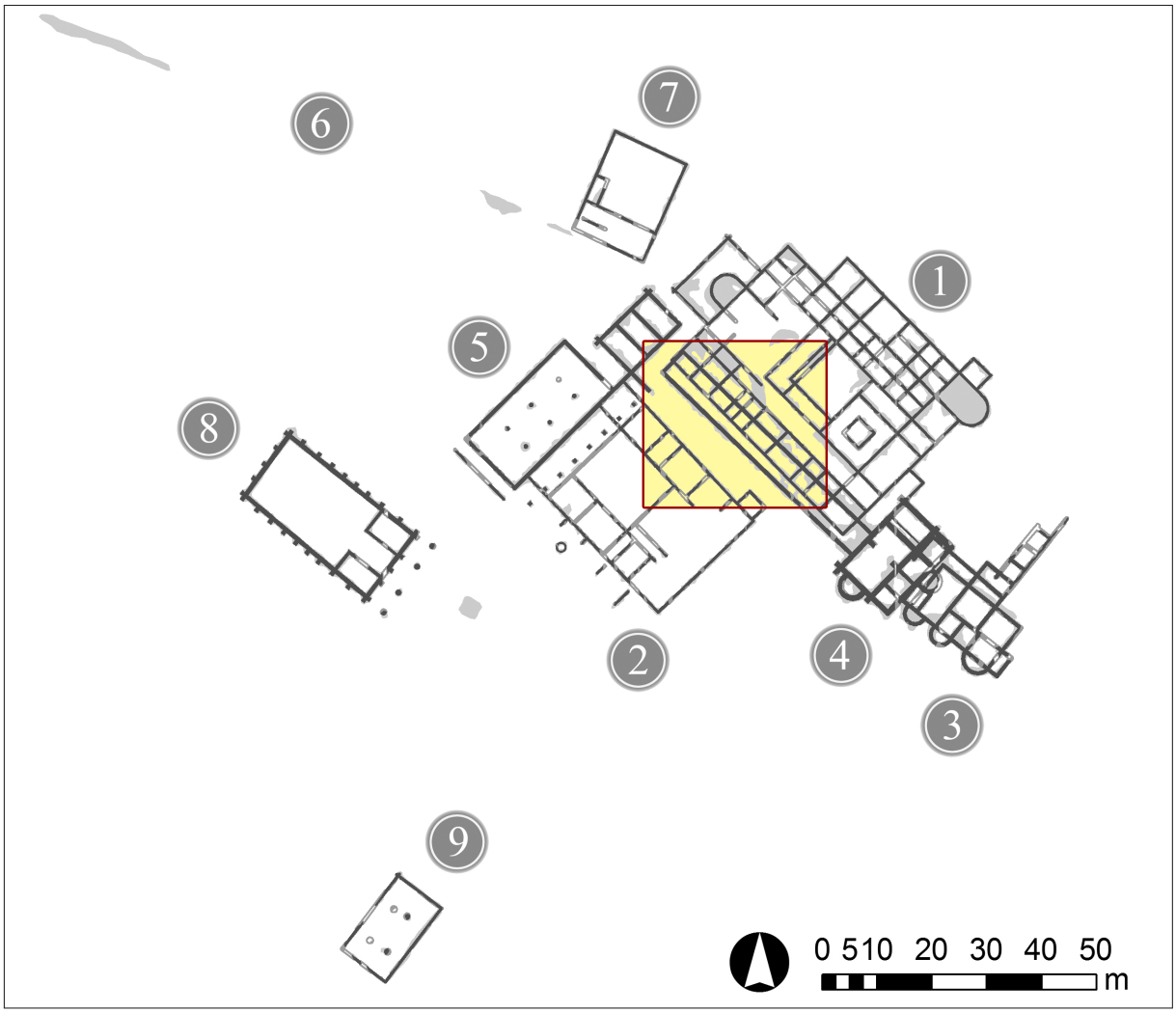

Fig. 8. Identified buildings from the air at the villa site of Cserdi with the area of the GPR survey. 1 – latter main building; 2 – former main building; 3–4 – bathhouses; 5 – store building; 6 – road; 7 – outbuilding; 8 – store building(?); 9 – outbuilding (mapped by Máté Szabó).

27 Szabó et al. 2014, 257.
28 Szabó et al. 2014, 257.

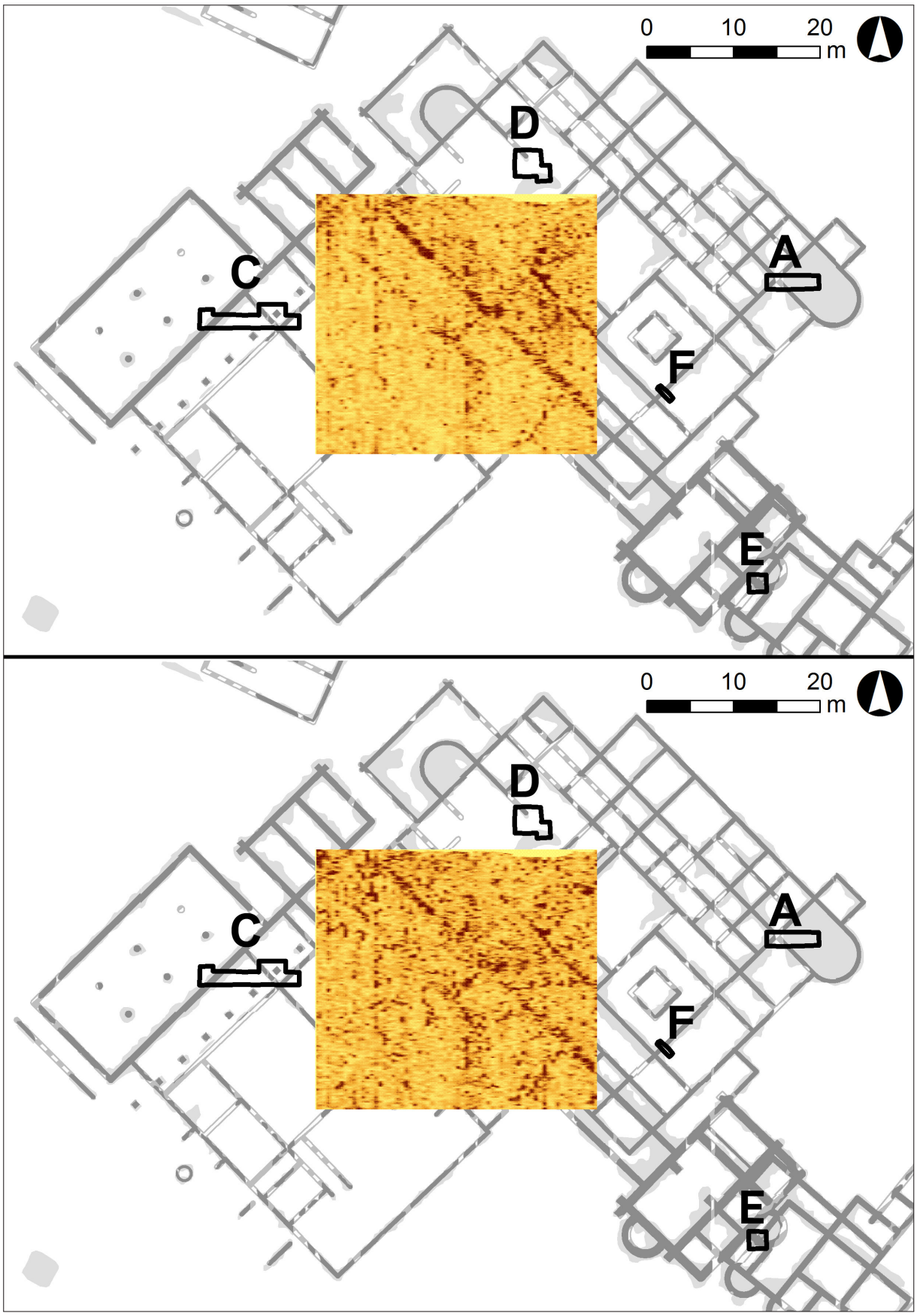

Fig. 9. The results of the GPR survey in 70 and 80 cm depth and the excavation trenches of the main buildings of the cserdi villa site (mapped by Gábor Bertók – Máté Szabó).

Our survey partly measured the former main building *(Fig. 8.2)*, where the faint traces of the remains of unbuilt walls were visible. The pictures can make it clear what our excavation trench 'C' justified[29], that the building was demolished even in Roman times.

The results of the GPR survey conducted alongside the excavation in 2012 made us easier to understand the anomalies that can be seen on the aerial photos that were also confirmed by the excavation data. Although we need more researches to understand the structure of the villa buildings, it is an important result of the measurement that we can expect floor levels in a significant part of the latter main building.

Results of the magnetic surveying

The Cserdi site was delineated by scattered materials on the surface. The structure of its building-complex was investigated by aerial survey and GPR survey inside the main buildings and test excavation in the past years. The area belonging to the villa is about 20 hectares, but the question about its structure was still standing, therefore we decided to survey the surrounding area by magnetic method, because it is the most effective geophysical method.

We carried out the surveying on 50×50 meters large squares using Overhauser magnetometers in continuous mode introduced in Hungary by László Lenkey and Mihály Pethe[30]. We measured the vertical gradient of the magnetic field along lines, which followed the lines of sunflowers planted in 0.75 meter distance from each other. At the beginning we positioned at every 2 meters, and later at every 50 or 50+50 meters, because we were able to walk with constant speed on the almost flat area. The survey area is divided by a busy road, and because the magnetic field of the vehicles distorts the natural magnetic field, we skipped from surveying 30–50 meters wide lanes on both sides of the road. The surveying was carried out by archaeology students from the University of Pécs during a short time period, which resulted in the fall off the quality of the data.[31] The size of the daily survey areas and the quality of the data varied due to the fluctuation of the number of the students. Altogether we have surveyed more than 10 hectares, which is large enough to resolve some problems related to the site *(Fig. 10)*.

The most striking feature of the magnetic map are the numerous anomalies, which were not visible on the aerial images. In most of the cases the archaeological object, which causes the anomaly, is unknown, except those occasions when the shape of the anomaly is characteristic for the object. Without control excavations we will show only preliminary interpretations of the magnetic anomalies.

The shape and size of the pit-like anomalies varies. The land was used from prehistoric times until Roman age, but it is not possible to date the pits based on their form. According to the

29 Szabó et al. 2014, 258.

30 The method allows measuring the magnetic field at every 20 or 25 cm along the survey line depending on the walking speed. The data are positioned at certain distances in order to enable good fitting between the lines. The length of the distance depends on the surface conditions, (e.g. flat or hilly topography, how viable is the area), and the regularity of the walking speed.

31 The clothing of the survey crew must not contain any iron or steel objects. This requirement was not always fulfilled, because the students shifted each other from day to day, and they were not always able to provide the right clothing. Therefore, some parts of the magnetic map are striped depending on their magnetization. Luckily, the archaeological anomalies can be identified on the magnetic map.

excavation probably most of them are archaeological objects, thus they belong to a large and significant site-complex, which extends over the survey area. Only one pit-like anomaly was excavated in the eastern side, which belongs to the base of a Roman age oven ('E' and 'F' trenches of the excavation in 2015)*(Fig. 10.1)*.[32]

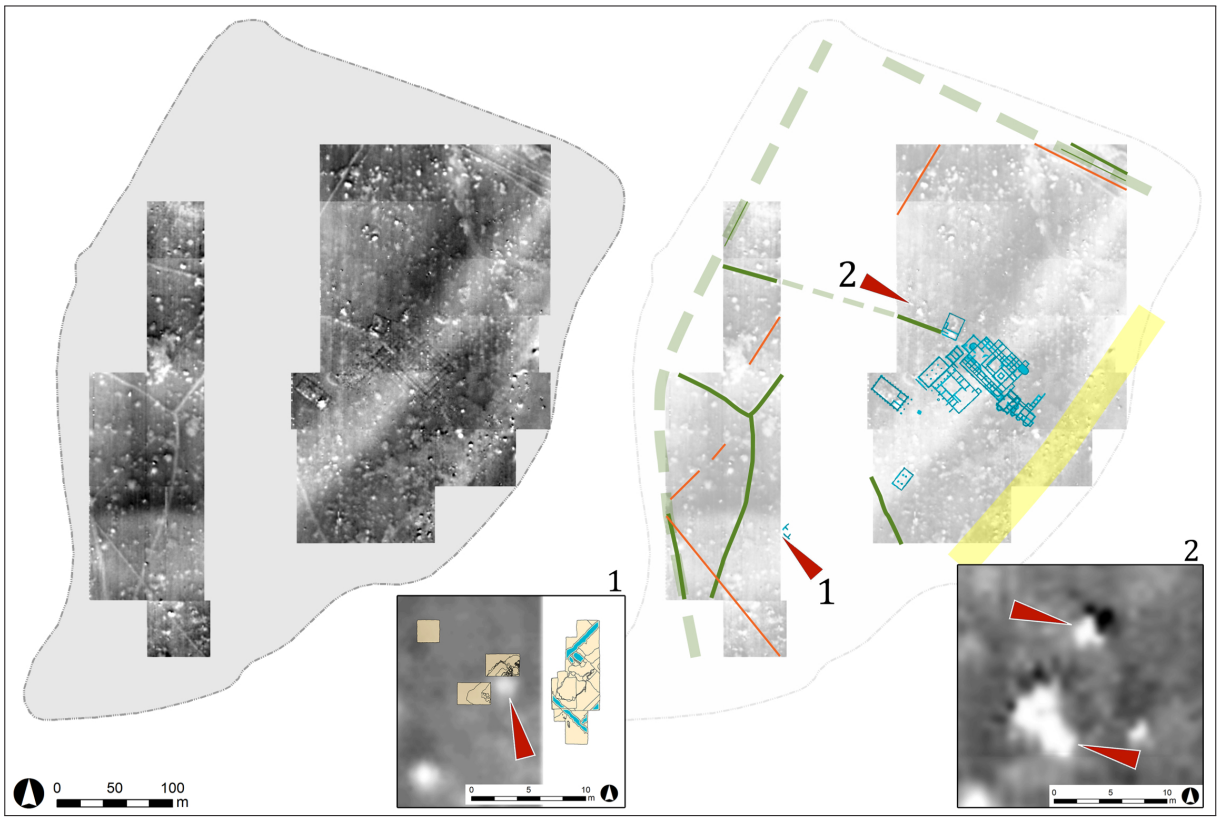

Fig. 10. The results and interpretation of the magnetometer survey of Cserdi. 1 – location of the excavation in 2014–15; 2 – findspots of iron tools. Blue – identified buildings; Orange – field boundary or fence; Green – road ditch; Yellow – former shrubland (mapped by Máté Szabó – Vera Szabó).

The small size and high amplitude dipole anomalies belong to it are mostly recent iron and steel objects. Their age and function can be established only after detailed research. We interpreted a group of dipoles recently. In 2012 a Roman age hammer has been found before the magnetic survey. Later, the magnetic measurements revealed a dipole near the finding place of the hammer and another dipole a few meters north to it. In spring 2016 iron tools[33] also dated to the Roman period was discovered from the northern anomaly *(Fig. 10.2)*. Based on the two findings we suspect that the nearby dipoles indicate a workshop or an iron tool deposit, which were destroyed by ploughing.

Another characteristic features of the magnetic anomaly map are the linear traces. We interpret them as trenches rather than solid structures. They have two types: the thin straight lines (denoted by orange colour in *Fig. 10*) are suited for the orientation of the villa. Taking into account the Roman age findings they probably mark the borders of the parcels or the boundary of the estate. The wider and less regular lines (denoted by green colour in *Fig. 10*) probably belong to former roads or ditches beside the roads. The dashed lines drawn towards the buildings of the

32 Szabó 2015a, 37, the No. 3 phenomenon on the lower fig.
33 Szabó et al. 2016, 6–7.

villa and in the western and northern boundary of the study area denote those features, amongst which we assume relationship based on the artefact-pattern and the aerial photos.

Naturally, the buildings of the villa are also visible in the magnetic map, but their shape is different from the one shown on the aerial photos, and we were able to gain additional information from the magnetic picture. In spite of the lower resolution of the magnetic method compared to the aerial photos, we can establish the relative age of the different structures. It is evident that some buildings have already been demolished during their use, and the ruined structures result in smaller anomalies similarly to the aerial photos.[34] The internal part of the latter main building *(Fig. 8.1)* is not shown in detail, and the outbuilding *(Fig. 8.5)* connected to its northern side is indicated only by debris. A large extent anomaly is visible on the side of the *porticus* in the southern room of the building, which is supported by pillars and is located in the western side of the building complex *(Fig. 8.8)*. Based on its shape and size, the anomaly might be attributed to flooring, or a furnace, or large amount of iron objects depending on the function of the room. The first options and the structure of the building point toward the hypothesis that the building functioned as road station, because it resembles to the recently discovered road stations at Gönyű-Nagysáros,[35] and Bátaszék-Lajvér[36]. Otherwise, the possible iron objects would indicate an outbuilding.

Besides the archaeological features the boundary of the field system, which was eliminated in 2010, is also sharply shown (denoted by yellow colour in *Fig. 10*). Close to the former boundary several dipoles are present. Most of them are very likely due to recent iron waste, but some might belong to ammunitions from World War II.[37]

Finally, we can conclude that the results of the magnetic survey significantly contributed to our knowledge about the site. The most striking features of the magnetic map are the large number of anomalies, which indicate extensive land use, and the linear tracks. The anomalies of the building-complex corroborate the former interpretations of the aerial photos, and provided additional data for further thinking. The magnetic map of the site is not complete, several parts and details are missing, and thus further magnetic surveys are desirable.

Ground Penetrating Radar investigation in the footsteps of a special finding

Extensive field researches were conducted at the site in the first months of 2014, whose main aim was to clarify the extent of the villa site through metal detecting and field survey. A special finding and a new building came to light in March and its layout and context was basically clarified by excavations in 2014 and 2015.[38] Due to the discovery of the unearthed artefacts as well as the previously unknown building lies east of the main road, we examined the area with Ground Penetrating Radar.[39]

34 We note that smaller magnetization of the building material has the same effect, but the excavations support the interpretation written in the text. Szabó et al. 2014, 258.
35 Bíró – Molnár 2009, 18–28.
36 Majerik et al. 2008, 17–18.
37 In the summer of 2015 a shrapnel projectile came to light by metal detecting in this area.
38 Szabó 2015.
39 Due to the close proximity to the main road our magnetometer survey just touched this area in 2013, and provided data neither from the building nor from its environment.

The archaeological finds and other remains were found below the depth of the cultivator or partially disrupted by it. Because of the proximity of the main road and built structures we decided to use GPR, which, besides a 2D plan could also present stratigraphic data. Using the approximately centre point of the excavation a 30×30 meters large area was measured. We utilized a Mala Geoscience GPR mounted with Ramac monitor, XV11 control unit and 500MHz shielded antenna and a 0.5 meter measuring space was used.

The results of the survey were weaker than we expected. In addition to the well visible excavated area other parts of the survey provided faint and patchy picture about the remnants of the building. Traces of walls or premises were almost entirely impossible to identify on the GPR maps from different depths, but the continuing excavation could give answers to several problems in 2015.

It became clear that wall foundations were preserved only remnants of 5–10 cm in thickness and their material was also not good quality; it contained debris instead of whole stones, brick and mortar. Nevertheless, the "patchy" picture of the GPR measurement confirms our perceptions about the size of the building but, unfortunately could not clarify its structure and layout *(Fig. 11)*.

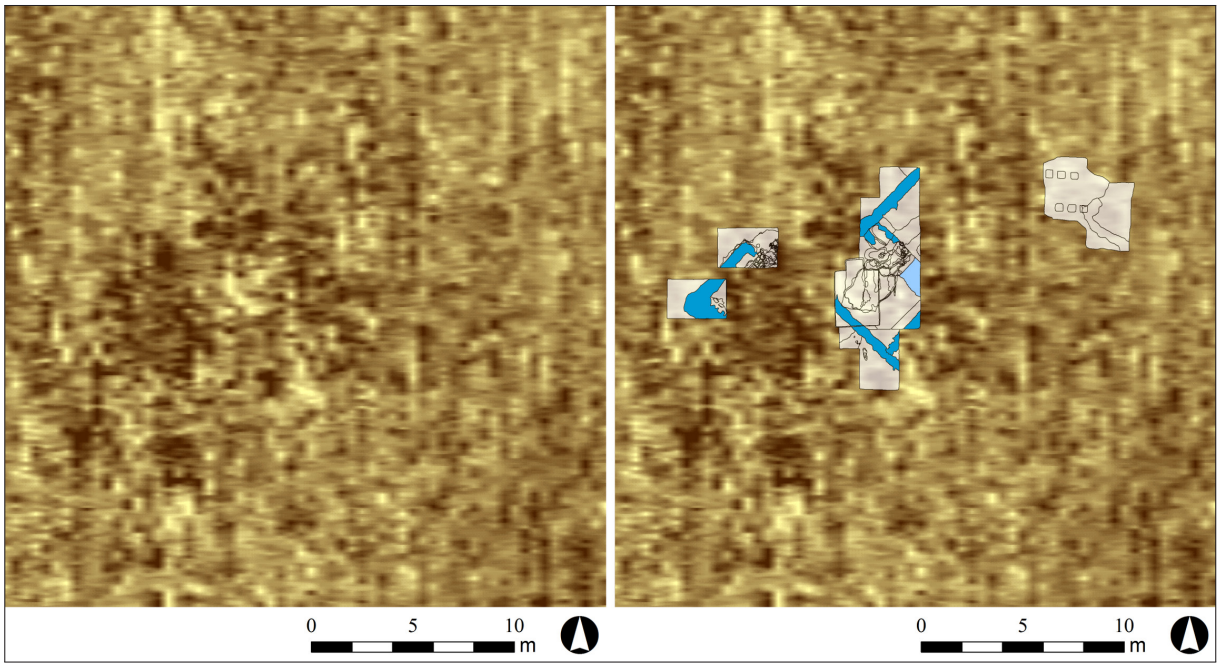

Fig. 11. The result of the GPR survey in ˜40 cm depth and the trenches of the 2014–15-year excavations (the excavated wall-foundations are in blue) (mapped by Gábor Bertók – Máté Szabó).

The role of Earth Resistivity Tomography in better understanding the structure of the building

In early spring of 2015 we carried out Earth Resistivity Tomography (ERT) in an area of 40×40 meters incorporating the site of the rescue excavation conducted in 2014.[40] ERT was developed to determine the subsurface resistivity distribution. We may expect good results from the method where large resistivity contrast exists between the archaeological structures and their

40 Berkecz 2015, Diploma thesis, ELTE TTK.

environment, e.g. in cases of stone or brick walls and foundations.[41] During the excavation in 2014 we found a piece of wall foundation, and after GPR survey we decided to apply ERT as well to explore its wider context.

We carried out the survey along lines using the instrument ARES with multielectrode cables. The survey lines were running in a net in 1 meter distance from each other. The lines were oriented in NS and EW directions in order to reduce the effect of anisotropy, which might result from one directional survey. The electrode distance along the lines was 1 meter. It follows from the position of the lines and electrodes that the resistivity was determined in a grid with 1×1 meter spacing. We determined the resistivity in several layers using the software RES3DINV. In this study we present the resistivity distribution of the upper two layers only. The first layer is 0.5 meter thick with middle depth of 0.25 meter, while the second one is 0.6 meter thick with middle depth of 0.8 meter. The resistivity distribution in these depths and its interpretation is shown in *Fig. 12.*

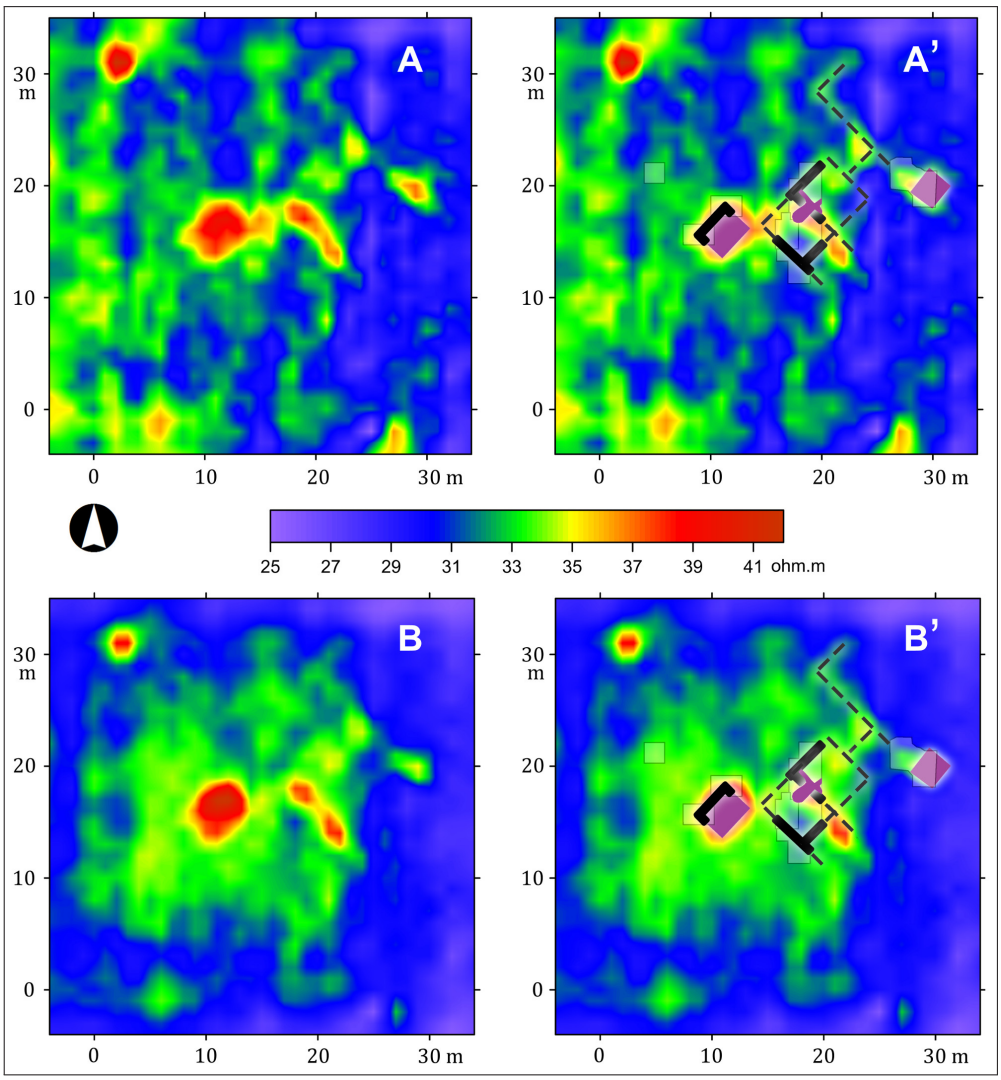

Fig. 12. ERT images of the excavation area of 2014–15 and their interpretation. A: ERT in 0.25 m depth; B: ERT in 0.8 m depth. Interpretation: black line – stone or brick wall; dotted line – supposed stone or brick wall; purple – oven, *praefurnium*, heating system (mapped by László Lenkey – Dávid Berkecz – Máté Szabó).

41 Raáb et al. 2011; Schmidt et al. 2015, 74–75.

In 0.25 meter depth large resistivity contrasts exist, and the relatively high resistivity anomalies have a regular shape *(Fig. 12A)*. In 0.8 meter depth a medium resistivity anomaly occupies the central part of the study area (denoted by medium grey colour in *Fig. 12B*), which fades the resistivity contrasts. However, inside this zone the same regular anomalies are also present as in 0.25 meter depth. Their direction is consistent with the orientation of the main building-complex *(Fig 8.1, 2, 4, 5)*, and the direction of the wall, which was unearthed in 2014. Surprisingly, the wall itself is not visible in the resistivity map.

We carried out an excavation in summer 2015 based on the ERT results, and it shed light to some of the open questions. In the sections we found several walls corresponding to the high resistivity anomalies, and we were able to partly reconstruct the orientation and form of the building *(Fig. 12A'; 12B')*. In the figures we denoted the existing walls inside the sections and the supposed walls outside the sections by continuous and dashed black lines, respectively. In the sections only the lowermost 5–10 cm thick foundation of the walls exists consisting of broken stones and bricks. It explains why the "walls" have discontinuous and indefinite image in the resistivity maps. On the contrary, the strong anomalies can be attributed to the heating system (*praefurnium* and heating canals), and the burnt platforms of two ovens (denoted by purple colour in the figure).

The regular anomalies, aligned with the main directions of the structures proved by the excavations, predict further walls or parts of the heating system. However, their precise structure and the extent of the building are not clear due to the weak anomalies and the interfering signals of the furnace platforms. The south-eastern closure of the building is missing in the resistivity maps. A strong anomaly running in south-western direction, which coincides with a wall excavated in the section, postulate the prolongation of the wall, but the perpendicular wall and the south-eastern corner are not visible. It is possible that the southern side terminated in a *porticus* and thus, we should expect only the foundations of the pillars similarly to the outbuilding attached to the main building, which we have excavated before.[42]

The results of the ERT are in agreement with the outcomes of the excavations. Based on the resistivity maps we can set up new research goals, and plan the next excavations. And vice versa, the findings of the future excavations will refine the interpretation of the resistivity, as we have shown above. In general, the ERT complements the other methods, or in the present study it substitutes the missing magnetic survey or the GPR survey, which did not have useful results. The difficulties in the interpretation of the ERT in the present study derive from the unfavourable condition of the archaeological structures.

Szabadszentkirály-Gerdei-árok partja *(Fig. 1.3)*

The archaeological site is located west from the village, on the bank of Gerdei-árok (stream). It is known by the archaeological register since 2000, but there were no further investigations. We could identify some parts of the site by an aerial reconnaissance of the Aerial Archaeological Archive of Pécs in 2009. Faint traces of buildings were visible in crop-marks from the air.

42 Szabó et al. 2014, 258.

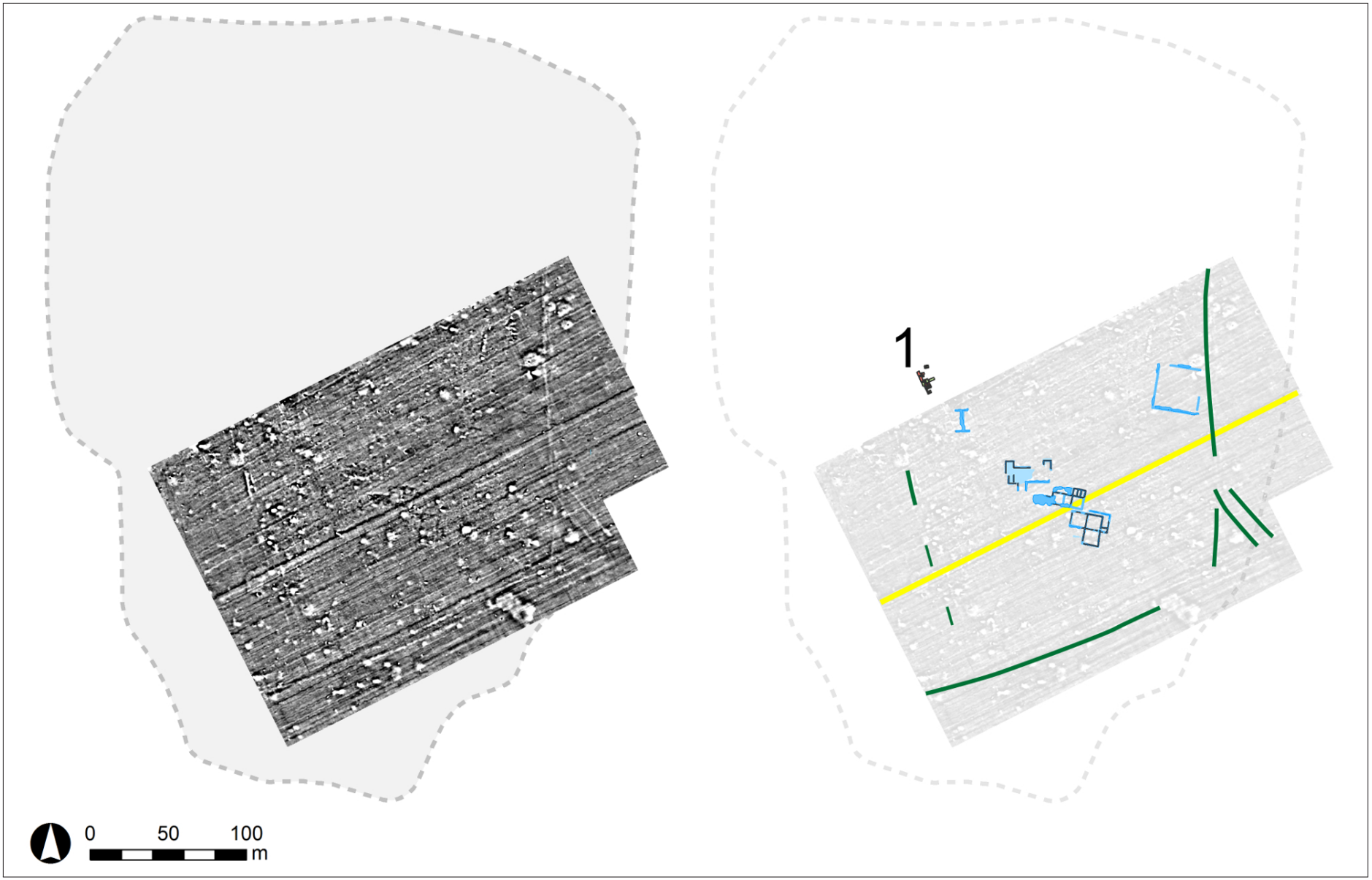

Fig. 13. The results and interpretation of the magnetometer survey of Szabadszentkirály. 1 – location of the excavation in 2014; Blue – identified/supposed buildings/walls; Green – ditch/road ditch; Yellow – recent land boundary (mapped by Mihály Pethe – Máté Szabó).

The identification of phenomena had to wait until 2014. Field surveys, metal detecting and RPAS (Remotely Piloted Aircraft Systems) researches[43] obtained additional information and also a rescue excavation were conducted in the first half of the year, but the main result was the precise delineation of the site.[44] Besides continuing work in the second half of the year, magnetometer survey was carried out in order to better understand the structure of the site.

Magnetic surveying in the southern part of the site

The amount and distribution of demolished building materials observed during field walking and determined in aerial photos are different in the site. We specified the survey area to incorporate the buildings shown on the aerial photos in order to resolve the bias between the results of the different methods.

We surveyed the study area using Sensys DLM fluxgate magnetometers in vertical gradient mode. Five pairs of probes were mounted on a cart in 0.5 meter distance from each other, thus we were able to measure a 2.5 meter wide stripe at once. We repeated the survey in a smaller area using Overhauser magnetometer also in vertical gradient mode (see the description of the survey at the Bakonya and Cserdi sites) for comparing the results obtained by the different instruments.[45] They were basically the same, thus we present only the magnetic map constructed from the Sensys data.

We have surveyed an area of about 6 hectares in 1.5 days *(Fig. 13)*. The area was divided by a trench into two parts, where different plants were raised. This subdivision is well visible in the magnetic map.

Besides the contours of the buildings, shown by weak signals on the aerial photos, numerous anomalies are present in the magnetic map. Without excavations it is difficult to date and define them exactly, however, they help to understand the relationship between the traces determined on the aerial photos and the surface scattering of the small-finds.

Similarly to the Cserdi site, several pit-like structures can be seen in the area. They have different size and forms, and some of them might have functioned as pit-house and others as borrow pits indeed. According to the results of the field walking most of the pit-like features have archaeological age showing that the study area belongs to an extensive archaeological site.

There are some dipole-type anomalies in the area. It is generally thought that most of them belong to recent iron and steel waste. However, in the study area many of them scatter in the area where small-finds were found. Thus, the origin and age of the source objects can be specified only by excavating them.[46]

Linear features are also present in the area. Besides the field boundary and the ploughing traces, in the southern part of the area a pair of line in ENE-WSW direction, in the western part a non-continuous line in the perpendicular NNW-SSE direction, in the eastern part a NS directed line, and in the south-eastern corner a short pair of line in NW-SE direction can be

43 The research assistance provided by Aeroart Ltd. (András Balogh and Tamás Schnur) is gratefully acknowledged.
44 Szabó 2014, 76–77.
45 Oelberg 2015, Diploma thesis, ELTE TTK.
46 Most likely, part of the anomalies can be attributed to archaeological objects and features, similarly to the cases in Cserdi.

seen. They might be of archaeological age, but we think they could be rather modern, perhaps related to modern roads, agriculture or to the mill which stood nearby.[47]

The traces of the buildings which were identified on the aerial photos are also visible. Their structure is less detailed in the magnetic map compared to the photos, but the two methods complement each other. We postulate other buildings in different parts of the study area due to the large amount of demolished building materials observed during field walking, but their existence was not proven by the magnetic surveying.

The magnetic surveying contributed important data to our knowledge about the Roman site at Szabadszentkirály. The site was identified by building materials and small-finds, and half of its area was covered by the survey. The magnetic map shows archaeological and recent features, and linear traces. The large amount of building materials spread on the surface fits to the anomalies shown in the magnetic map and the traces of the buildings are identified both by the aerial photos and the magnetic surveying. The diffuse location of the observed buildings and other buildings postulated due to the large amount of building materials spread on the surface raise the hypothesis that a significant settlement with stone houses or houses with stone foundation existed in the area. The settlement later might have evolved partly into a Roman villa.

The verification of the hypothesis is an important task in the future. It can be achieved by magnetic surveying of the northern part of the site, comparison of the results with the artefact-pattern and test excavations.

Conclusions

Geophysical survey plays an essential role in the understanding of archaeological sites and landscapes nowadays. In our cases, each site already had aerial and field data and being supplemented by these measurements, provided many new results.

It is instructive, that besides detailed traces of buildings visible from the air, many other anomalies, mostly unidentifiable on the aerial photographs and were previously presumable only by field surveys were shown in the measurement maps. It also confirms that comprehensive results, which make an entire site and its environment understandable, are only expected by complex application of different methods.

Our non-invasive archaeological methods, including geophysical surveys play a significant role in revealing that these sites have more complex structures than we previously thought, and former researches - based mainly on field walking - that identified these sites as Roman villas can be problematic, and like the definition, their individual history and the role they played in the Roman rural landscape has to deal with criticism. Besides the bulding structure, the magnetometer survey has revealed many other anomalies from different ages at Cserdi.The structural map of Szabadszentkirály suggests the possibility that a Roman settlement, probably with a stone-phased building period played a more prominent role thant the villa.

The different measurement methods, the size of the surveyed area and the achieved results are, however, only guiding examples and in order to understand these sites and their environment, further researches are needed.

47 Pesti 1982, 885.

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