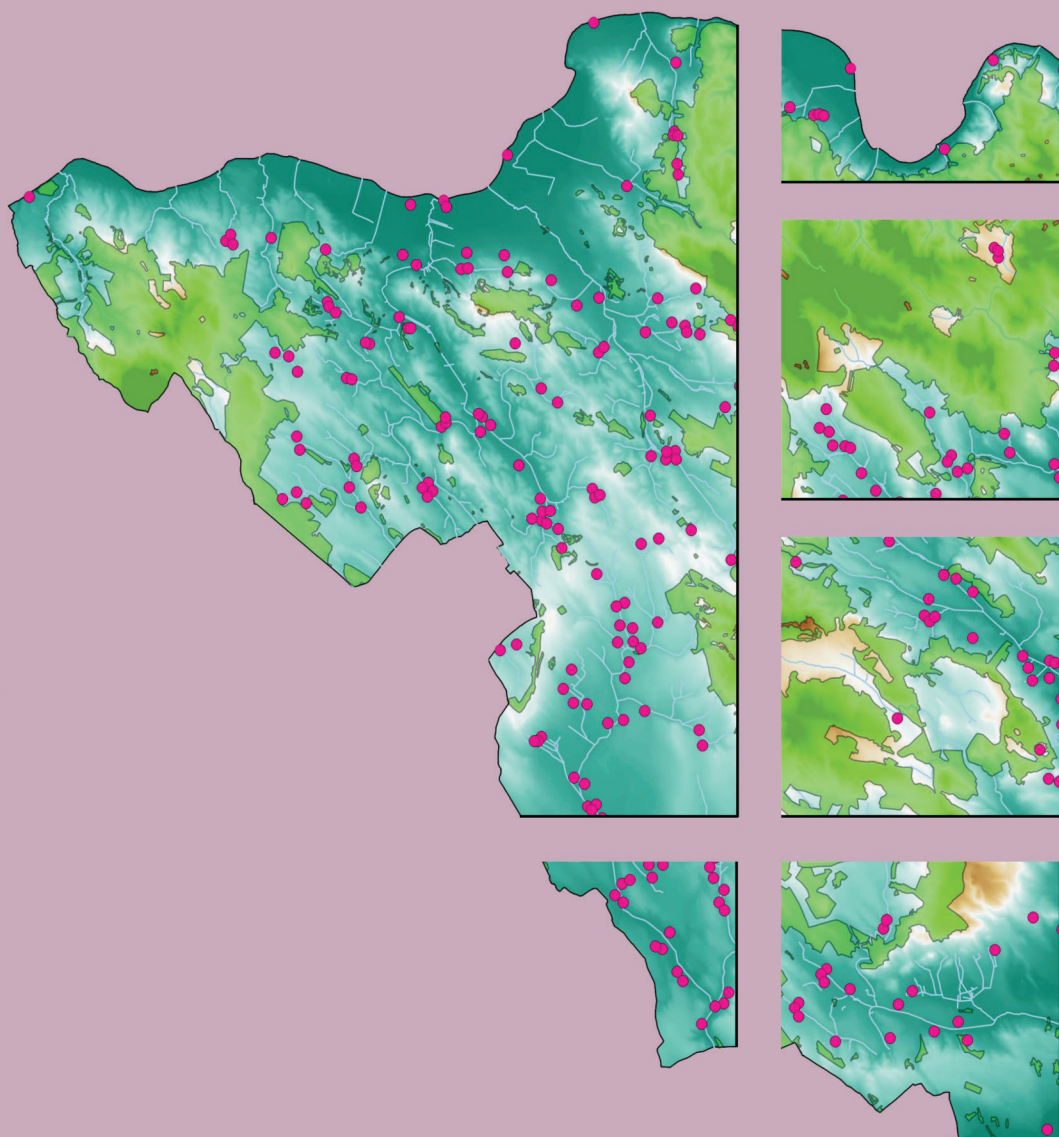


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ex Instituto Archaeologico Universitatis de Rolando Eötvös nominatae



Ser. 3. No. 5. | 2017

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Report on magnetometer geophysical surveys conducted in Hungary, Austria and Croatia in the framework of the Interreg Iron Age Danube project

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Abstract

One of the main objectives of the Iron Age Danube project is to learn more about the nine important sites of Eastern Hallstatt culture with modern topographic methods. The information gathered through aerial archaeological, ALS, geophysical, field survey and test excavation techniques as well as archaeobotanical analyses ultimately aims to reconstruct the former landscape, both in terms of 3D terrain, land cover and vegetation. However, the program is much more than a traditional research program: promotion of archaeology, broad presentation of results, involvement of local governments, public education and tourism institutions, schools in the zone of the concerned sites; moreover, initiation of cultural/tourism developments on the basis of results are all have a prominent role in the project. The leading institution of the program is the Joanneum in Graz, which, alongside the organization, also takes part in the research, public education and communication tasks.

Introduction

The Interreg Iron Age Danube program is led by Marko Mele (Joanneum, Graz), and wide-ranging objectives are supported by the multifaceted expertise of the participating institutions. The research tasks are carried out primarily by universities and research institutes (Eötvös Loránd University, Faculty of Humanities, Institute of Archaeological Sciences; University of Vienna, Institute of Pre- and Protohistory; Karl-Franzens-University of Graz, Institute of Archaeology; University of Ljubljana, Department of Archaeology; University of Maribor, Department of Botany; Institute of Archaeology, Zagreb). Partly research, partly public cultural activities are the responsibility of Joanneum, Graz; the National Museum of Zagreb and the Matrica Museum of Százhalombatta (until the end of 2017) and the Hungarian National Museum (from January 2018). Communication is an obligation for all institutions, but publishing house Archaeolingua, Budapest has the most important role in this field.



In the territory of Hungary, the tumuli field and the Iron Age settlement of Százhalombatta, the necropolises (tumuli groups, flat cemetery) and the Iron Age settlement(s) of Süttő, and the Sopron–Várhely tumuli field and the Early Iron Age fortified settlement are part of the project. In Austria, the necropolis and the Early Iron Age settlement of Strettweg and the tumuli of Grossklein; in Slovenia, the Early Iron Age site complex of Poštela (settlement, flat cemetery, tumuli field) and the Novo mesto tumuli field; in Croatia the tumuli of Jalžabet/Martijanec and the Kaptol site complex (tumuli and Early Iron Age settlement) belong to the project (*Fig. 1*).

Methodology

The listed sites, both in their terrain and modern land cover, are of different character and their preliminary researchedness is significantly different. This defines both research possibilities and the strategy, and of course it has an impact on the results during the timespan of the project. The sites of Százhalombatta and Süttő, as well as the tumuli fields of Strettweg and Jalžabet/Martijanec lie in an approximate flat area, while the settlement of Strettweg, the tumuli of Grossklein and Novo mesto, as well as the Sopron–Várhely, Poštela and Kaptol site complexes are in the mountains. The current land cover is in correlation with these differences in the terrain; most of the necropolises of Süttő are under large-field arable cultivation and the parcel size is relatively large also in the case of the tumuli field of Strettweg. Narrow, so-called “belt-parcels” are dominant in Jalžabet/Martijanec, while in Százhalombatta, mosaic cultivation (interconnected, various shaped closed gardens, orchards, arable fields, and hay-fields) is characteristic. The necropolis of Novo mesto is covered by grove, the settlement is covered by forest and there is a similarly mixed land cover at the Grossklein site, while the settlement of Strettweg, Sopron–Várhely, Poštela and Kaptol are entirely in the forest.

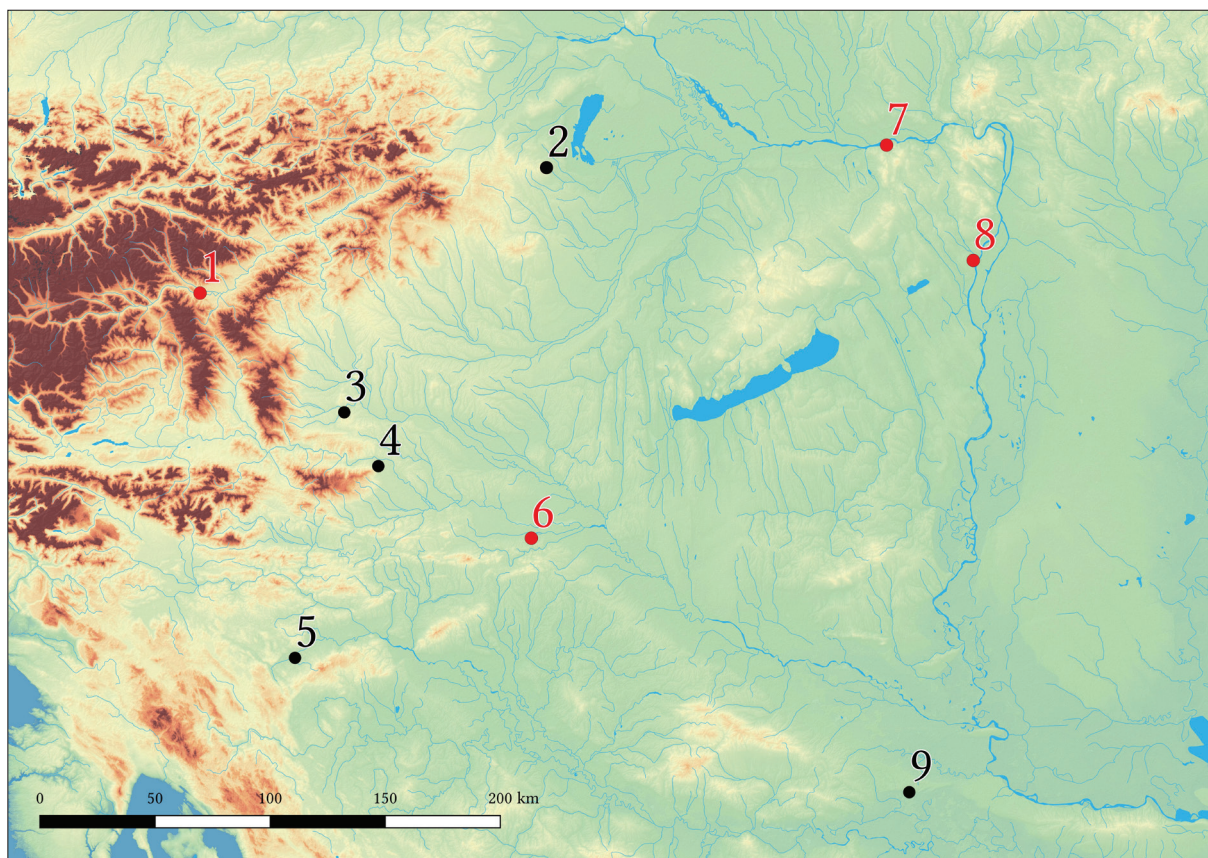


Fig. 1. Early Iron Age sites included in the program. 1 – Strettweg bei Judenburg (Obersteiermark, Austria), 2 – Sopron–Várhely (Győr-Moson-Sopron county, Hungary), 3 – Grossklein bei Leibnitz (Steiermark, Austria), 4 – Poštela near Razvanje, (Maribor, Slovenia), 5 – Novo mesto (Lower Carniola, Slovenia), 6 – Jalžabet/Martijanec (Varasd county, Croatia), 7 – Süttő – Nagysánctető, Kissánc, Sánctűdő and Sánctöldek (Komárom-Esztergom county, Hungary), 8 – Érd/Százhalombatta–Sánc-hegy and Százhalom (Pest county, Magyarország), 9 – Kaptol (Požega-Slavonia County, Croatia). Locations where the team of the Institute of Archaeological Sciences – Eötvös Loránd University conducted geophysical surveys in 2017 are marked in red (A. Bödöcs).

It is a fortunate circumstance that ALS-based terrain models are available for project partners from all partially or fully wooded surfaces (Strettweg, Grossklein, Novo mesto, Sopron–Várhely, Poštela and Kaptol).¹ It should be noted that there are also tumuli/earthworks covered by small wooded parts in Százhalombatta, Süttő and Jalžabet/Martijanec, therefore one of the project's main objectives is to carry out ALS in these areas as well. Aerial archaeological photography was successful in Százhalombatta and Süttő before the project.² In 2017, test drone photography at Százhalombatta and Süttő, moreover, UAV and helicopter aerial photography were carried out in Százhalombatta, primarily for the expansion of 3D reconstruction opportunities.

On a smaller scale, geophysical surveys were also carried out prior to the EU program: there were magnetometer measurements at the Százhalombatta tumuli field in 2012–

1 Without any claim to completeness: TIEFENGRABER 2015, 541; MELE 2015, 502; CZAJLIK et al. 2012, 68; MLEKUŽ – ČREŠNAR 2014; CEKOVIĆ et al. n.d.

2 CZAJLIK et al. 2016, 60; CZAJLIK et al. 2015, 64–70.

2014,³ at Süttő in 2014–2016,⁴ and at Strettweg in 2011–2014,⁵ and magnetic susceptibility measurement, georadar (GPR), electrical resistivity, electrical resistivity tomography (ERT) surveys at Poštela, and georadar on Falkenberg/Strettweg in 2014-2015.⁶ According to previous experience, the Institute of Archaeological Sciences of the Eötvös Loránd University is responsible for the continuation of magnetometer surveys in Százhalombatta, Süttő, Strettweg, Jalžabet/Martijanec and Sopron–Várhely, while the group from the University of Ljubljana continued the research in Poštela and Kaptol and started surveying Grossklein and Jalžabet. In addition to the use of remote sensing methods, the participants of the project carried out smaller-larger ground surveys, collecting surface finds on the surveyed sites. Test excavations in 2017, according to the program, took place at Strettweg, Grossklein, Jalžabet and Kaptol.



Fig. 2. Érd/Százhalombatta – Százhalom, tumuli field. Areas surveyed in 2017 using magnetometer geophysical method on the topographic map (L. Rupnik).

Geophysical surveys were started on behalf of the Institute of Archaeological Sciences of the Eötvös Loránd University on 11 February 2017 and the last measurement was on 13 November. The instrumental background was partly covered by the Department of Geophysics of the Eötvös Loránd University (László Lenkey, 2 GSM19 Overhauser magnetometers) and partly by Balázs Holl (Trimble GeoXH GPS). From August 2017, we have been working with the devices acquired in the framework of the project (2 GSM19W Overhauser magnetometers, Trimble Geo 7 GPS). Devices were arranged and used identically all year round at all sites. The

3 CZAJLIK et al. 2016, 60-65.

4 CZAJLIK et al. 2015, Fig. 8.

5 TIEFENGRABER 2015, 543.

6 MUŠIČ et al. 2014, 2015.

measurement of the temporal change of the magnetic data was solved by local base measurements, and the rover unit proceeded in variometer layout, the distance between the lines was 0.75 m and the distance within the line was 0.5 m. The GPS data were corrected on the basis of base stations. At every location we tried to carry out the measurements in ideal conditions under the given circumstances. On arable lands, this meant the avoidance of deep-ploughed or seed-bed areas, therefore surveys were usually conducted in the pre-sowing phase, or immediately after harvesting. The orchards of Százhalombatta, after consulting with the owners, were surveyed after pruning, but before flowering. It should be noted, that depending on the type and age of the orchard, a number of lines have been omitted from the measurements, which may cause minor or major problems on the resulted anomaly map but does not generally affect the final evaluation.

The most challenging task was surveying the Százhalombatta site of mosaic cultivation, where 46 hectares was measured in 25 working days (*Fig. 2*). At Süttő, under the circumstance of large parcel cultivation, nine hectares in four days; at Strettweg, on the measurable areas 17 hectares in eight days, and at Jalžabet, six hectares in three days were surveyed with the magnetometer. In July 2017, GPR measurements were also carried out experimentally at Százhalombatta and Jalžabet, however, archaeological structures were not detected using this method.

Since the fieldwork on two out of the four Hungarian sites under research is related to the earlier Early Iron Age research programs of the Institute of Archaeological Sciences (Eötvös Loránd University), they are presented in more detail by a brief description of their research history. At the same time, the Strettweg site was previously researched by the University of Graz (Susanne and Georg Tiefengraber), and the research on Jalžabet was conducted by the Zagreb Institute of Archaeology (Saša Kovačević).

Results

Érd/Százhalombatta–Százhalom and Százhalombatta–Sánc-hegy (Transdanubia, Hungary)

South of Budapest at Érd/Százhalombatta is the beginning of a characteristic loess wall with the river Danube flowing directly by its foot with minor interruptions almost until the valley of Dráva, which represents the eastern border of Transdanubia. At its highest point to the north, in an area accentuated from south and west by a system of natural loess rifts, was the settlement of the Early Bronze Age Nagyrév culture, then the hillfort of the Bronze Age Vatya culture and later – in an expanded area – the Early Iron Age settlement established. The area is still inaccessible from the direction of the Danube, where a 40-45 m tall concave bank is the border. To the north and to the west, emerged the Early Iron Age tumuli field (Százhalom).

In a study published in 2016, it was attempted to compile a detailed topographic research history of the site which was first mentioned in written sources as *Zazholm* at the end of the 13th century, thus only the available traditional ground survey data will be supplemented here.⁷

The topographic data, and 140 years of research history on the tumuli field between Érd and Százhalombatta and the settlement of Százhalombatta–Sánc-hegy in Százhalombatta, were summarized by István Torma in 1986 in the 7th volume of the Archaeological Topography of

7 CZAJLIK et al. 2016, 57–59; T. NÉMETH et al. 2016, 291–292.



Fig. 3. Solitary(?) encircled phenomenon (trace of an Early Iron Age tumulus?) east to the Százhalombatta tumuli field (Z. Czajlik, 9 June 2017).

Hungary (MRT).⁸ From his description it appears that a systematic ground survey, including the collection of surface finds was not carried out – the field work was only intended to verify a map of the tumuli field,⁹ which was based on an aerial photograph made in 1953. Therefore, the boundaries of both sites were determined on the basis of the visible tumuli, the earthworks of the fortified settlement and the archaeological phenomena identified on the 1953 aerial photograph.

Based on the regular aerial archaeological surveys since 2001 and the processing of archive aerial photographs, it has become clear that the necropolis is larger than previously recorded. In the course of the magnetometer geophysical surveys started in 2012, it was identified a large number of circular structures not only in the previously empty areas without archaeological phenomena, but in some cases, in line with the data from aerial photography, beyond the known boundaries of the site, which led to the questioning of fundamental topographic data. Thus, from 2013 onwards, the extension of the necropolis was one of the key issues of the research program.

Based on the previous map and the aerial photography, largely due to the aerial archaeological survey in March 2014, that was carried out in very good vegetation and weather conditions, the limits of the area with the circular phenomena could be suspected.¹⁰ This was confirmed by magnetometer surveys to the north, west and south in 2017, but it is not identified the edge

⁸ DINNYÉS et al. 1986, 27, sites 1–2; 228–233, Pl. 37.

⁹ DINNYÉS et al. 1986, 229, Fig. 26.

¹⁰ CZAJLIK et al. 2016, Fig. 5.



Fig. 4. Trace of NE–SW oriented ditches(?) on the magnetic anomaly map (red arrows), north of the Fécamp-type Celtic rampart (yellow arrow). Implanted in GE-imagery of 31 July 2009 (S. Puszta – Z. Czajlik).

of the cemetery to the east yet. One of the reasons for this is that due to the closed gardens east of the modern road between Érd and Százhalombatta, there are iron fences and air cables under voltage that are technically and physically restraints for magnetometer measurements, and the boundary cannot be defined clearly on the basis of the results from the measurable areas.

The situation became more complicated with the results of the aerial photography carried out in June 2017, which – in addition to the previous photographs with uncertain interpretation – clearly indicated the remains of some solitary tumuli(?) east of this zone (Fig. 3).¹¹ Just a little later, in July 2017, we observed new phenomena in the magnetometer survey south of the above-mentioned circular ditches, north of the fortified settlement. Remains of a wider, 130 m long, NE–SW oriented straight trench(?) and a further ditch section can be observed in the magnetic anomaly map, which are only 100–200 m north from the Fécamp-type Celtic rampart (Fig. 4).

In order to facilitate the interpretation of the data obtained by remote sensing methods, we started systematic surface surveys in the southern area of the necropolis from March 2017 (Fig. 5). These clearly indicated that there was no significant space without finds between the circular structures and the fortified settlement. According to our present knowledge, in line with the results of the smaller ground surveys by Gabriella T. Németh in the 2010s, the most likely explanation seems to be that the Early Iron Age settlement was much larger than previ-

11 The aerial archaeological research was supported by the NRDIO 111058 project.

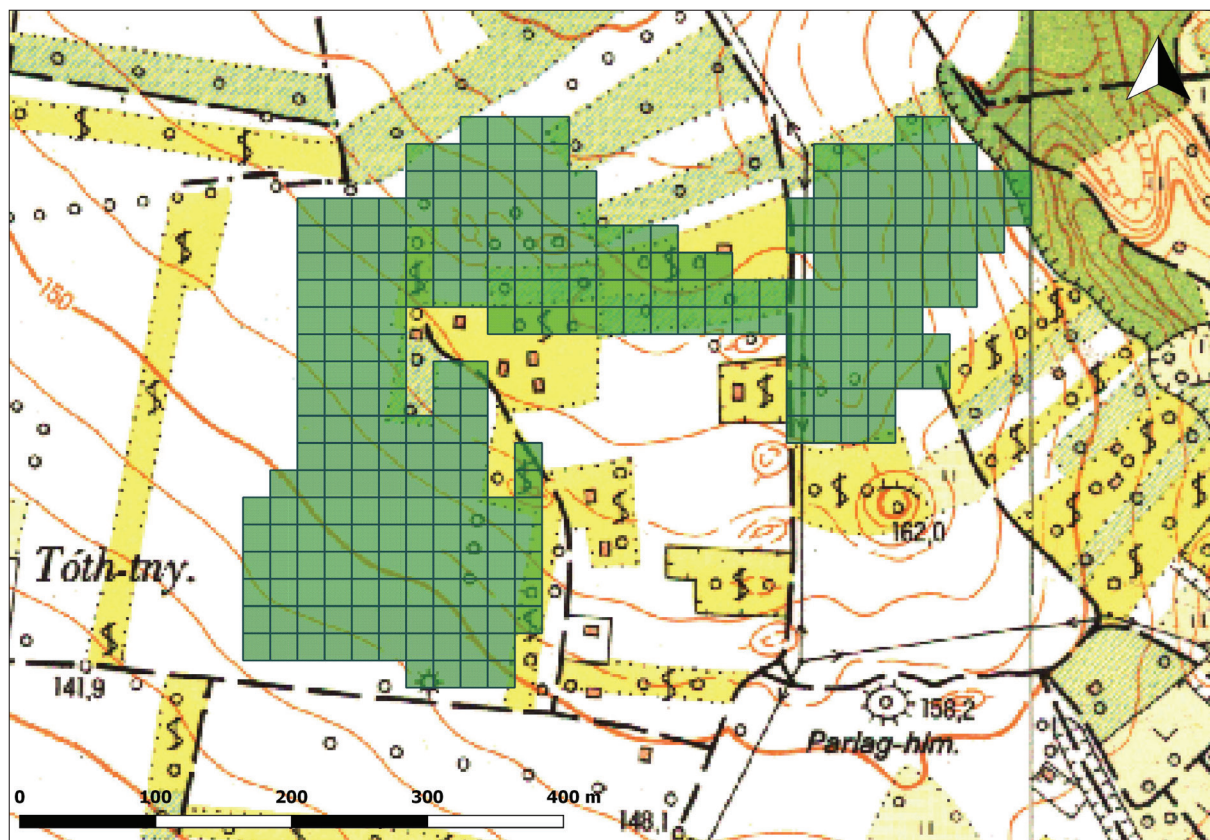


Fig. 5. Areas surveyed with systematic surface survey in the southern part of the Százhalombatta tumuli field (L. Rupnik).

ously assumed on the basis of the imposing Iron Age earthworks. Another important result of the ground surveys is that in the southern zone, the presence of surface finds draws a different picture of the extension of the site, than it would be assumed on the basis of the geophysical surveys, so this work is planned to be extended to all accessible parts of the necropolis in 2018, beyond the boundaries defined by the circular ditches and other features.

Summarizing the results on the internal division of the site, the size of the settlement to the west, between the tumuli and the loess wall next to the Danube is reaching 10 hectares, of which probably 5 hectares area was fortified. The current northern fortification is a Fécamp-type Celtic rampart, while the southern part of the fortification has been destroyed because of the brick factory activity since the end of the 19th century – now it can be reconstructed only with old maps (Fig. 6). The total area of the tumuli field and its associated circular ditches is at least 75 hectares. The number of circular phenomena is 365 on the basis of the 2017 geophysical surveys (and aerial photography), a number which can reach or even exceed 400 by the size of the remaining, measurable areas.

Süttő–Nagysánctető, Kissánc, Sánci-dűlő and Sáncföldek (Transdanubia, Hungary)

Similarly to Érd/Százhalombatta, the Early Iron Age settlements and cemeteries were established on the top of the loess plateau next to the Danube. As detailed in our previous publication, there were two settlements on the loess wall cut up by gullies, sloping into the Danube

(the fall is approx. 40 m), and the necropolises were further south.¹² However, it is a significant difference that this series of loess plateaus is much shorter, and the Neszmély–Süttő section is bordered by mountains from the south, the Gerecse mountain range of more than 600 m.¹³ This made possible the formation of a unique micro-region, which was connected to the territories north of the Danube by cultural ties in prehistoric times.

The first topographic research of the Süttő site identified in the 1930s was carried out between 1968 and 1971 by István Horváth and István Torma in the works of the Archaeological Topography of Hungary. In addition to the identification of a part of the tumuli, on the basis of the two previously known hillforts, an Early Iron Age site complex similar to Százhalombatta have been documented.¹⁴ Both the Nagysánctető settlement and the tumuli, as well as the flat cemetery found in the meantime, were part of the research programs of Éva Vadász and Gábor Vékony between 1978 and 1990, but these could not be processed and evaluated before they deceased. The archaeological evaluation of their previous research is currently carried out by Katalin Novinszki-Groma, in the framework of her PhD-dissertation.¹⁵

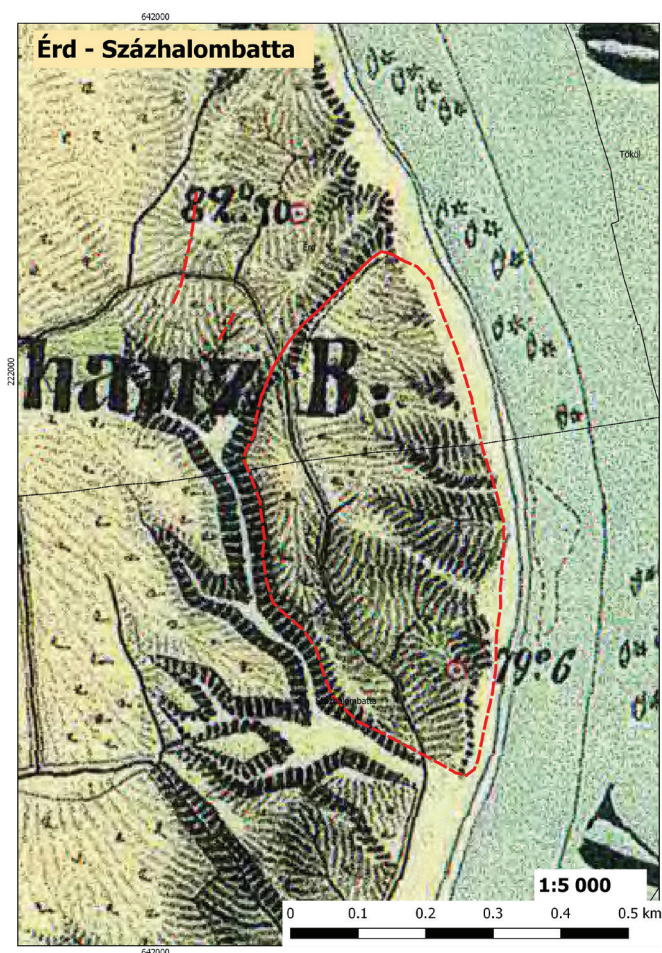


Fig. 6. Százhalombatta–Földvár. Late Iron Age fortified settlement. Topographic reconstruction using the Second Military Survey (1806–1869) implanted the newly identified ditches(?): see Fig. 4. (Z. Czajlik – B. Holl).

12 CZAJLIK et al. 2015, 62–66.

13 CZAJLIK et al. 2015, Fig. 4.

14 HORVÁTH et al. 1979, 311–313.

15 Preliminary reports on the matter: NOVINSZKI-GROMA 2017a; 2017b.

The detailed topographic research of the site that was mainly known previously by Éva Vadász's publications¹⁶ was initiated in 2013. In addition to the regular aerial archaeological prospection, we conducted geophysical magnetometer surveys in 2014. Results of these surveys, together with a detailed evaluation of preceding research history, topography and geomorphology data, were published in 2015.¹⁷ In cooperation with the Institute of Archaeology of the Hungarian Academy of Sciences, we carried out Overhauser and fluxgate magnetometers comparative measurements in 2016. In the course of the simultaneously conducted large-scale field surveys and drone aerial photography, traces of a previously unknown Early Iron Age settlement west of the southern tumuli group were observed.

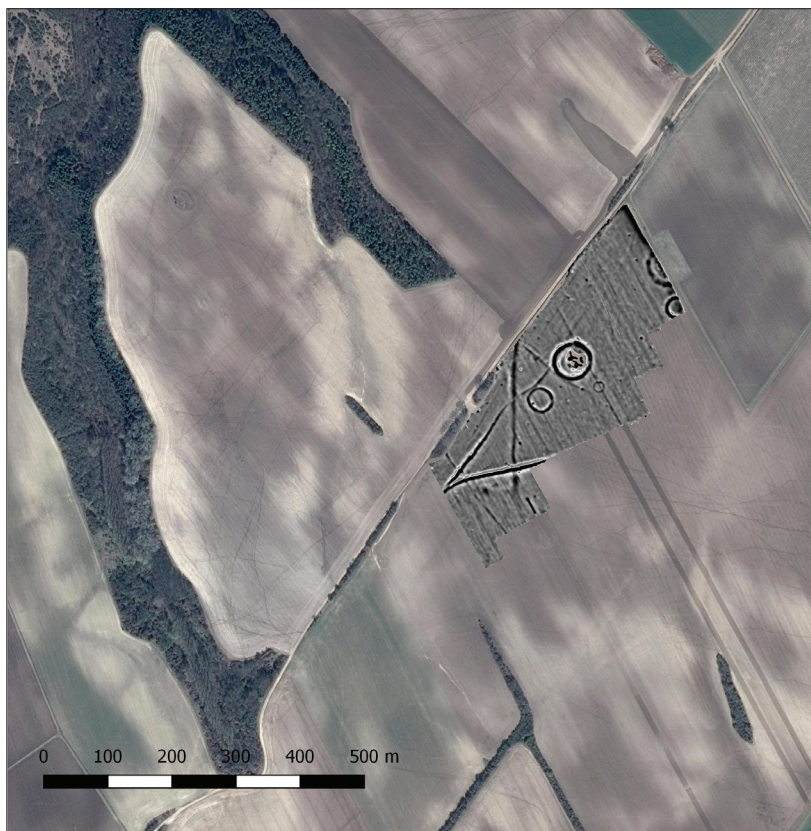


Fig. 7. Süttö–Sáncföldek. Magnetic anomaly map based on the 2017 magnetometer surveys implanted in GE-imagery 29 March 2017 (S. Pusztá – B. Holl).

In the framework of the Iron Age Danube project, geophysical surveys were carried out in 2017 on the southernmost part of the site complex, south of the dirt road connecting Süttö and Dunaszentmiklós (*Fig. 7*). The most prominent circular ditch encircles a relatively large tumulus. East of that, also encircled with a circular ditch, there is the second tallest tumulus of the tumuli group south of the dirt road, researched by Éva Vadász during her excavations between 1978 and 1982. Southwest of the large mound to the west, and south of the excavated tumulus, the circular ditches on the magnetic anomaly map indicate much flatter tumuli, also known from earlier maps published by Éva Vadász. However, the small circular ditch south-east of the large mound (*Fig. 8*) to the west is new.

¹⁶ VADÁSZ 1983, 1986.

¹⁷ CZAJLIK et al. 2015.



Fig. 8. Süttő–Sáncföldek. Early Iron Age burial mound on a drone photograph (L. Rupnik, 24 March 2017).

In December 2017, field surveys were carried out to document the boundaries of the Early Iron Age settlement identified west of the southern tumuli group in July 2016. During the examination of the surrounding areas we identified a grave that could be dated to the transition of the Late Bronze Age/Early Iron Age.

Strettweg bei Judenburg (Obersteiermark, Austria)

The site of Stettweg, north of the Mur river and south of the Pöls creek, is an alluvial valley surrounded by mountains, with well-observable traces of modern iron mining in the adjacent areas, e.g. on Falkenberg (not so extraordinary in Styria). The research area is entirely under agricultural utilization, mainly on smaller or larger parcels, cultivating arable grain, and a relatively dense asphalt road network facilitates the traffic between the villages and majors (Fig. 9).

The research of the Strettweg necropolis – similarly to Százhalombatta – Százhalom – can be traced to the 19th century, when the Strettweg Cult Wagon came to light. A sensational result of modern research was the excavation of a group of almost destroyed princely tumuli (Tumulus II “Helmet grave”, Tumulus III and “Bleikolmhügel”) and especially the re-identification of the famous “Cult Wagon grave” (Tumulus I).¹⁸ At that time, some older aerial archaeological surveys, which were probably confined to a few flights, could not detect further burials in the immediate vicinity of the princely grave,¹⁹ but interesting further traces of questionable

18 EGG 1996.

19 EGG 1996, Pl. 2/1.



Fig. 9. Magnetometer survey areas in the Pölsbach valley, between Waltersdorf and Pölsweg, implanted in high resolution orthofoto (GIS Steiermark 2013, A. Bödöcs).

burials (Pöls, Schloss Gusterheim) could be identified in the Pölsbach valley.²⁰ On the other hand, some new aerial photos show many crop marks from circular ditches in the area of Waltersdorf and Strettweg. These flight data were, ordered by the county of Styria (GIS Steiermark) in the dry summer of 2013. From 2011–2014, Susanne and Georg Tiefengraber initiated large-scale magnetic geophysical research using a multichannel fluxgate magnetometer. The results showed a varied picture, besides the burials enclosed by large, presumably deep circular ditches, circular ditches of half or one-third of their diameter are also present. The phenomena do not fill the available space evenly, they form groups, occasionally relatively far from each other.²¹ From 2012, archaeological excavations have also started, with the research of the larger circular ditches, but also of smaller circular (Tumuli IV–IX in the grave-group “Hauptgruppe”) and rectangular ditches respectively graves (grave-group “Pölsweg”).²²

Due to the late sowing, we had to carry out the measurements in the grave-groups “Müllweg”, “Pölsweg” and “Totenweg” under relatively good weather conditions but on many ploughed surfaces, which did not help to achieve good results. It was surprising that we experienced a very strong anomaly along the road north of Waltersdorf (grave-group “Müllweg”), probably due to the filling of the base of the road with iron-containing rock and iron slag. Our measurements have detected the filled paleomeanders generally well, which are also visible on some

20 EGG 1996, Pl. 2/2.

21 TIEFENGRABER 2015, 543.

22 TIEFENGRABER 2013, 313–316; TIEFENGRABER – TIEFENGRABER 2015, 245–264.

of the aerial photographs showing that the Pöls used to have a curvier water-course, more south of its present location. Due to the parcel boundaries, the ploughed surface and “extra” magnetic anomalies, the background of the surveyed areas was more uneven than average, however, we could identify two small groups of smaller circular features (*Fig. 10*). Among them, in the vicinity of the most remote, westernmost one from the princely grave, Iron Age ceramics were collected on the surface, indicating that measurements would be worthwhile to continue westward in 2018.



Fig. 10. Magnetic anomaly map of recently discovered small circular ditches (tumuli?) north to Waltersdorf, implanted in high resolution orthofoto (GIS Steiermark 2013, S. Pusztai – A. Bödöcs).

Jalžabet–Bistričak (Podravina, Croatia)

The area called Podravina in Croatian and Dráva-mente in Hungarian is a 15 to 30 km wide alluvial plain belonging to the Drava Valley, which is bordered by the Somogy and Baranya Hills from the north, and by Macelj, Toplička Gora, Kalnik, Bilogora and Papuk Mountains from the south. To the south of Drava, prehistoric settlements (and cemeteries) were emerged on the Quaternary terraces bordering the alluvial plain.²³

Following the previous studies of Marina Šimek, the research history of the Jalžabet/Martijanec part of the Podravina region has been summarized recently by her and Saša Kovačević.²⁴ The most important conclusions of these studies that the Early Iron Age tumuli of the region began to be surveyed in 1956,²⁵ devoting the greatest attention to the great mounds of Martijanec and Jalžabet. The latter is one of the largest tumuli of the Eastern Hallstatt Circle with a diameter of 75 m and a height of 12 m. The shape of the mound called Gomila is also interesting, which suggests a truncated cone. In 1963, on the northern and southern sides, research trenches were excavated, in which an artificial pebbled level (mantle of the tumuli?) was reached.²⁶ 130 m east of Tumulus I, Marina Šimek identified and excavated the remains of

23 ŠIMEK – KOVAČEVIĆ 2014, 231–232.

24 ŠIMEK 1998, 493; 2004; ŠIMEK – KOVAČEVIĆ 2014.

25 VINSKI-GASPARINI 1961, 39, Fig. 3.

26 ŠIMEK – KOVAČEVIĆ 2014, 234, Fig. 2.

Tumulus II, where a burial chamber made from wood and stone with *dromos* were observed.²⁷ Although Tumulus II was flattened, the remains of the mantle made from pebbles were found. In 1989, geoelectric measurements were carried out in north-south direction through the two tumuli, and the third section crossed the two tumulus east-west, which was pioneering work for the time being in Croatia.²⁸ In 2016, a fluxgate magnetometer survey was conducted by Cornelius Meyer on behalf of the Eastern Atlas geophysical company from Berlin at the Gomila and its surroundings, and a ground penetrating radar (GPR) survey was also carried out on a smaller surface at the top of the Gomila.

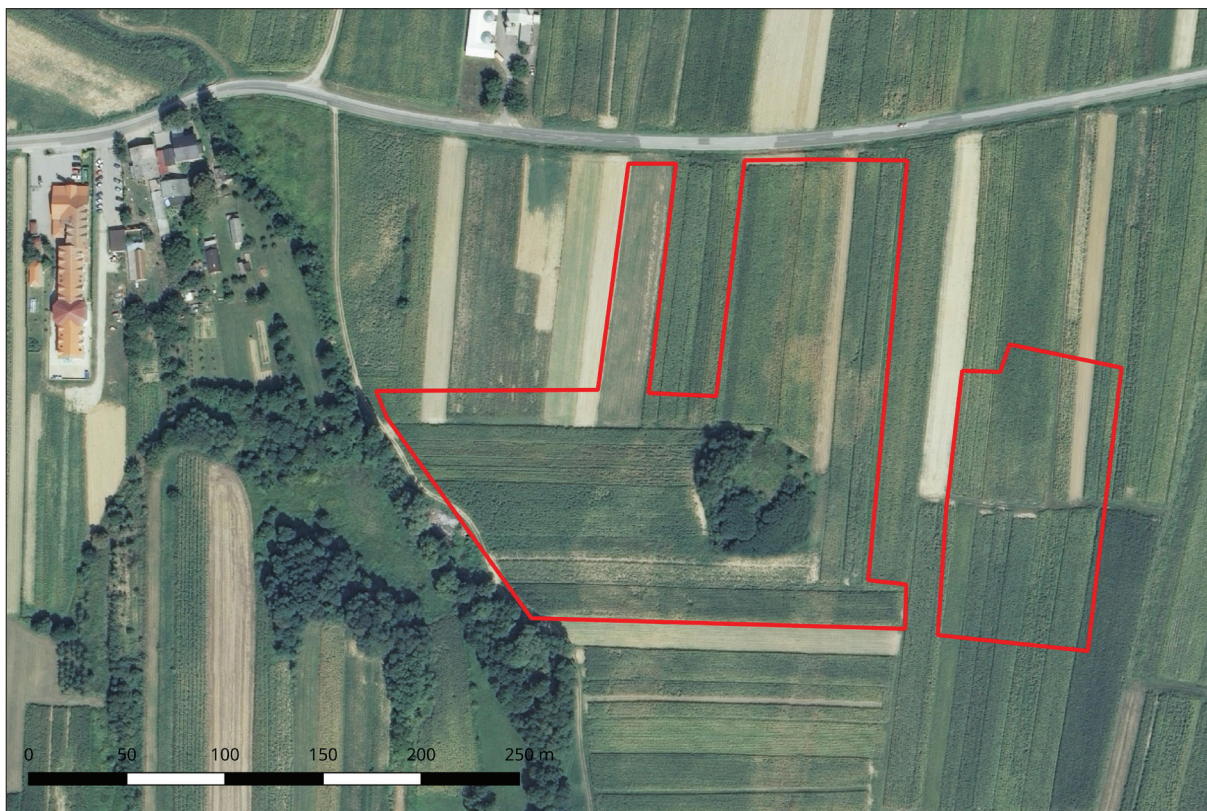


Fig. 11. Magnetometer survey areas in Jalžabet – Bistričak (Podravina, Croatia) implanted in DOF5 (Digitalna Ortofoto Karta 1:5000, A. Bődöcs).

Cultivation in narrow parcels is characteristic for the whole region, with the disadvantage that crop rotations are mostly different in adjacent parcels (Fig. 11). Therefore, during the first series of measurements carried out in April 2017, we only surveyed areas not yet ploughed or sown, as well as the top and the side of the tumulus, as long as its slope allowed it. In July 2017 we carried out measurements on the missing parts following the harvest of autumn sown grain, and started experiments with the GPR. An unexpected difficulty was on both occasions that there was often a significant difference in height between the parcels and occasionally even a smaller trench formed, which did not allow the gapless joining of the surveyed areas. Partly due to this, modern cultivation trails have remained the dominant elements of the magnetic anomaly map. It is not possible to observe the incidental remains of the excavated tumulus and certainly the disturbance caused in 1963 by the trenches north and south of the

27 ŠIMEK 2004, 126–127, Fig. 40.

28 BATURIĆ et al. 1990; ŠIMEK – KOVAČEVIĆ 2014, 235, Map 3, Fig. 5.



Fig. 12. Magnetic anomaly map in Jalžabet – Bistričak (Podravina, Croatia) implanted in Croatian base map 1:5000 (A. Bődöcs).

Gomila do not assist in the evaluation either. There are few archaeological phenomena on the map for that matter, a larger pit (ditch initiative?) on the north-western – northern side of the Gomila=Tumulus I (and the traces of the excavated Tumulus II) should be mentioned here. Results of the magnetometer survey done in 2016 and 2017 were indicative and later were tested by archaeological excavation during Iron-Age-Danube Interreg DTP Camp Jalžabet in September 2017. During September Camp, 3D electrical resistivity tomography survey was conducted at the top of the Gomila by Brane Mušić from University of Ljubljana. One of the indicative results after archaeological excavation in Jalžabet in September 2017 is that soil is very rich with alluvial iron. This can help during future geophysical surveys in Jalžabet area.

The approximately flat surface on the top of the truncated cone-shaped mound (Gomila) made it possible to carry out measurements there as well (Fig. 12). A few months later, in September 2017 became clear that the most significant anomaly was probably caused by the illegal tunnel through which they reached the burial chamber and robbed the tumulus of unparalleled interest. After robbery was discovered, with intervention funds of the Ministry of culture of the Republic of Croatia Institute of archaeology started rescue excavation of Gomila. The excavation, which proved to be very demanding, complex and expensive, will be continued in 2018.

Summary, perspectives

In 2017, in the framework of the Interreg DTP Iron Age Danube project, we carried out magnetometer geophysical survey at four important Early Iron Age necropolises in three countries, on altogether 76 hectares. Research has relied on previous topographic programs in each case, which helped to organize and significantly increased the effectiveness of the surveys.

We worked with methods developed by Sándor Pusztá and Balázs Holl, and later by us in our own projects for decades throughout the whole period, only the details of data processing can be different between the measurements.

In general, it can be stated that surveys on the loess plateaus provided clearer, more easily evaluable results than the ones in the alluvial areas (Strettweg) and their bordering Quaternary terrace surfaces (Jalžabet). This is mainly due to the greater geological inhomogeneity of the latter areas, and secondarily, in the latter case the small-parcel agricultural cultivation (Jalžabet) and special local conditions (ferriferous inhomogeneities?).

The most important task of the next period is to prepare the ALS survey in the zone of Jalžabet–Martijanec and the execution of geophysical surveys based on the existing ALS-based DTM at the – in this regard unresearched – site of Sopron–Várhely. At the same time, aerial archaeological photography and magnetometer surveys must be continued on the sites in focus, as well as systematic field surveys in larger areas for the interpretation of archaeological phenomena observed with various methods.

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