ACADEMIA ROMÂNĂ
FILIALA TIMIȘOARA
Institutul de Cercetări Socio-Umane „Titu Maiorescu”

STUDIA BANATICA

SERIES HISTORIA

Anul II

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ARCHAEOLOGY

HISTORY

ENCLOSED SETTLEMENTS AND CULTURAL DYNAMICS IN THE EARLY ENEOLITHIC OF THE LOWER MUREȘ REGION

Victor Sava, Adrian Cristian Ardelean**, Daniela Sava***, Adriana Sărășan*****

Cuvinte cheie: eneolitic timpuriu, Tiszapolgár, Bodrogkeresztúr, așezări fortificate, Regiunea Mureșului de Jos, tranziția neolitic-eneolitic
*Key-words:*Early Eneolithic,Tiszapolgár, Bodrogkeresztúr, enclosed settlements, Lower Mureș Region, Neolithic–Eneolithic transition.

Așezări fortificate și dinamici culturale în eneoliticul timpuriu din regiunea Mureșului de Jos

Abstract: The present study focuses on an under-researched type of Early Eneolithic settlement in the Intra-Carpathian area, namely enclosed settlements. These sites, typically surrounded by a ditch and occasionally a palisade, some with complex stratigraphy, evoke the tell-type habitations characteristic of the Late Neolithic. By identifying four new sites of this kind and reassessing the previously known settlements at Pecica–PEC012ASZ/Forgaci and Sântana–Holumb = Dâmbul Popilor, we highlight the persistence of certain Late Neolithic traditions in the construction of tell-like settlements. The primary objective of this study is to identify and typologically characterise Early Eneolithic enclosed settlements in the Lower Mureș region. Non-invasive research methodologies are here employed for reconstructing the transition from Neolithic tell-type habitats to the horizontal settlements that are characteristic of the Tiszapolgár and Bodrogkeresztúr cultures. The results of the research indicate that the transition from the Neolithic to the Eneolithic in the Lower Mureș region was not indicative of a cultural rupture, but rather a gradual process of adaptation. The continuity of certain construction practices, such as the delimitation of space by ditches, reflects a sustained structural approach to the organization of communal areas. This finding opens new avenues for research into the relationships between mobility, identity, and collective memory in prehistoric communities.

Introduction

After nearly five centuries of continuous occupation in Neolithic tells, significant transformations can be observed in the social, economic, and cultural organization of communities[1]. These changes mark the transition to the Early Eneolithic, characterized by more dispersed settlements, the emergence of dedicated funerary spaces, and the appearance of distinct social hierarchies.

Thanks to recent research and the extensive use of AMS dating, the chronology of this period has become increasingly precise. The major changes associated with the abandonment of tells were not abrupt but unfolded gradually over several generations, representing slow transformations within segments of society[2]. Regarding funerary practices, there is evidence of a gradual adaptation to Eneolithic realities, without a sudden rupture from earlier Neolithic

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[1] See: Brummack, Diaconescu 2014; Diaconescu 2014; Drașovean 2014; Drașovean 2021, 411-473; Siklósi, Szilágyi 2021; Drașovean 2022.
[2] Sava 2015, 303-304.

traditions[3]. For example, recent studies indicate that diet and domestic animal management east of the Tisza did not undergo substantial changes between the Late Neolithic and the early Eneolithic[4]. However, strontium isotope analyses of human and animal remains suggest increased mobility among Early Eneolithic populations, particularly within the Bodrogkeresztúr cultural sphere[5]. Although these transformations are observable at the end of the Neolithic and the onset of the Eneolithic, aDNA studies indicate continuity of genetic lineages throughout the 5th millennium BC[6].

To better understand the particular dynamics inherent to the Early Eneolithic in the lower Mureș region[7], a case study focused on settlements of this period was undertaken. The study area encompasses Arad County, covering approximately 8,000 km², which corresponds to the central portion of the Lower Mureș region. Considering recent discoveries in the county's lowlands—especially the cemetery at Pecica-PEC011 and the surrounding settlements—this region provides a unique opportunity to investigate the evolution of human habitats during the Early Eneolithic.

The current paper focuses on a scarcely known type of settlement within the Tiszapolgár and Bodrogkeresztúr cultural areas enclosed settlements. These settlements, typically enclosed by a ditch and occasionally by a palisade, some with complex stratigraphy, recall the tell-type habitations characteristic of the Late Neolithic. By identifying four new sites of this type and reassessing the previously known settlements at Pecica–PEC012ASZ/Forgaci and Sântana–Holumb = Dâmbul Popilor, we highlight the persistence of certain Late Neolithic traditions in the construction of tell-like settlements.

Terminologically, this study employs terms such as "enclosure", "fortification", "tell", or "tell-type settlement." Here, these terms are used descriptively to denote any topographically visible boundary in the form of a ditch or bank, irrespective of its function (defensive, symbolic, or for drainage). The term "enclosed settlement(s)" is arguably the most neutral and appropriate for the sites discussed, as it reflects the realities observed without attributing an exclusively defensive role to the ditches.

The primary objective of this study is to identify and typologically characterize Early Eneolithic enclosed settlements in the Lower Mureș region, integrating non-invasive methodologies to reconstruct the transition from the Neolithic tell-type habitats to the horizontal settlements characteristic of the Tiszapolgár and Bodrogkeresztúr cultures.

Methodology

Over the past several years, a series of non-invasive archaeological investigations have been conducted within the studied area, aimed at assessing the archaeological potential of specific micro-regions. To this end, systematic field surveys were undertaken across several administrative-territorial units (ATUs). Within the framework of the ArheoPecica project, ATU Pecica and its surrounding areas were investigated. During these surveys, three of the sites discussed here were identified: Curtici – CRT012ASZ, Pecica – PEC035ASZ, and Pecica – PEC037ASZ[8]. The well-known settlement Pecica – PEC012ASZ/Forgaci was also reassessed as part of the same project[9]. Furthermore, three additional flat settlements and two

[3] Siklósi 2013.
[4] Giblin, Yerkes 2016.
[5] Giblin 2009; Giblin et al. 2013; Hoekman-Sites, Giblin 2012.
[6] Szécsényi-Nagy 2025.
[7] See: Sava 2015, 12–15 for a geographical and cultural definition of this region.
[8] Sava et al. 2023a, 255-256.
[9] Sava et al. 2022.

previously unknown funerary spaces in the Pecica micro-region were identified and partially excavated over the last decade[10].

In 2024, the results of further surveys conducted in the north-western corner of Arad County were published[11]. On this occasion, the settlement at Macea – MAC002ASZ was identified, together with another unenclosed site in ATU Pilu[12]. Additional unenclosed settlements were discovered during investigations in ATU Șagu[13].

For the purposes of this study, a selection of the known Early Eneolithic settlements in Arad County was made based on the presence of fortification features. Of the six sites under consideration, four sites have been recently discovered (Curtici – CRT012ASZ, Macea – MAC002ASZ, Pecica – PEC035ASZ, Pecica – PEC037ASZ), while two have already been extensively documented in the existing literature (Pecica – PEC012ASZ/Forgaci, Sântana – Holumb = Dâmbul Popilor).

In order to obtain relevant data on the selected settlements, several non-invasive methods were applied. Surface surveys enabled the establishment of relative chronologies, the approximate size of each settlement, and the intensity of habitation. For Pecica – PEC012ASZ/Forgaci, additional information was drawn from archaeological test trenches conducted at the end of the 20th century, as well as from various rescue excavations targeting different parts of the site.

Digital elevation models (DEMs) were generated for each settlement using freely available LiDAR data provided by the Government of Romania via https://geoportal.ancpi.ro/portal/home/. Satellite imagery from Google Earth and declassified CORONA images from the 1960s (https://corona.cast.uark.edu/atlas#zoom=3&center=0,3000000) were also utilized. In addition to these datasets, all six sites were documented through drone photography. The DEMs, satellite images, and aerial photographs enabled the identification of several characteristic features of each settlement.

Two settlements were selected for magnetic prospections. Pecica – PEC035ASZ was fully surveyed over an area of approximately 2.5 ha, while in Sântana – Holumb = Dâmbul Popilor, 3.5 ha were surveyed, covering a substantial portion of the site, though not its entirety. Nevertheless, the data obtained provide valuable insights into the internal organization of the settlement.

LiDAR and magnetic data were verified through direct field observations. However, interpretations of ditch morphologies must consider the effects of ploughing and erosion, and the lack of systematic excavations necessitates caution when assessing the function of these features.

Results: Description of the Archaeological Sites

Archaeological investigations conducted over time in Arad County have led to the identification of 53 Early Eneolithic settlements. Of these, 43 are associated with the Tiszapolgár ceramic style, while 10 correspond to the Bodrogkeresztúr ceramic style (**Fig. 1.1**). The majority of the settlements are located in the lowland areas, both south and north of the Mureș River. Only a few are situated within the mountainous gorge of the Crișul Alb or near some of its tributaries. Settlements linked to the Tiszapolgár ceramic style are considerably more widespread than those of the Bodrogkeresztúr style, maintaining an approximate ratio of 4:1.

[10] Sava et al. 2017; Sava, Ursuțiu 2020a; Sava, Ursuțiu 2020b; Sava et al. 2023a, 252-256; Sava et al. 2023b.
[11] Sava 2024.
[12] Cireap et al. 2024.
[13] Sava et al. 2025, 119-112, 142-150.

These settlements are predominantly located in areas rich in water resources, often near paleochannels that remain visible today, either in the field or on DEMs generated from LiDAR data. Analysis of settlement density provides a clearer understanding of the intensity of land exploitation and the degree of aggregation of communities during this period.

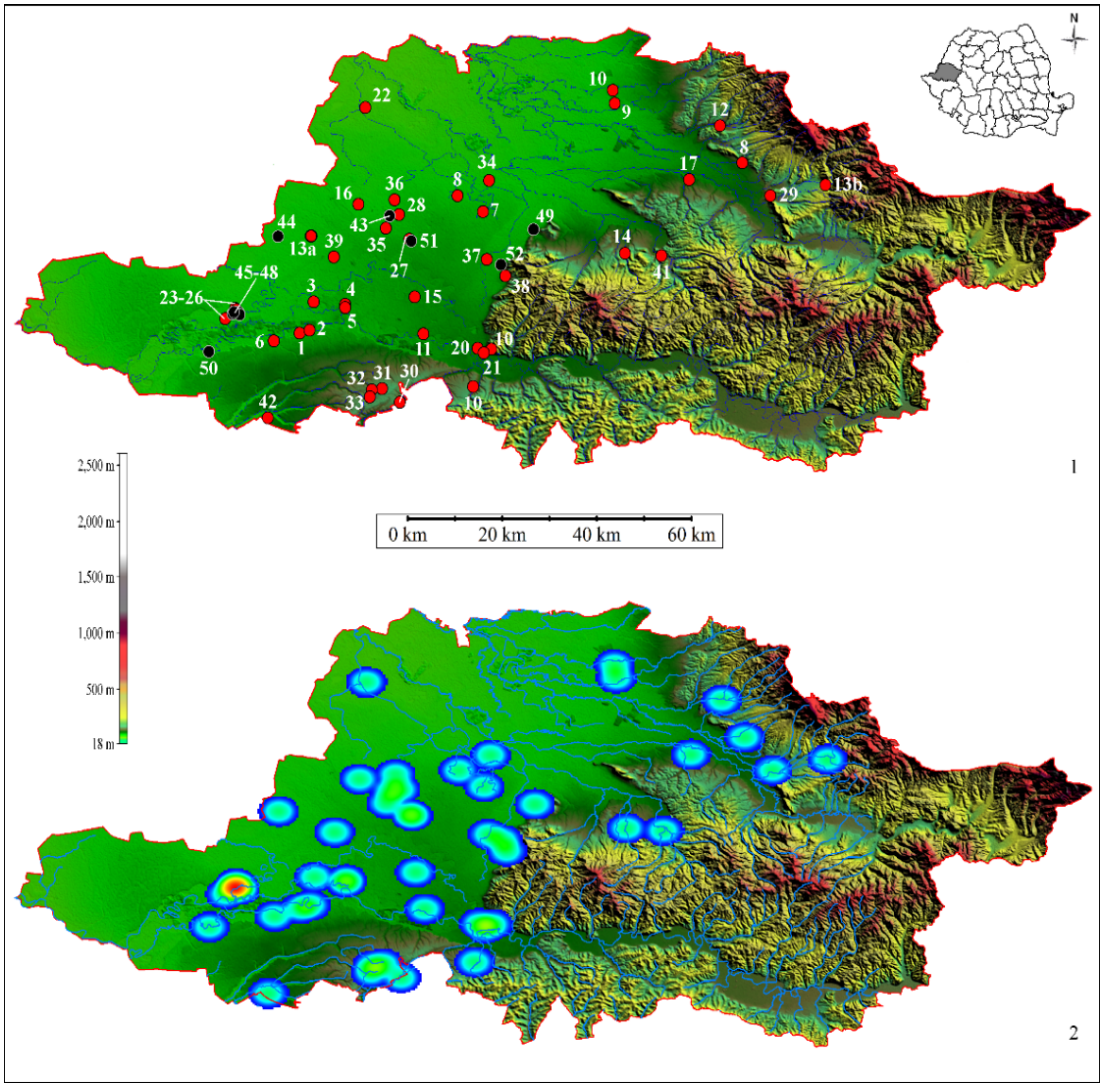


Fig. 1. 1. Early Eneolithic Settlements in Arad County: Tiszapolgár (in red): 1. Arad – *Aradul Nou-Bufniţ*; 2. Arad – *Ceala*; 3. Arad – Gai; 4. Arad – *Grădişte 2/Curtea fostei intreprinderi de Drumuri şi poduri municipale Arad*; 5. Arad – Uzina de apă; 6. Bodrogu Nou – *La Hodaie = Către Vale*; 7. Caporal Alexa – *2 km nord-est de sat*; 8. Cărand – *La Cărămzel*; 9. Cermei – *Drumul Sămădăului*; 10. Chesinţ – *Obiectiv 11 = Râtu SSE*; 11. Cicir – *Hotar*; 12. Comăneşti – *Vechiul Cimitir*; 13a. Curtici – CRT012ASZ; 13b. Dezna – Coasta Robilor; 14. Dud – *Cioaca-Chiciora*; 15. Horia – Satini; 16. Macea – *MAC002ASZ*; 17. Mânerău – Casa Ungurului; 18. Olari – *Movilă*; 19. Păuliş – *Dealul Bătrân*; 20. Păuliş – *La Năidoreni*; 21. Păuliş – *Vatra Satului*; 22. Pilu – *PIL035ASZ*; 23. Pecica – *PEC002ASZ;* 24. Pecica – *PEC011ASZ*; 25. Pecica – *PEC035ASZ*; 26. Pecica – *PEC037ASZ*; 27. Sântana – *Cetatea Veche*; 28. Sântana – *Holumb = Dâmbul Popilor*; 29. Sebiş – *Dealul Pleşa*; 30. Şagu – *SAG026ASZ*; 31. Şagu – *SAG033ASZ*; 32. Şagu – *SAG034ASZ*; 33. Şagu – *SAG035ASZ*; 34. Sintea Mică – *La Metrii*; 35. Şimand – *Fostul I.A.S. Scânteia*; 36. Şimand – *Pusta Török*; 37. Şiria – *Punct 11*; 38. Şiria – *Punct 16*; 39. Şofronea – Hotarul Satului; 40. Şomoşcheş; 41. Tauţ – Deluţ; 42. Vinga – Izvor. Bodrogkeresztúr (in black): 43. Curtici – *Terenul dintre conacul Lukács şi cârciuma lui Vásárhely*; 44. Iratoşu; 45. Pecica – *PEC012ASZ/Forgaci*; 46. Pecica – *PEC007ASZ/Sit 15*; 47. Pecica – *PEC010ASZ*; 48. Pecica – *PEC011ASZ*; 49. Pâncota – Totani; 50. Sânpetru German – Malul Înalt; 51. Sântana – Cetatea Veche; 52. Şiria. 2. Density Map of Early Eneolithic Settlements in Arad County

As illustrated in **Fig. 1.2**, the settlement network is relatively dense between the Vinga Plain and the southern Crișuri basin (around the Sântana area). The densest micro-region is Pecica, where at least eight Tiszapolgár and Bodrogkeresztúr settlements are documented (**Fig. 1.1**, nos. 23–26, 45–48). In this area, the settlements are situated in close proximity to one another. Another significant cluster is found in the Curtici–Sântana region (**Fig. 1.1**, nos. 16, 27–28, 35–36, 43, 51), although the distances between settlements here are greater. Smaller clusters occur in Șagu (**Fig. 1.1**, nos. 30–33), Păuliș (**Fig. 1.1**, nos. 30–33), and Șiria (**Fig. 1.1**, nos. 37–38, 52).

Curtici – CRT012ASZ (**Fig. 1.1**, no. 13a; **Fig. 2**)

The settlement is situated southwest of the town of Curtici, in a zone less intersected by the large paleochannels that characterize the eastern part of the ATU. The terrain surrounding the settlement is elevated, providing natural protection from flooding for the small prehistoric community. Adjacent to the site, a paleochannel likely ensured convenient access to water during the rainy seasons. In the lower-lying area immediately southwest of the settlement, several large paleochannels are present, which most likely functioned as a more permanent water source.

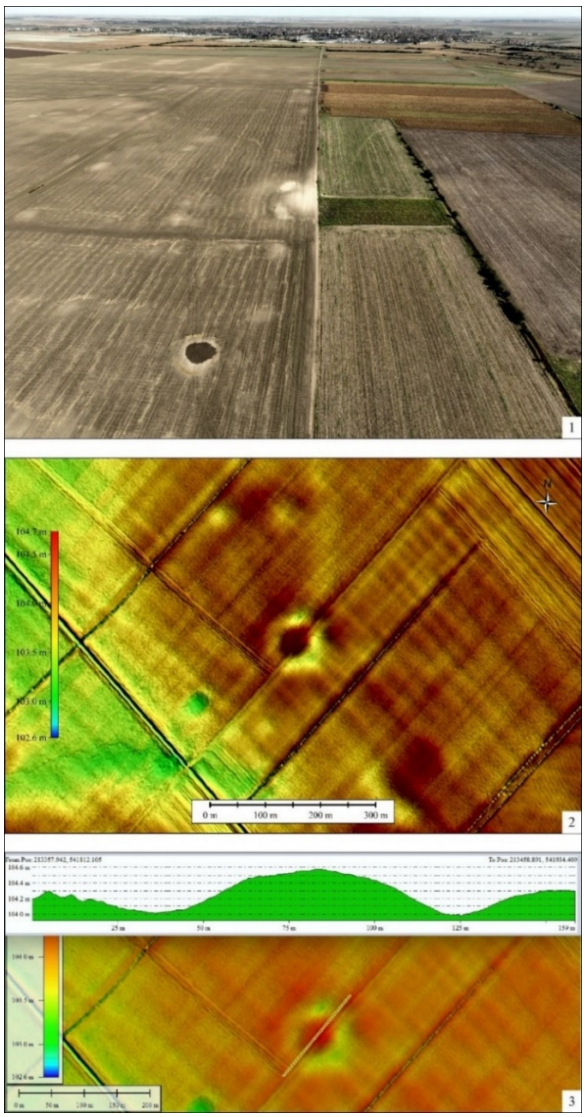


Fig. 2. The Curtici-CRT012ASZ Settlement. 1. Drone image of the settlement; 2. Digital elevation model of the settlement; 3. Digital elevation model of the settlement showing the cross-sectional profile

The field survey carried out in September 2025 resulted in the identification of this settlement. The central area exhibits a lighter coloration (**Fig. 2.1**), and the soil is notably ashy. The settlement, approximately 70 m in diameter and covering an area of 1,435 m², is enclosed by a well-defined ditch, which currently has a width of about 25 m (**Figs. 2.2–2.3**). The total site extends over roughly 1.45 ha. Within the central area, numerous ceramic fragments characteristic of the Tiszapolgár style were recovered, along with animal bones, fragments of querns, and a significant quantity of daub.

Macea – MAC002ASZ (**Fig. 1.1**, no. 16; **Fig. 3**)

Through the analysis of satellite imagery, aerial photographs, and the digital elevation model, complemented by field surveys, an Early Eneolithic settlement enclosed by a ditch was identified. The ditch encloses an area of approximately 5,850 m² (roughly 83 × 78 m), with a maximum width of 12 m. Within the perimeter defined by the ditch, ceramic fragments, large pieces of daub, and animal bones were recovered. The ceramics belong to the Tiszapolgár style, characterized by sharp and perforated handles. Most Eneolithic artifacts are concentrated within the central area of the settlement, although the surveys also indicate a southern extension of habitation beyond the ditch.

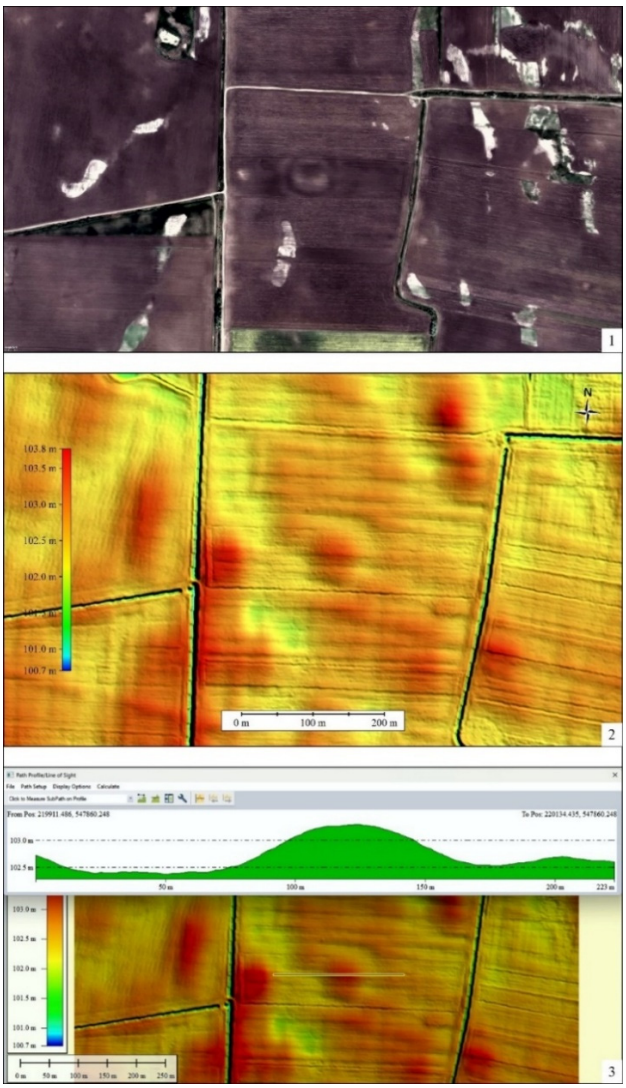


Fig. 3. The Macea-MAC002ASZ Settlement. 1. Satellite image of the settlement (source: Google Earth); 2. Digital elevation model of the settlement; 3. Digital elevation model of the settlement showing the cross-sectional profile.

In the area outside the ditch, to the west, ceramic fragments decorated with brush-strokes or incisions—typical of the Early to Middle Bronze Age—were also recovered. This archaeological site was first mentioned by Pădurean and Dorogostaisky (2015), although the chronological attribution provided there is inaccurate. Two chronological horizons were noted, Neolithic and Bronze Age[14]. It should be emphasized that our 2023 field surveys did not yield any Neolithic artifacts.

The surveys confirmed the presence of a significant Tiszapolgár settlement. The close chronological and geographical proximity between the Late Neolithic settlement MAC001ASZ = Topila and the Early Eneolithic settlement MAC002ASZ raises important questions, which, however, cannot be addressed without further research.

Pecica – PEC012ASZ/Forgaci (**Fig. 1.1**, no. 45; **Fig. 4-5**)

In a restricted area north of the town of Pecica, near the Forgaci Valley, a cluster of Early Eneolithic settlements has been identified (**Fig. 4**). Six of these settlements are situated in the vicinity of the PEC011 cemetery, which is the largest Early Eneolithic funerary site in the intra-Carpathian region, with 280 graves[15]. Available AMS data suggest contemporaneity between this cemetery and the surrounding settlements[16].

Approximately 1.5 km southwest of the PEC011 cemetery, another contemporaneous funerary site, comprising a few graves, has been documented. Adjacent to this site lies a small Tiszapolgár settlement[17]. Collectively, these seven settlements and two funerary spaces, active during the second half of the 5th millennium BC, represent one of the most dynamic Early Eneolithic micro-regions within the intra-Carpathian area. The archaeological context at Pecica provides a unique opportunity to investigate key aspects of the Eneolithic, owing to the unusually high density of contemporary settlements and cemeteries within a limited area. Moreover, the fact that most of these sites have undergone excavation ensures a robust and valuable dataset for analysis.

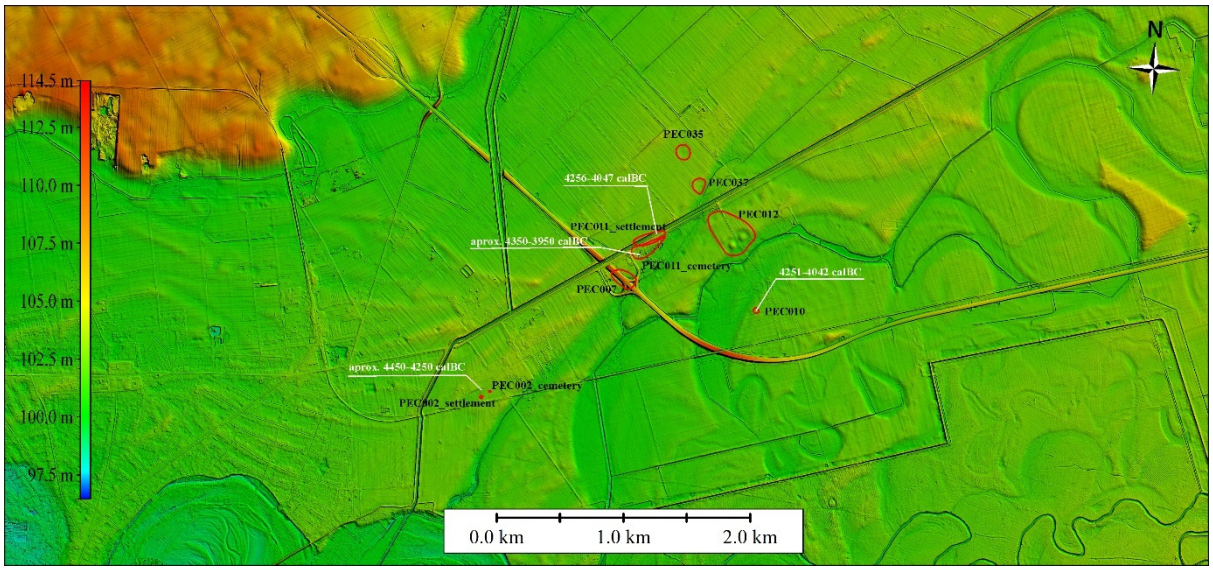


Fig. 4. Digital Elevation Model of the Pecica Area, showing Early Eneolithic Settlements and Funerary Spaces (site boundaries highlighted in red)

[14] Pădurean, Dorogostaisky 2015, 181-182, Fig. 7a-7b.
[15] Sava, Ursuțiu 2020a; Sava, Ursuțiu 2020b.
[16] Sava, Ursuțiu 2020a, Tab. 5.
[17] Sava et al. 2023b.

The PEC012ASZ/Forgaci settlement is situated on the northern edge of the Forgaci stream, occupying higher ground that would have protected it from potential flooding during periods of heavy rainfall. The stream remains active today, particularly in spring, and the settlement area rises approximately 2–3 m above its bed.

The most prominent features of the settlement are two elevated zones, set apart from the surrounding plateau by ditches and adjacent to the Forgaci Valley. These ditches enclose two approximately circular areas, clearly distinguishable in the digital elevation model (**Fig. 5**). The ditches measure roughly 30–35 m in width and currently retain a depth of about 1 m.

The two central areas have been designated as "Settlement 1"[18] / "Tell A"[19] (southwest) and "Settlement 2" / "Tell B" (northeast). The "core" enclosed by the ditch of Settlement 1 covers approximately 2,560 m², whereas Settlement 2 encloses roughly 2,880 m². Limited excavations within the central areas of both settlements have not provided sufficient data to fully characterize the nature of habitation[20]. Published results from the 1989 excavation indicate the presence of two occupation levels, within which various pits were identified[21]. More recent pre-development excavations north of the central areas confirm that the settlement extended beyond the ditches[22], revealing additional pits and ditches that suggest a relatively low-intensity occupation in the peripheral zones.

Overall, the PEC012ASZ/Forgaci settlement spans approximately 10 ha.

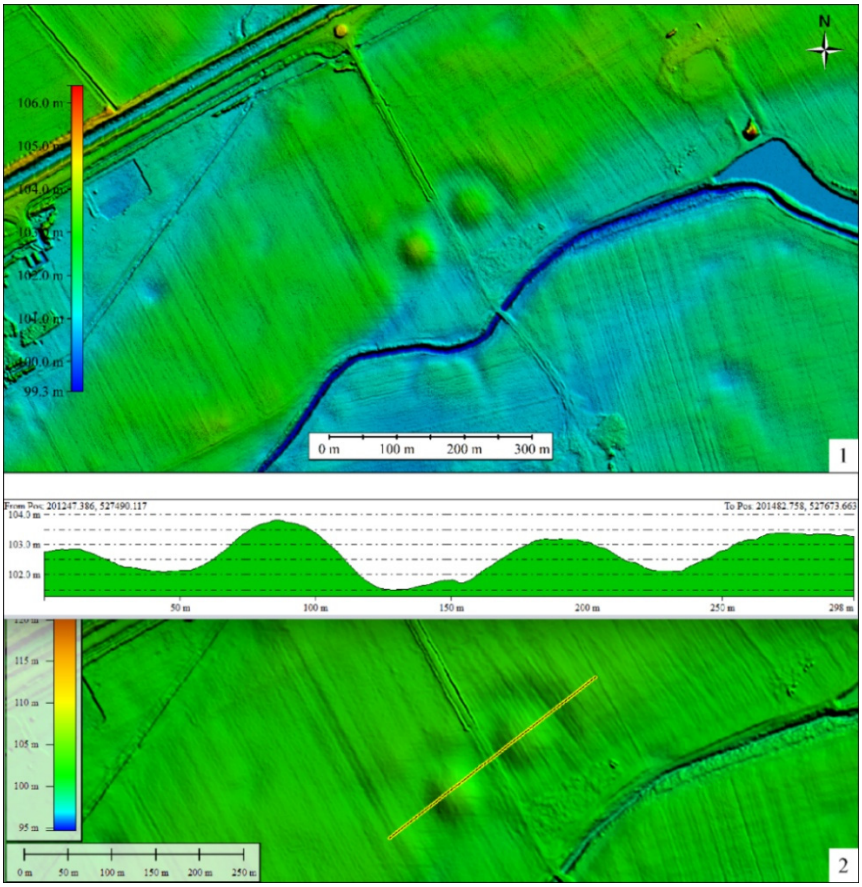


Fig. 5. The Pecica-PEC012/Forgaci Settlement. 1. Digital elevation model of the settlement; 2. Digital elevation model of the settlement showing the cross-sectional profile

[18] Luca 1993, Plan 2.
[19] Pădurean 1982, 29.
[20] Luca 1993.
[21] Luca 1993, 49-52, Planul 3-4.
[22] Sava et al. 2022.

Pecica – PEC035ASZ (**Fig. 1.1**, no. 25; **Fig. 6-8**)

One of the objectives of the ArheoPecica project is to process the data obtained during excavations at the Early Eneolithic cemetery PEC011. In addition to analysing the funerary findings, the research aimed to identify contemporaneous settlements. Systematic field investigations have recently led to the discovery of two sites, Pecica – PEC035 and PEC037, located in close proximity to both the PEC011 cemetery and the PEC012 settlement.

Both PEC035 and PEC037 exhibit an approximately circular layout. Surface collections yielded Tiszapolgár ceramic fragments and numerous animal bones. The settlements are clearly visible and readily identifiable in satellite imagery (**Fig. 6.1**) and are situated near an area extensively intersected by paleochannels (**Figs. 6.2–6.3**).

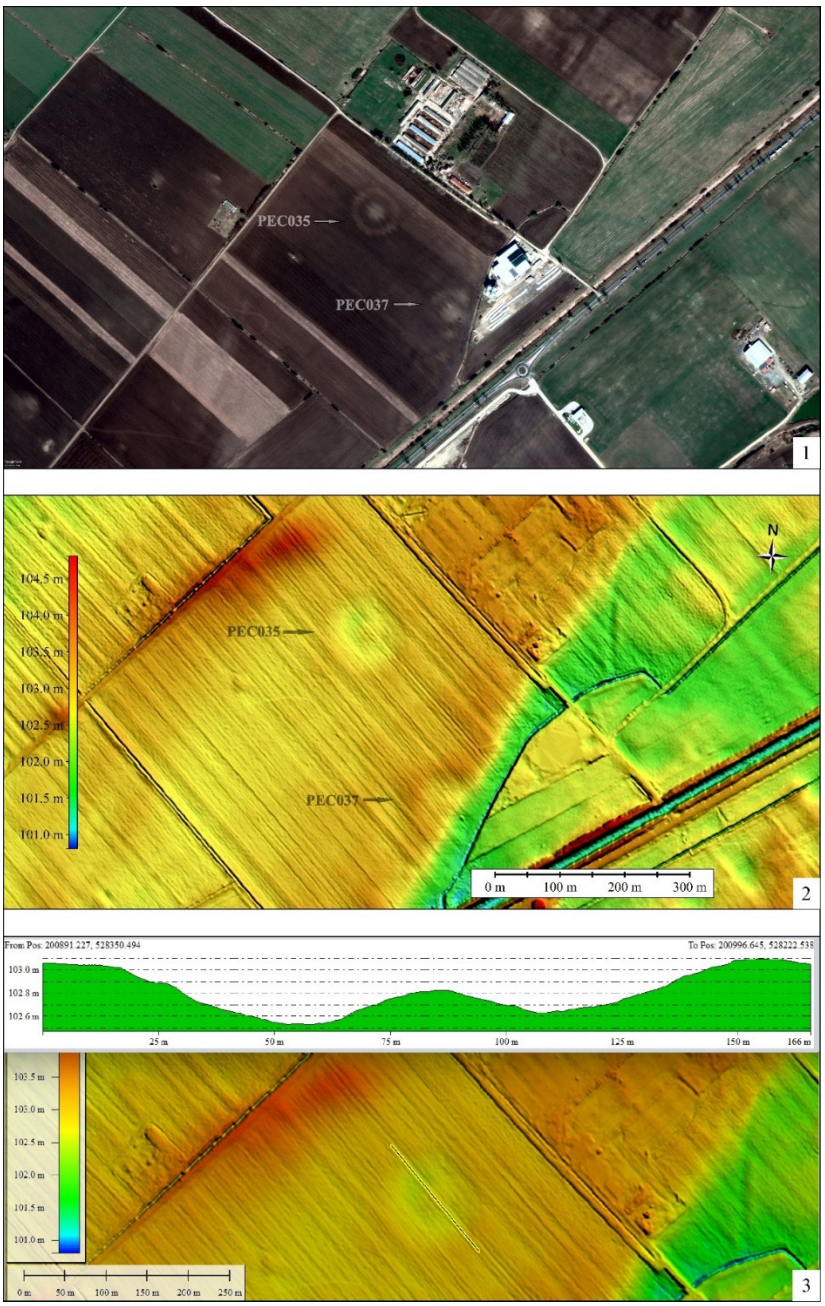


Fig. 6. The Pecica- PEC035 and PEC037 Settlements. 1. Satellite image of the settlements Pecica – PEC035 and Pecica – PEC037 (source: Google Earth); 2. Digital elevation model of the settlements Pecica – PEC035 and Pecica – PEC037; 3. Digital elevation model of the settlement Pecica – PEC035 showing the cross-sectional profile

In addition to the field surveys, magnetic measurements were conducted at the PEC035 site over an area of 2.5 ha (**Fig. 7**). The results revealed the presence of a fortification system (**Fig. 8**), which represents the principal structural feature of the site. The ditch is substantial, with a maximum diameter of approximately 80 m and a width of 12–14 m, enclosing an area of roughly 4,800 m². Within this central area, an anomaly following the trajectory of the ditch was identified, with a diameter of approximately 44 m and a width of about 1 m, enclosing a central space of approximately 1,500 m². The interpretation of this anomaly is complex, as it may represent a palisade or possibly a second ditch.

Across the surveyed area, around 1,600 magnetic anomalies with archaeological potential were recorded (**Fig. 8**). Most of these are small and semicircular in shape. One anomaly covers approximately 11 m², 104 anomalies exceed 1 m², and the remaining features are smaller. Outside the two concentric ditches, no additional large magnetic structures were detected.

The field survey was conducted on freshly ploughed land, which facilitated the identification of the site's features. Numerous Tiszapolgár ceramic fragments and a substantial quantity of animal bones were collected. As anticipated, artifacts were concentrated within the central area. Moreover, in this zone, the soil is light-colored, grayish, and highly clayey, a characteristic also observable in satellite and aerial imagery.

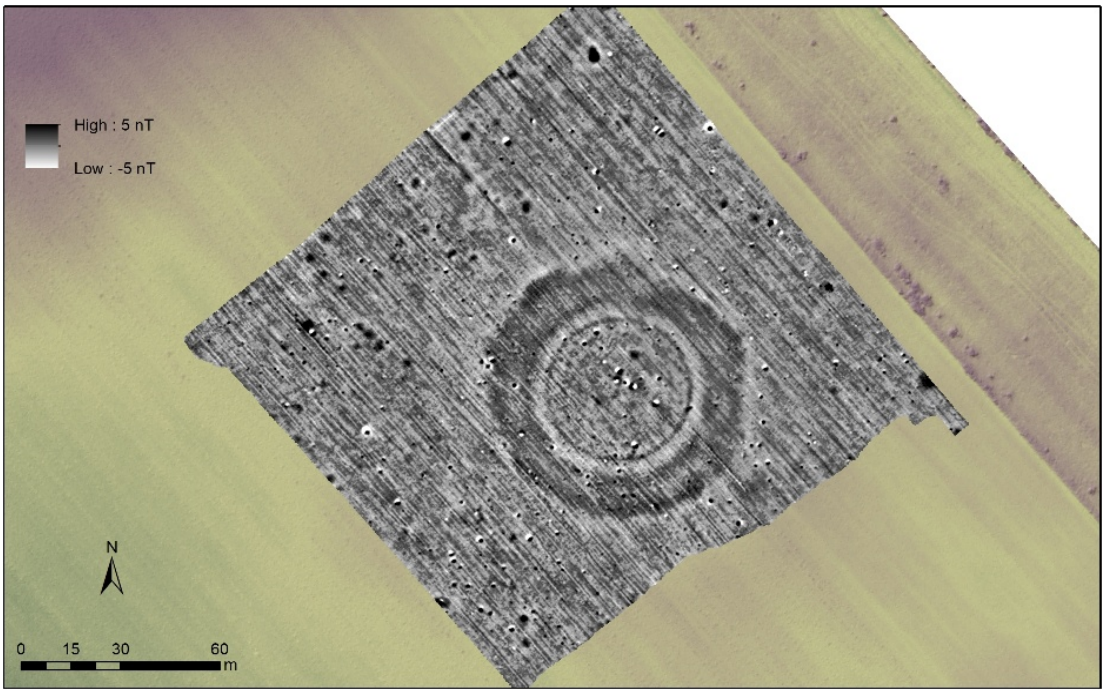


Fig. 7. The magnetic survey map from Pecica – PEC035 Site

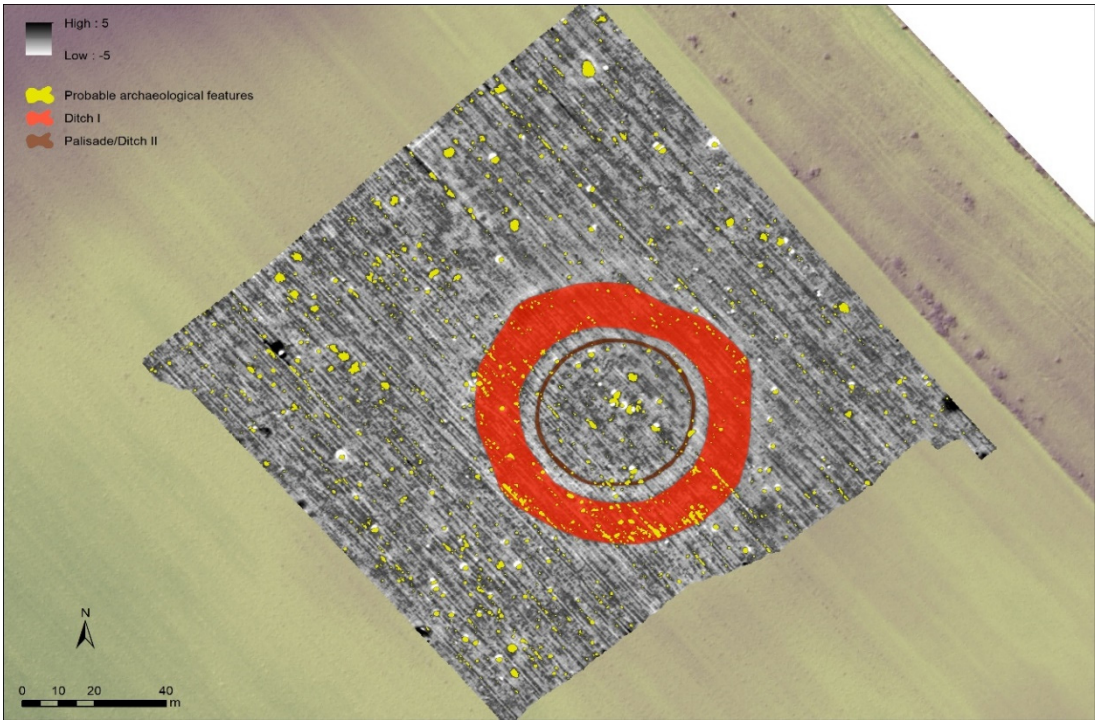


Fig. 8. Interpretation of the magnetic survey map from Pecica – PEC035 Site

Pecica – PEC037ASZ (**Fig. 1.1**, no. 26; **Fig. 6.1-2**).

The PEC037 site is situated approximately 170 m south-southeast of PEC035. Similar to the latter, a ditch surrounds a central area. Unlike PEC035, however, the ditch at PEC037 terminates at the edge of a large paleochannel. The central area covers roughly 1,500 m², and together with the enclosing ditch, the entire site extends over approximately 0.7 ha.

Most of the artifacts were concentrated within a gray-colored zone corresponding to the core of the site. As at PEC035, this central area—characterized by light-gray, highly friable soil—yielded the majority of ceramic fragments and animal bones. The occurrence of Tiszapolgár ceramics at both sites indicates a probable contemporaneity between PEC035 and PEC037.

Sântana – Holumb = Dâmbul Popilor[23] (**Fig. 1.1**, no. 28, **Fig. 9-12**)

This important Early Eneolithic settlement, although known since the second half of the 19th century[24], has remained insufficiently investigated. The distinctive character of the site was first evidenced by the test excavation conducted in 1963 by S. Dumitrașcu[25]. Although the provisional and incomplete excavation report does not provide a comprehensive understanding of the site, the documented stratigraphic sequence remains a key source of information (**Fig. 9**[26]).

Despite the inaccuracies visible in the drawing reproduced in Fig. 9 and the inherent limitations of excavation and documentation practices of the 1960s, several occupation levels can nonetheless be identified. Dumitrașcu assigned all of these layers to the so-called "Tisa Neolithic culture," interpreted today as belonging to the Tiszapolgár Eneolithic culture. The

[23] As a result of reviewing the specialized literature, it can be easily established that the Eneolithic settlement at Dâmbul Popilor = Holumb is located in ATU Sântana and not in ATU Curtici, as incorrectly recorded in the National Archaeological Record.

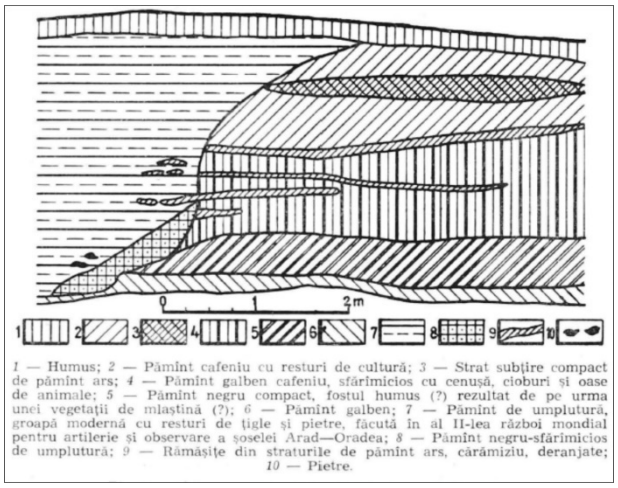
[24] Márki 1882, 115-118; Barbu et al. 2002, 448, nr. crt. 141-149.

[25] Dumitrașcu 1975.

[26] See: Sava 2015, pp. 33–34, Fig. 12 for a summary of the excavation conducted by S. Dumitrașcu and a drawing adapted from the northern profile of trench SI.

seven stratigraphic units (labelled A to G) appear to have a total reported thickness of 2.60 m. Between –0.60 m and –2.40 m, several floor levels—likely four—were recorded, together with numerous traces of structural debris.

However, a close examination of the stratigraphic drawing published in the report indicates that the anthropogenic deposits measure approximately 2 m in thickness, rather than 2.60 m. This value corresponds more closely to observations made in the field and to the data derived from the digital elevation model of the site (**Fig. 10.2–3**).



1 — Humus; *2* — Pământ cafeniu cu resturi de cultură; *3* — Strat subțire compact de pământ ars; *4* — Pământ galben cafeniu, sfărîmicios cu cenușă, cioburi și oase de animale; *5* — Pământ negru compact, fostul humus (?) rezultat de pe urma unei vegetații de mlaștină (?); *6* — Pământ galben; *7* — Pământ de umplutură, groapă modernă cu resturi de țigle și pietre, făcută în al II-lea război mondial pentru artilerie și observare a șoselei Arad—Oradea; *8* — Pământ negru-sfărîmicios de umplutură; *9* — Rămășițe din straturile de pământ ars, cărămiziu, deranjate; *10* — Pietre.

Fig. 9. Northern Profile of Trench SI at Sântana–Holumb = Dâmbul Popilor (after Dumitrașcu 1975)

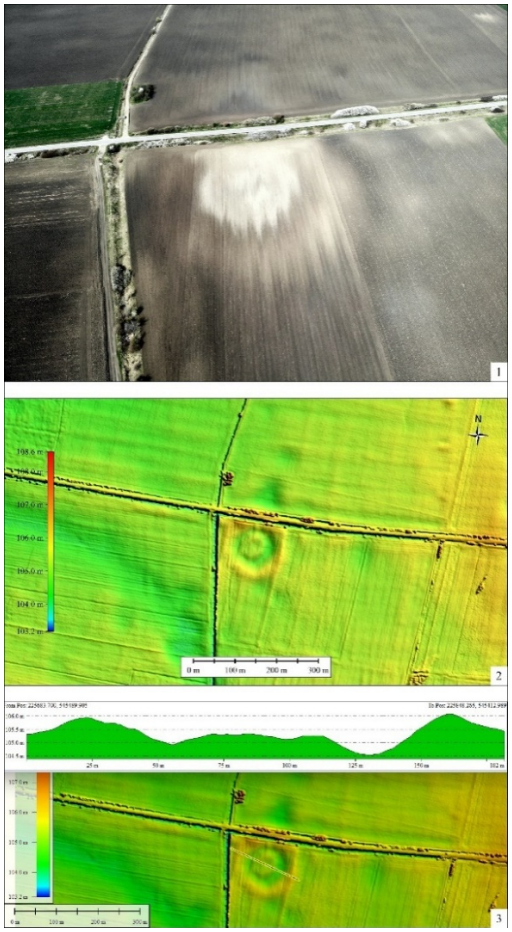


Fig. 10. The Sântana–Holumb = Dâmbul Popilor Settlement. 1. Drone image of the settlement; 2. Digital elevation model of the settlement; 3. Digital elevation model of the settlement with the cross-section profile

Recent non-invasive investigations at the Sântana–Holumb = Dâmbul Popilor settlement comprised the development of a digital elevation model, the creation of an orthophotoplan, geophysical surveys covering 3.5 ha, and systematic field surveys. These integrated approaches provided a robust foundation for the analysis of the site. Drone imagery (**Fig. 10.1**), satellite data, and the orthophotoplan, complemented by the results of the field survey, revealed several salient features of the settlement. To further enhance the dataset, a magnetic survey was also conducted (**Fig. 11**).

The settlement is situated west of the town of Sântana, within the lowest-lying sector of the administrative unit, at an elevation of 105 m above sea level. The community's access to water was likely facilitated by a meandering paleochannel located approximately 100 m southwest of the site. This topographic position provided natural protection against periodic flooding while maintaining probable year-round access to a reliable water source.

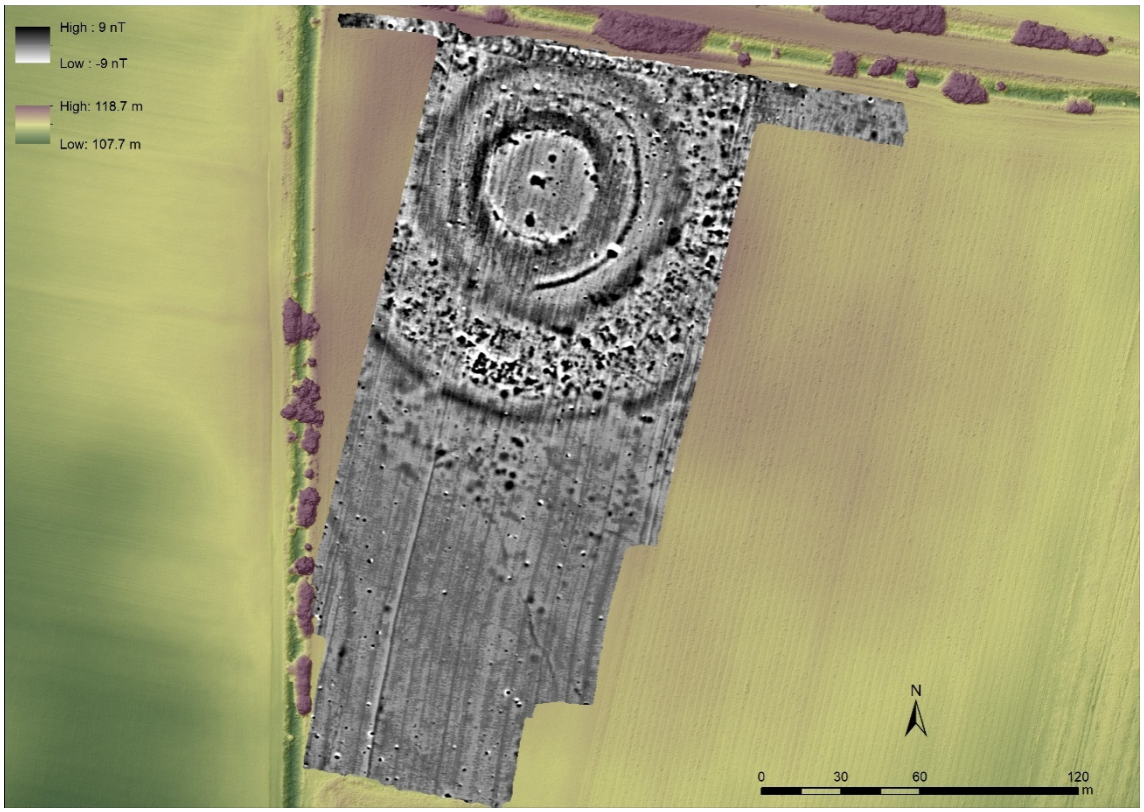


Fig. 11. The magnetic survey map from Sântana–Holumb = Dâmbul Popilor settlement, overlaid on the digital elevation model

The non-invasive investigations reveal a complex system of circular and semicircular ditches that structure the settlement into several distinct functional zones (**Fig. 12**). The outermost feature, Ditch I, is identified only in the southern half of the surveyed area. Although incompletely mapped, the recorded segment shows an average width of approximately 6 m. Two clear interruptions occur along its southern arc, representing probable passageways that regulated access into the settlement. As the northern part of Ditch I remains unmapped, its full diameter cannot be determined, though its preserved southern course suggests a substantial enclosing element.

Ditch I encompasses Ditch II, which forms the main enclosed habitation circuit of the site. Ditch II encloses an estimated maximum diameter of ca. 100 m and has an average width of about 7 m. The zone between Ditch I and Ditch II contains a high concentration of positive

magnetic anomalies interpreted as domestic structures, including houses, pits, hearths, and other features associated with daily habitation. Surface finds (daub, ceramics, lithic) further confirm intensive occupation within this intermediary ring.

Further inward, Ditch III forms a smaller enclosure, with an average width of ca. 8 m and an internal diameter of approximately 60 m, corresponding to a central area of 1,455 m². Only a limited number of anomalies occur within this inner space, suggesting that it may have functioned as a relatively open area or a space reserved for activities that did not leave substantial magnetic signatures.

A fourth element, Ditch IV, appears as a thin, ca. 1 m wide semilunar ditch, positioned between Ditch I and Ditch II along the northeastern side and curving southwards without forming a closed circuit. Its morphology and placement suggest an additional internal boundary or structural subdivision within the overall ditch system.

Across the surveyed area, more than 1500 probable archaeological features (highlighted in yellow in **Fig. 12**) were identified. These anomalies occur throughout the entire investigated surface, including outside Ditch I, indicating activity areas beyond the principal enclosed settlement core. Notably, however, their density decreases markedly inside Ditch I, and a further reduction toward the southern limit of the surveyed area suggests that the settlement does not extend beyond this point.

In summary, the geophysical data illustrate a highly structured settlement composed of concentric and partially concentric ditches, an inner open central area, a surrounding habitation zone between Ditches I and II, and peripheral activity extending beyond the main enclosure. This configuration reflects an organized spatial layout consistent with large, complex prehistoric settlements documented elsewhere in the region.

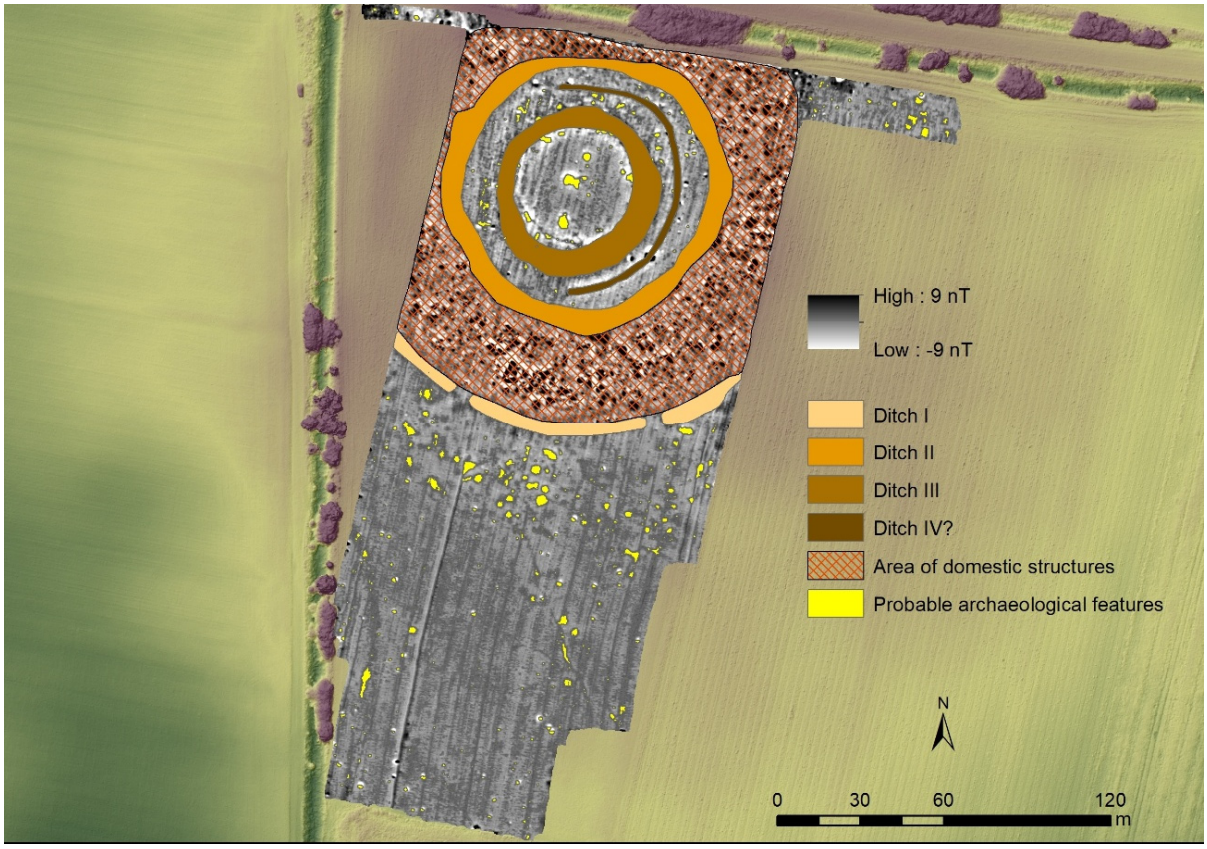


Fig. 12. Interpretation of the magnetic survey map from Sântana–Holumb = Dâmbul Popilor settlement, overlaid on the digital elevation model

Discussion

Field surveys conducted in the Lower Mureș region have led to the identification of Early Eneolithic settlements associated with the Tiszapolgár and Bodrogkeresztúr cultures, some previously mentioned in the literature, as well as the discovery of previously unknown sites. Of the 53 recorded settlements, six exhibit evidence of fortification. These sites were selected for further non-invasive investigations. For each of the six settlements, digital elevation models and aerial images were produced, while geophysical measurements were carried out at Pecica – PEC035ASZ and Sântana – Holumb = Dâmbul Popilor.

The combined analysis of fieldwork data and geospatial datasets indicates the presence of fortification elements in these settlements or in specific parts of them. The six enclosed sites display various forms of enclosure, including single ditches, double ditches, or multiple concentric enclosures. Most fortified settlements are defined by a ditch enclosing areas ranging from 1,435 m² to 5,850 m². In the case of Sântana, two concentric ditches are present, while at Pecica – PEC012ASZ/Forgaci, two adjacent settlements, each protected by its own ditch and perhaps a palisade, have been documented. In several cases, traces of habitation were also observed beyond the ditches.

Regarding the internal organization of these settlements, the clearest evidence comes from sites where geophysical measurements were performed. At Pecica – PEC035ASZ, only a few small anomalies were detected within the central area, and no clear structural elements indicative of permanent habitation were observed. This suggests that the attribution of this site as a residential settlement remains uncertain. It is possible that this enclosure, located near other confirmed settlements (Pecica – PEC007, PEC011, PEC012ASZ/Forgaci), served a different function within the Pecica settlement cluster.

A particularly notable case is the settlement at Sântana – Holumb = Dâmbul Popilor. Its central area is enclosed by a ditch and a possible palisade. Similar to Pecica – PEC035ASZ, the central area shows a limited number of anomalies, with no clear structural elements of habitation. Numerous buildings, heavily affected by contemporary agricultural activity, are distributed around the ditch. The entire settlement is enclosed by an additional ditch, reflecting a complex spatial organization in which a clear distinction exists between central and residential areas.

The case studies presented here highlight the considerable variability of settlements in the Lower Mureș region, even among sites within the same micro-region. Some settlements exhibit complex internal organization, with portions—or the entirety—enclosed by ditches. Others, such as Pecica – PEC012ASZ/Forgaci and Sântana – Holumb = Dâmbul Popilor, show two or more anthropogenic layers, indicative of prolonged habitation. These findings demonstrate that, in some cases, the Late Neolithic tradition of multi-generational occupation within the same restricted perimeter persisted into the Early Eneolithic. However, changes in settlement organization are also evident. Most sites are relatively small settlements or farms, and the cases presented here represent exceptions. The Pecica settlement cluster, for example, shows multiple communities occupying an area of approximately 250 ha, favouring horizontal settlement patterns rather than vertical occupation characteristic of the Late Neolithic tells.

The distribution of settlements suggests a coherent network of micro-centres spaced 2–5 km apart, which may reflect a planned model of territorial occupation. It is likely that each micro-region included a central enclosed settlement surrounded by several satellite farms. The presence of multiple enclosures and concentric ditches may indicate not only protective concerns but also a hierarchy of space, with central areas serving ritual or prestige functions. This spatial configuration could correspond to the emergence of a local elite, also reflected in differences within funerary inventories.

The preferential location of settlements on slightly elevated terrain near paleochannels indicates an economy dependent on the control of aquatic resources. The fluvial microrelief of the Lower Mureș offered strategic advantages, including access to water, fertile land, and high visibility across the landscape.

The evidence presented in this study suggests a gradual transition from the Neolithic to the Eneolithic. Although some communities abandoned the old tells, they maintained certain Late Neolithic traditions, such as enclosing settlements with one or more ditches or using a restricted area for prolonged occupation. Expanding the scope of our investigations, several examples further illustrate this gradual transition toward the Early Eneolithic societal model. For instance, the Neolithic tell at Uivar-Gomilă shows, after the cessation of Neolithic habitation and following a Foeni horizon, a dispersed Tiszapolgár occupation and a funerary space. One of the Neolithic ditches was reused by the same Tiszapolgár community[27]. A similar case, with upper layers of a Neolithic tell inhabited during the Early Eneolithic, has been documented at Crna Bara[28]. Perhaps the most thoroughly documented case contributing to understanding the Neolithic–Eneolithic transition is the study from the confluence of the Criș rivers, where investigations reveal great variability in Eneolithic settlements and the persistence of Neolithic traditions[29]. These findings converge with the data obtained in the Lower Mureș region.

Overall, the present study confirms that the transition from the Neolithic to the Eneolithic in the Lower Mureș region did not represent a cultural rupture but a gradual process of adaptation. The persistence of certain construction traditions, such as the use of ditches to delimit space, reflects a structural continuity in the perception of communal areas. This observation opens new avenues for research into the relationships among mobility, identity, and collective memory in prehistoric communities.

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