

## LARGE-SURFACE MAGNETOMETER SURVEY OF NEOLITHIC SITES IN THE KALOCSA AND TOLNA SÁRKÖZ

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*Over the last few decades, compared to the complete excavation of sites found in areas affected by earthwork, a growing emphasis has been put on the more reliable preliminary exploration of the extension and type of archaeological coverage in the fields of archaeological research and cultural heritage protection. The change in attitude has been promoted to a great extent by the technical development of remote sensing, non-destructive field surveys and GIS. These non-invasive techniques include magnetometry. Due to the developments, the latest generation of magnetometers is suitable for surveying large, continuous areas. In autumn 2011 and spring 2013 two particularly important Neolithic sites in Tolna Sárköz, and one in Kalocsa Sárköz were subjected to nearly complete magnetometer surveys within the frame of an international collaboration. Prior to the surveys, field walking was undertaken at all three sites, and in the case of the two sites in County Tolna even excavations were conducted. The aim of the present investigations has been to define more precisely the extension of the sites, and to prepare further scientific research projects.*

As a result of the development of non-invasive, instrumental methods, it has become possible by now to determine the exact extension of sites or archaeological coverage over large areas. However, instrumental surveys are generally only suitable for detecting the position of archaeological features. For the exact determination of the age and type of sites, other field methods have to be used, such as systematic field walking, or the so-called shovel test.\* If possible, the observations must be confirmed with test trenches as well.

One possible method for the instrumental survey of archaeological features is magnetometry. The scientific basis for the method is the observation that archaeological features in the ground exhibit different magnetic signatures than the surrounding material because of varying magnetic susceptibilities and permanent magnetization. With the help of a magnetometer, this magnetic field can be measured and differentiated from the magnetic field of the environment.

In the last decade, archaeological research too started to apply magnetometers that are suitable for assessing large, contiguous areas, even entire sites during a relatively short period of time. In the past two years, the Institute of Archaeology of the Research Centre for Humanities, Hungarian Academy of Sciences, joining an international collaboration, had an opportunity to conduct large-surface magnetometer surveys on three already known archaeological sites (Fajsz-Kovácsalom, Alsónyék-Bátaszék and Tolna Mőzs Neolithic settlements and their wider environment). The research was undertaken within the framework of the European FP7 project of the *Römisch-Germanische Kommission* of the *Deutsches Archäologisches Institut* (Frankfurt) investigating Neolithic settlement systems.

The field surveys were undertaken in two separate stages in autumn 2011 and spring 2013, adjusted to the size of the areas to be assessed and the land use of agricultural areas. The applied instrument was a

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\* Shovel test: a method used for the identification of archaeological sites, which can primarily be used effectively on territories exempt from deep agricultural cultivation (such as pastures, woodlands, and bushy areas). The essence of the method is that the uppermost layer of the ground is examined in a regular grid pattern, in small test pits, to find out whether it holds any find suggesting archaeological sites.



*Fig. 1: Sensys Magneto® MX, sixteen sensor magnetometer at the Alsónyék archaeological site*

Sensys Magneto® MX, sixteen sensor fluxgate magnetometer, which – under ideal conditions – allows an area of 25 hectares to be surveyed a day (*Figure 1*). Due to local agriculture based primarily on wheat and maize production, there was a relatively short period of time when large, continuous areas exempt from cultivated plants were available for investigation. This timeframe was limited to the period following the autumn harvests and preceding the spring sowing.

As it has been already mentioned in the introduction, magnetometer surveys have their own limitations. Although the method can be used well to record anomalies of archaeological origin, it is not suitable for dating the identified site in itself. Therefore, when selecting the sites to be investigated, it was of primary concern to have archaeological information about the area, and to know the periods occurring at the site. It is important that well identifiable, datable settlement structures would be available, which are clearly recognizable on the results of the surveys and allow us to identify the continuation of settlement details already known from excavations. In the Tolna area we selected two sites partially excavated before the construction of the M6 motorway. The Neolithic site at Tolna-Mözs can be dated to the period of the Central European Linear Pottery Culture. At the Alsónyék site there was a settlement that was occupied in several phases of the Neolithic, but it belonged mainly to the Late Neolithic Lengyel Culture. These sites yielded a large amount of well-datable artefacts. Data suitable for GIS use recorded during the excavation were also available to us: settlement structures, house clusters, and ground plans of houses.

At Fajsz-Kovácsshalom, in Kalocsa Sárköz an already known, tell-like settlement was assessed. So far, no archaeological excavation has been conducted there. Archaeological coverage is known from field walking and a systematic series of core samples. On the basis of finds collected from the surface, the multi-layer settlement can be dated to the beginning of the Late Neolithic period, but the early layers found at the bottom of the nearly three-metre-thick stratigraphic sequence could have also developed from the beginning of the Middle Neolithic. In the following we present the preliminary results of the surveys undertaken at the three sites.

## KALOCSA SÁRKÖZ

### *Fajsz*

Kovácsshalom at Fajsz, in Kalocsa Sárköz is a site that has long been known from the archaeological point of view. It must have been a hill rising above an inundation area before the river regulations. Due to its geomorphological conditions, it provided an excellent site for human habitation in several periods.

As a result of modern agricultural cultivation, a significant amount of surface finds can be found on the higher parts of the elevation. Our investigations were targeted at the intensity and the dimensions of human settlement at the top of the hill, as well as settlement structures on the plains surrounding the elevation.

In the framework of a Hungarian-German co-operation in 2001, core soil samples were taken which showed a definite anthropogenic stratigraphic sequence at the top of the hill, and a deep, filled up trench around that. The magnetometer surveys, supplemented by the dating of artefacts collected on the area, testified that the very top of the hill was under intensive use during the late phase of the Neolithic. Anomalies suggest that this part of the hill was once covered by a thick layer of debris, which has been significantly destroyed by agricultural cultivation by now. However, on the flat area surrounding the hill we did not find any evidence of features of human origin.

On magnetometer maps made at the southern side of the hilltop, one can clearly see burials encircled by trenches, which are likely to be relics of an era later than the Neolithic period. On the surface, the existence of the burials was shown only by large quantities of human bone fragments. We did not discover any artefact that would have determined the exact period (*Figure 2*).

## TOLNA SÁRKÖZ

The aim of magnetometer surveys in Tolna Sárköz was to measure possibly the entire extension of the partially excavated sites. Large-surface excavations connected to investments provide an opportunity to uncover only those areas that are affected by the earthwork, which normally do not comprise the entire archaeological site. In the case of the Tolna-Mözs site, for example, the north-south directed motorway track represented only a narrow strip of area from the site. The eastern and western dimensions of the Neolithic settlement were unknown; about this and the inner structure of the settlement only the magnetometer survey provided reliable information.

### *Alsónyék*

A significant part of the large site was uncovered by members of the Institute of Archaeology of the Hungarian Academy of Sciences during archaeological works preceding the construction of the M6 Motorway, between 2006 and 2009. In addition to several different periods, traces of colonization are known from nearly the entire Neolithic. In the southern part of the excavated area, at the place of the motorway engineering site, large pits and ovens of the Starčevo Culture dated to the Early Neolithic were discovered. We hoped that with the help of the magnetometer surveys, we would manage to identify in this area house clusters and house plans belonging to the period. Unfortunately, during the construction of the motorway the territory became significantly polluted with recent magnetic materials, thus limiting the results with respect to archaeological prospection. The evaluable observations proved merely that large clay extraction pits occurred outside the excavated area as well. Traces of house foundations were, however, not observed.

East of the junction, in 2008–2009, during excavations conducted before the construction of the access road and the roundabout junction, the staff of the Tolna County Museum Directorate identified – in addition to traces of several other periods – ditch sections seeming concentric, several pits, and inhumation burials clearly datable to the Late Neolithic. During the subsequent processing work, it was clarified that the features showed the characteristics of Sopot Culture dated to the early phase of the Late Neolithic. This time, the magnetometer survey focused on the concentric ditch sections. We assumed that we would be able to identify traces of circular ditches typical of the period. As a result of the assessment, however, it could be observed that the otherwise well-defined multiple trenches were not circular, but were adjusted to the meander of the former river bed found north of the area. The territory bordered by the river from the north was surrounded by the observed trench at the three remaining sides. In the area encircled by the ditch we observed numerous pits, the traces of some dwelling buildings – pieces of wattle-and-daub and features with



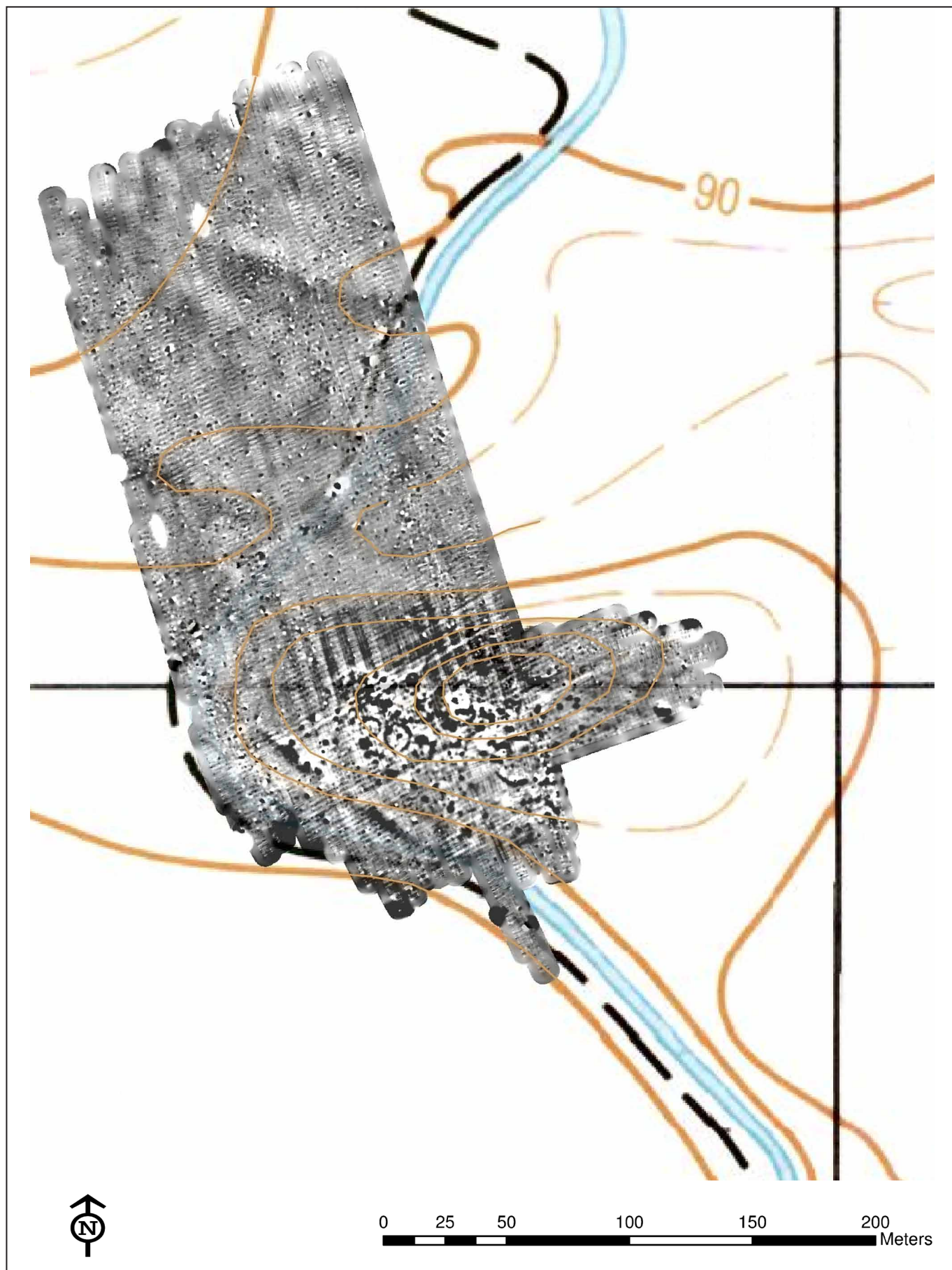


Fig. 2: Results of the magnetometer survey of a tell-like settlement at Fajsz on a 1:10.000 scale map

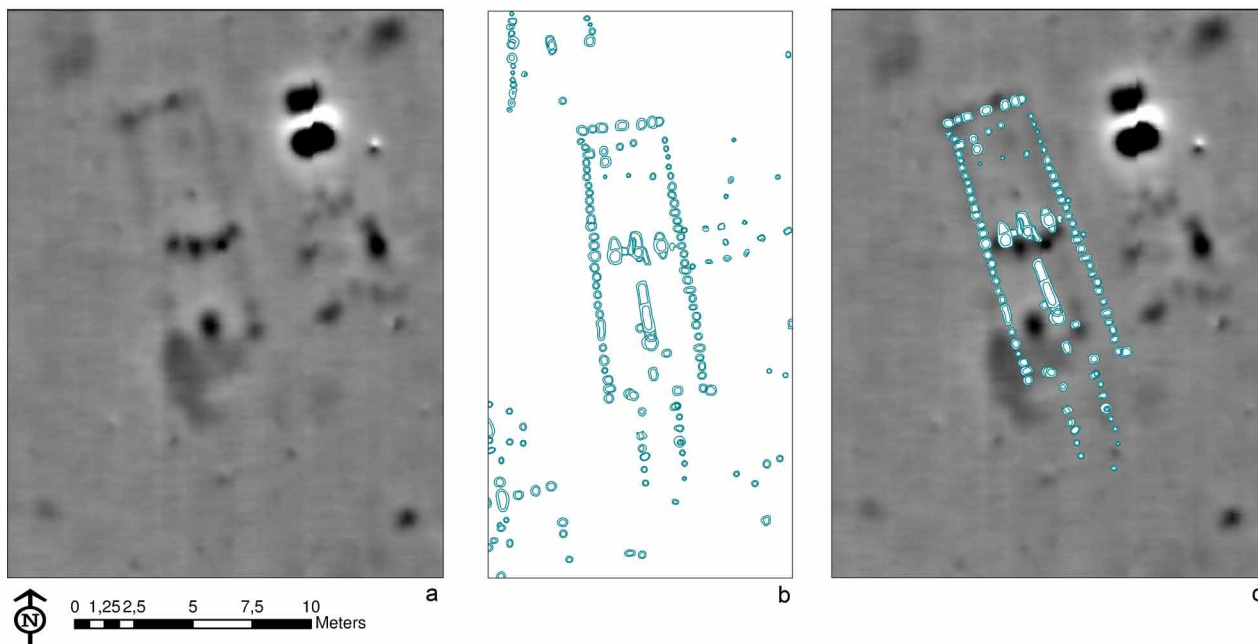


Fig. 3: Ground plan of a dwelling house belonging to the Lengyel Culture: a) identified by magnetometer survey; b) outline of an excavated building; c) the two types of data compared (Alsónyék)

foundation ditches – as well as traces of ditch sections of unknown age and burials presumably encircled by ditches. Interestingly enough, the magnetometer survey did not reflect any sign of the Avar graveyard, several burials of which had been uncovered during the excavations preceding the construction. The reason for this could be either that a large part of the cemetery was located west of the roundabout junction, outside the survey area, or that in the case of the cemetery the analysis of the data yielded by the magnetometer survey requires further refinement.

Based on the data of the excavations, the centre of the site was found at the territories of the motorway track and the junction. In this area, we have data about longitudinal pits belonging to the specific dwelling-house forms of the Central European Linear Pottery Culture and other pits of the settlement. In addition to that, a large number of house remains belonging to a large settlement of the Late Neolithic Lengyel Culture (Figure 3) and more than two thousand burials of its inhabitants were excavated.

Unfortunately, the former and present beds of the Lajvér Stream as well as a railway line pass through this part of the area. Consequently, the system of allotments is relatively fragmented. Due to crop rotation applied here, the measurement of territories adjacent to the excavated track was beset with several difficulties. In spite of that, on territories found east of the track, a pattern comprising some scattered dwelling houses could be identified. In addition, large ditches already observed during the excavations could be assessed, the functions of which have not been identified yet. At the north-eastern part of the investigated area we practically did not observe any archaeological feature. Nevertheless, the evaluation of the surveys was practically impossible because of the public utilities crossing the area, since the steel pipeline used for the transportation of gas highly distorted signals captured by the sensors.

Unfortunately, the territory found west of the junction could not be surveyed due to lack of time. The Late Neolithic site presumably continues in that direction.

#### *Tolna-Mözs*

The excavation of the site identified north of the junctions of M6 and M9 Motorways was conducted in 2008–2009. The relief model made of the area clearly shows that the track of the motorway passes through the middle of a gently sloping hill running in the middle of a network of riverbeds dried by now. At the southern edge of the hill ridge, it could be observed that people settled there in various periods.

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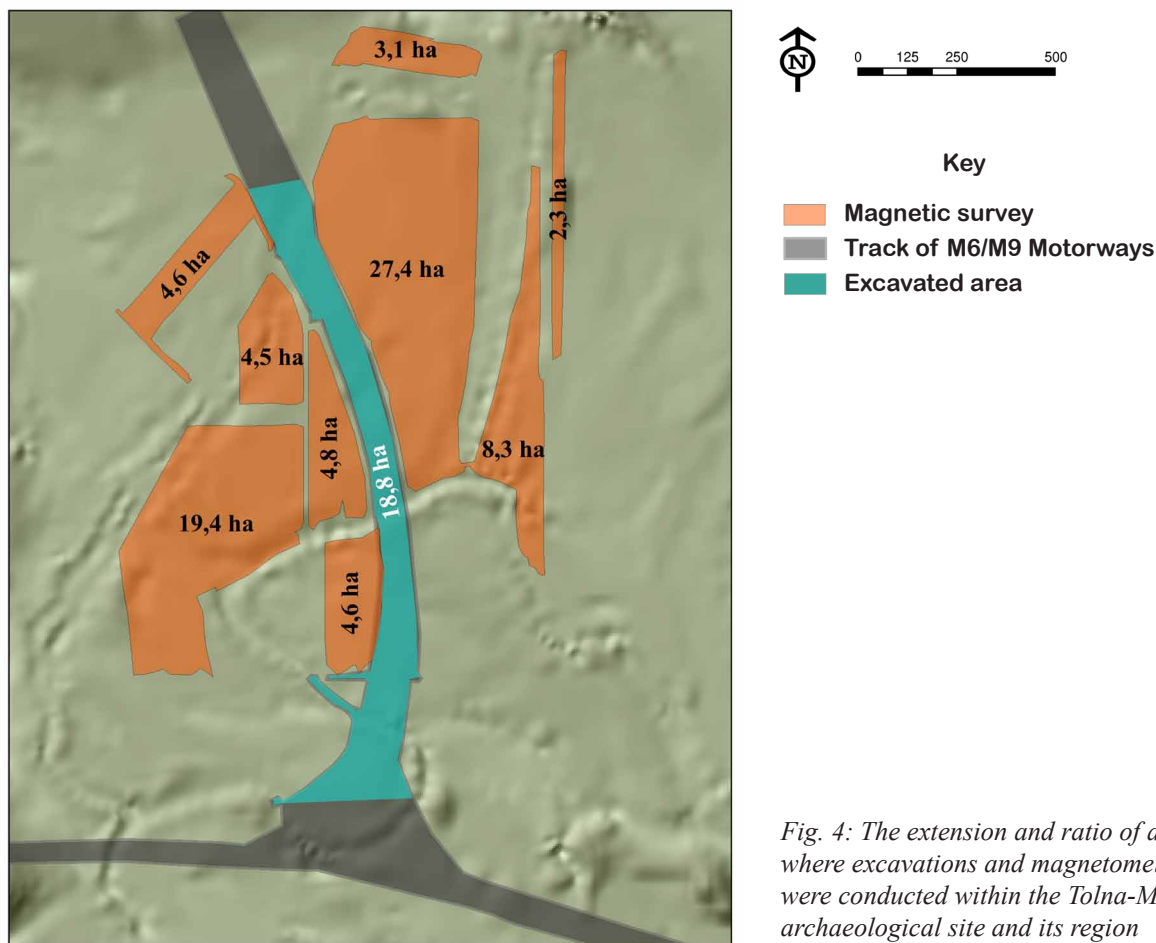
Despite the large number of features dug in one another, archaeologists processing the finds were able to differentiate a house cluster dated to the time of the Central European Linear Pottery Culture. The special post-structure housing type of the period is generally outlined on magnetometer maps. Post holes representing traces of the frame structure of houses can be less observed. However, the so-called longitudinal pits running parallel with the longitudinal axis of the house are generally clearly visible.

North of this area, the archaeological coverage of the site is far more modest. Two characteristic house clusters can still be well observed, which can also be dated to the period mentioned above. Based on the chronology and types of the unearthed pottery, however, experts could demonstrate chronological difference between the house clusters.

During the magnetometer surveys we had an opportunity to assess the whole territory of the hill ridge along the eastern and western sides of the motorway (*Figure 4*). Data demonstrate that the two house clusters identified at the northern part of the area continue eastwards. East of the three house clusters, a fourth group of houses was outlined on the opposite side of the river-bed remains that was unknown before the measurements. It also bears the characteristics of settlement patterns typical of the Central European Linear Pottery Culture. On the western side, over a territory essentially devoid of archaeological features, a fifth group of houses could be observed that was again identified exclusively by the magnetometer survey.

At the present stage of the investigations, the relative chronological position of the new house clusters discovered during the surveys cannot be determined more closely within the settlement, thus it is still not possible to outline the entire inner development of the settlement.

Outside the territory of the hill ridge that is also visible on the relief model, we did not discover anomalies suggesting archaeological features. This also demonstrates well that during the Neolithic, in the natural state of the area, the river beds and river bed sections were regularly or permanently under water at certain periods of time, which made them unsuitable for human habitation.



*Fig. 4: The extension and ratio of areas where excavations and magnetometer surveys were conducted within the Tolna-Mözs archaeological site and its region*



The magnetometer survey undertaken on a territory of approximately 130 hectares within the framework of an international collaboration is hitherto of unprecedented scale in Hungary. The surveys focused on three sites of a given geographical unit of approximately the same age. In each case we had archaeological data already prior to the magnetometer survey. The results of the survey clearly demonstrated that with the help of non-invasive instrumental techniques one can obtain a previously entirely unknown body of information about archaeological sites in a comparatively short period of time and at a relatively low cost. This holds true even for those sites, where, tens of hectares of territories were excavated connected to large-scale investments. Using the non-destructive research methods introduced above, one can assess the archaeological coverage of much larger areas. The method produces a great amount of high-precision data, which provides essential help for the appropriate planning of scientific research projects as well as archaeological excavations preceding constructions.

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