11TH INTERNATIONAL SCIENTIFIC CONFERENCE

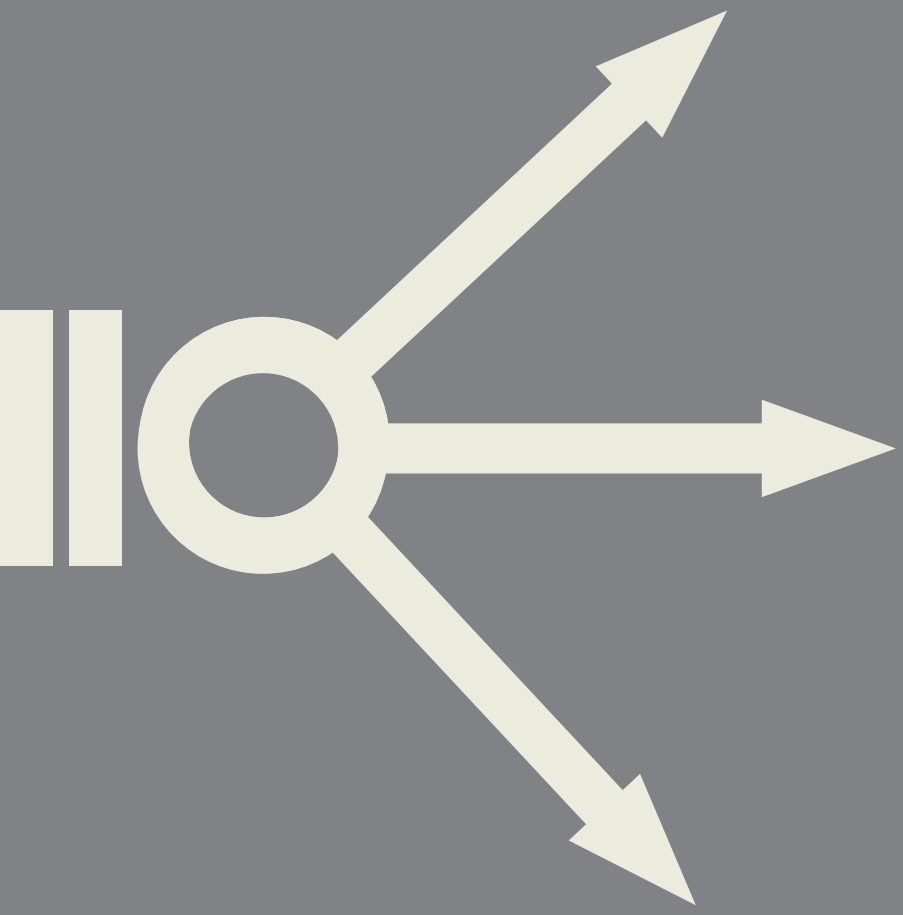
METHODOLOGY & ARCHAEOMETRY

Zagreb, 7th – 8th December 2023

12TH INTERNATIONAL SCIENTIFIC CONFERENCE

METHODOLOGY & ARCHAEOMETRY

Zagreb, 28th November 2024



PROCEEDINGS

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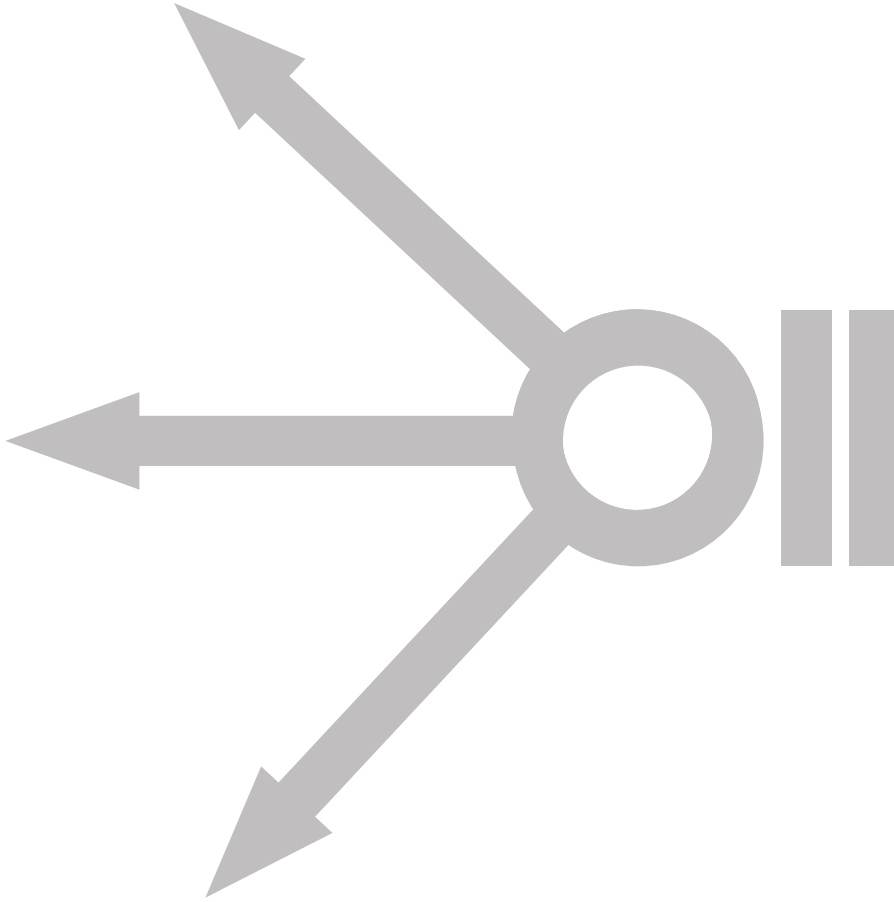

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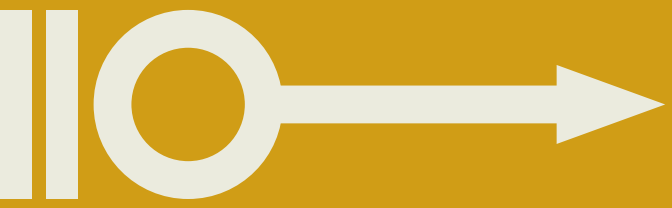

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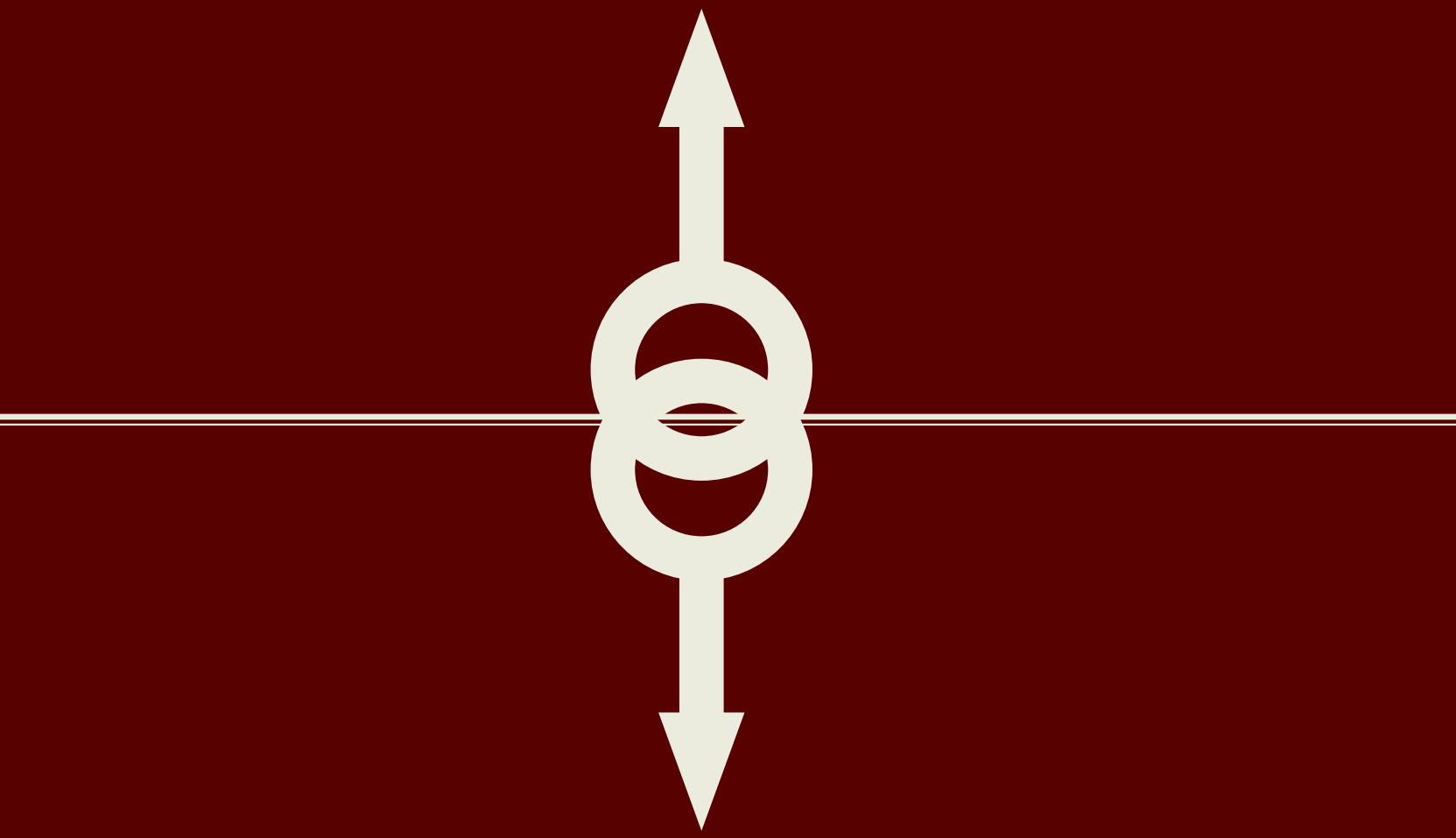

An Integrated Methodological Approach to the Archaeology of the Ludogorsko Plateau, Northeastern Bulgaria[1]

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The study presents the results of non-invasive (remote sensing and geophysical surveys) research conducted in a small area in Northeastern Bulgaria known as the Ludogorsko Plateau. These investigations are part of a broader research project that examines the spatial patterns and dynamics of settlement during the Bronze and Iron Ages in the Ludogorsko Plateau region.[2]

The research includes the identification of archaeological sites through the analysis of satellite imagery. For this purpose, the "History" tool in Google Earth Pro was used, allowing users to view the same area across different years and seasons. The studied sites are clearly distinguishable from the surrounding terrain by the presence of crop marks and soil marks. The subsequent phase entails on-site verification through targeted field surveys.

The archaeological materials were identified at the visited sites, usually pottery sherds, but in some cases also small finds such as spindle whorls, flints, and stone tools were also present. Geophysical surveys were conducted at several of the recorded sites, revealing anomalies with varying characteristics. The data show a high concentration of soil marks in the Topchiyska River area, which appears to have played an important role in the past. This study discusses examples of sites identified through non-invasive methods, particularly in the vicinity of the villages of Medovene, Brestovene, Pobit kamak, and Kamenovo in the Razgrad region.

Keywords: *non-invasive investigations, satellite imagery, Ludogorsko Plateau, Late Bronze Age, soil marks, geophysical surveys*

Introduction

The purpose of this paper is to present the results of preliminary observations, followed by field and geophysical surveys of four sites from the Late Bronze Age. These sites are located in Northeastern Bulgaria, in the area of the so-called Ludogorsko Plateau. Their examination includes the sequential implementation of precisely defined separate research components or steps in the study of each site: 1. Preliminary observation using software tools; 2. Field survey to the site and its registration (during which pottery sherds and finds from the surface are collected); 3. Geophysical survey. Consequently, a logically consistent system is established for the study and mutual verification of each subsequent stage and result with the preceding ones.

[1] The research is part of a doctoral thesis on "Spatial patterns and dynamics of the settlement of the Ludogorsko Plateau during the Bronze and Iron Ages".

[2] The publication is part of the realisation of a project "Non-destructive archaeology: an interdisciplinary study of the settlement pattern of the Ludogorsko Plateau in the Bronze and Early Iron Age", contract between The National Archaeological Institute with Museum at the Bulgarian Academy of Sciences and the Bulgarian National Science Fund No. КП-06-Н80/12 from 15.12.2023.

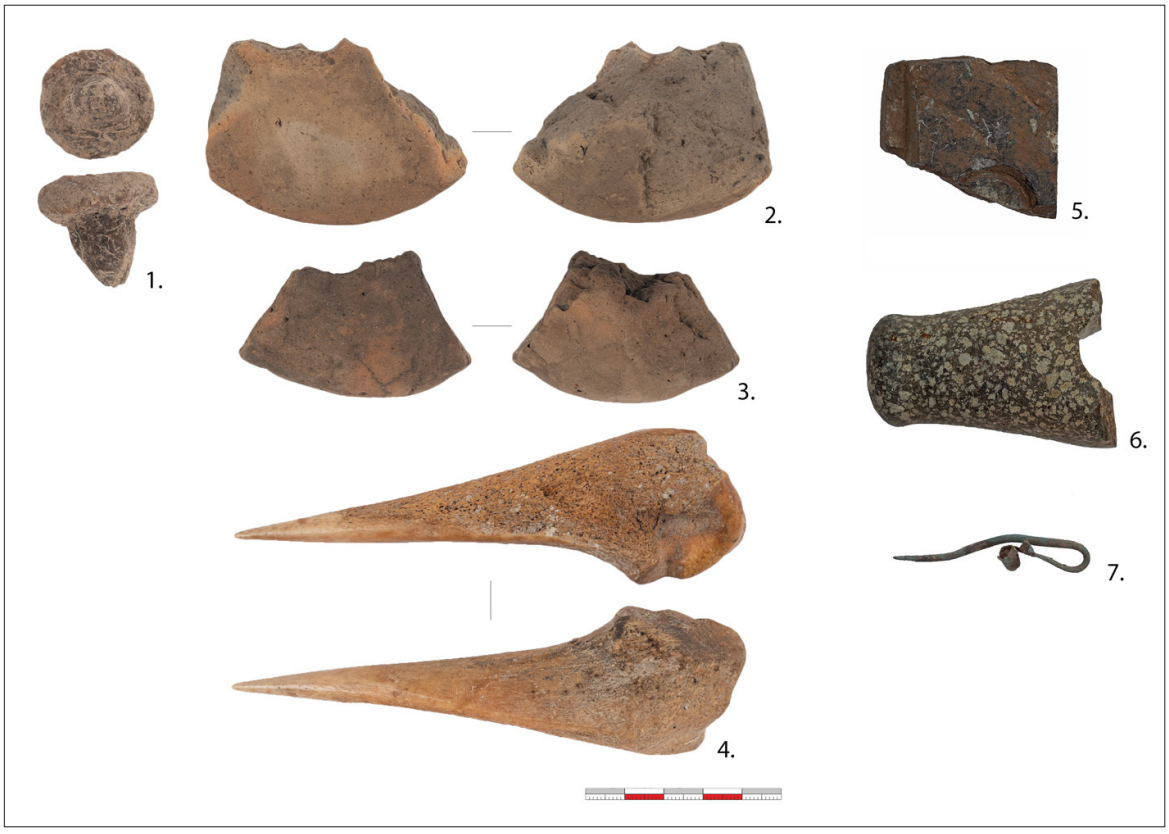

Figure 1. Finds from the Kamenovo, Yurtluka area, Feature No. 1: 1. Clay stopper; 2-3. Fragments of clay discs 1-3 (Minkov et al. 2024: 200, fig. 17); 4. Bone awl; Medovene: 5. Fragment of a stone mould; 6. Fragment of a stone axe; 7. Bronze pin 5-7 (Popov et al. 2025: 25), (photos by M. Raykovska).

History of the Research

The results presented in the study constitute a component of a large-scale project, the initial phase of which commenced in 2021 and covers significant territories in the Ludogorsko Plateau. The present project aims to investigate the possibility of establishing the presence of sites from the Late Bronze and Early Iron Ages in the area of Pobit kamak, Dabravata district – where the notable find of stone moulds originated (Leshtakov 2018). Among the objects that generated the most significant interest were the hoards of stone moulds utilised for the casting of metal objects of various types, including weapons, jewellery, and tools. These hoards were discovered fortuitously and lack an archaeological context, which complicates the investigation of their use, association with specific sites, cultural identification, interpretation, and chronology. This discovery has prompted scientific interest in determining the nature of the find, including whether it is accidental or not, and whether it belongs to a settlement feature or is an isolated deposit. These questions also relate to the presence of several hoards of metal artefacts from the Late Bronze Age, which are relevant to the issues concerning the origin and nature of such objects in this area. During the Late Bronze Age, the region exhibited a high concentration of hoards associated with Late Bronze Age metallurgy. Among them can be mentioned the deposits and single finds of metal discovered at the villages of Ionkovo, Sokol, Loznitsa, Kubrat, Dulovo, Isperih, and others. Sickles and hollow axes of Celtic type were found in many of these collective finds (Hristova 2018).

The research conducted in this study encompasses the territories of the contemporary villages of Kamenovo, Pobit kamak, Medovene, Brestovene, Ostrovo, and Savin, which are located in proximity to the contemporary town of Kubrat. Consequently, several sites have been registered, interpreted as settlements of the Late Bronze Age. This interpretation is based on an analysis of the mass ceramic material, the finds – including spindle whorls, flint and stone tools, as well as exceptional individual finds – stone moulds, and pieces of bronze pin, insignia (fragment of a stone axe/scepter) – that have been discovered (Hristova & Sandeva, forthcoming; Minkov et al., forthcoming *b*; Popov &

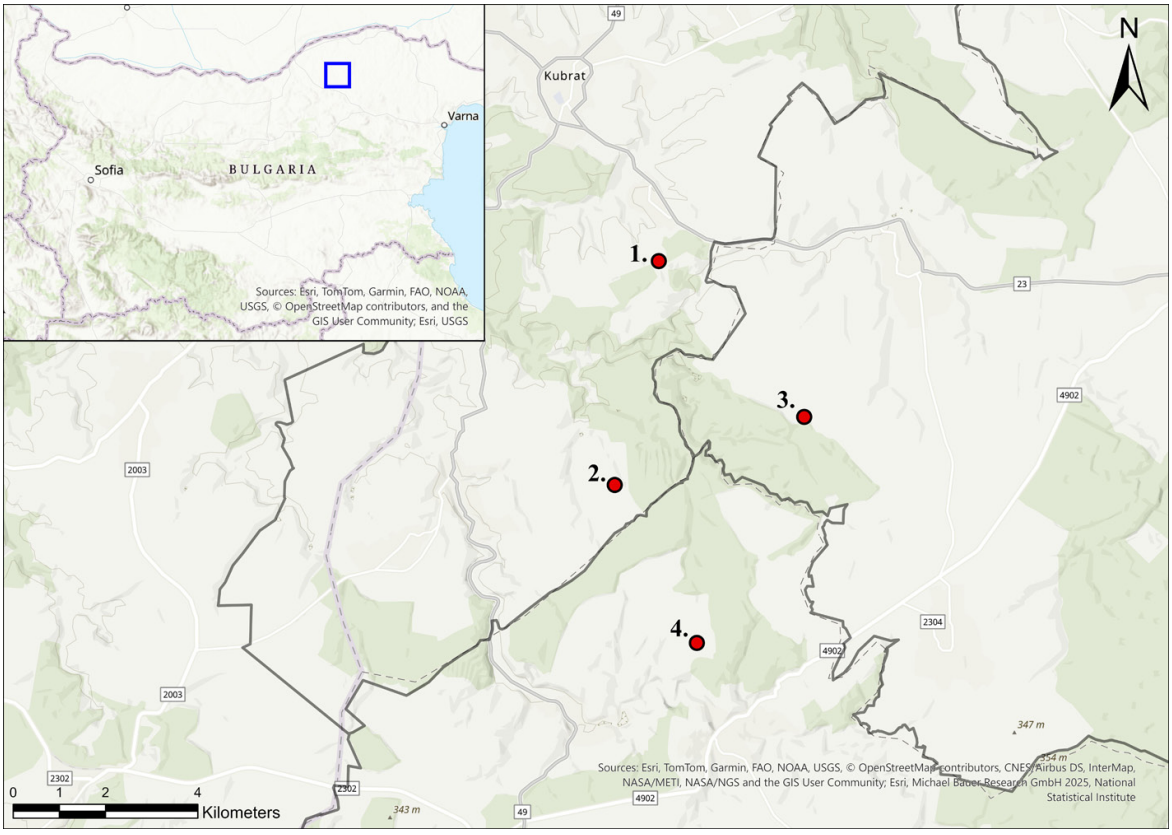

Figure 2. Map of the Ludogorsko Plateau, sites at: 1.Medovene; 2.Kamenovo; 3. Brestovene; 4. Pobit kamak (made by D. Sandeva).

Georgiev, forthcoming *a*; Popov, Georgiev, forthcoming *b*; Popov et al. 2025) (Fig. 1), along with the obtained 14C data.

Following the conclusion of field surveys in the areas of Kamenovo, Medovene, Brestovene, and Pobit kamak, geophysical surveys have been conducted.[3] In these areas, pottery sherds dating to the Late Bronze Age have been unearthed. A number of these sites coincide with previously identified artefacts and extend the empirical basis regarding the metalworking and metallurgy typical of this geographical region.

Geographical area. Main characteristics

The geographical area of the study, in which the four sites that are the focus of the research are located – Medovene, Brestovene, Kamenovo, and Pobit kamak – the Ludogorsko Plateau is located in Northeastern Bulgaria (Fig. 2). The term "crazy forest" is associated with the name of this region. The old name of the Ludogorie – Deliorman was used until 1942 (Iliev 2007: 34) and has been known since 16th century (Iliev 1999: 9). The boundaries of the area extend westwards to the Beli Lom and Topchiyskaya rivers, bordering the Razgrad and Samuilov Heights to the south, and reaching the Dobrudja Plateau to the east (Vladev 2020: 51; Vladev 2022: 4). The most prevalent soil type is black soil (chernozem), which is characterized by its exceptional fertility. Additionally, a large number of grey forest soils occur, which is due to the centuries-old oak forests for which the area is famous (Doykov & Doykov 2017: 38-39). The Topchiyska River constitutes one of the primary water sources in the region, and a substantial number of archaeological sites have been documented in its valley.

[3] All geophysical studies included in this research were conducted by Assoc. Prof. N. Tonkov and A. Atanasov (NAIM-BAS).

Materials and Methods

Before the beginning of archaeological ivestigations, several preparatory steps were taken, including the examination of satellite images and the analysis of topographical maps at scales of 1:5000 and 1:50 000. These sources provided significant insights into the toponymy of the region.

A variety of investigative methods were employed, including remote sensing using satellite imagery, field verification of potential archaeological sites identified from satellite imagery, and collection of archaeological surface material. Google Earth Pro enables users to „travel back in time" to 1985, when the first images of the Northeastern Bulgaria region were captured. In the initial phase, however, the image quality is insufficient and none of the recorded sites from this period could be identified. Since 2009, the multitude of satellite images have been carried out, which have shown very good image quality, especially in recent years (since 2019), allowing detailed observations of the areas and recognition of changes in the surrounding terrain. Over the past two decades, with advances in technology, an increasing number of satellite images have been acquired – sometimes two to three per year in different seasons – allowing the observation of plots at various stages of their agricultural use. A key advantage of this non-invasive remote sensing technique lies in its ability to capture temporal variations in the observed at different times. The images used to locate the archaeological sites were not subjected to post-processing. All possible variations are traced back in time, and the best images are selected for subsequent analysis of size, number of soil marks, and spacing. In the present study, this method was employed to identify crop marks and soil marks that could be potential archaeological sites (Gojda 2005; Verhoeven & Doneus 2011; Materazzi & Pacifici 2022).

The subsequent phase entails the substantiation of the soil marks, although they resemble anomalies attributable to prior human intervention, it is possible that natural changes influenced by the environment are responsible. Verification involves a site visit to the previously identified soil marks. The area is surveyed by a team of archaeologists, who walk either at regular intervals (15 to 20–25 m) or at uneven intervals across the site, depending on the chosen method, collecting any archaeological material that can serve as a chronological indicator – such as characteristic pottery sherds and finds, if present. Global Positioning System (GPS) is utilised to mark locations with elevated concentrations of archaeological material or finds, so their positions are known even though the land has often been deeply ploughed and some material may have been redeposited and scattered.

The soil marks previously identified for visitation are surveyed, and the surrounding area is also examined to allow for the detection of other concentrations of material that have no visible distinction from the surrounding terrain on satellite imagery. If archaeological material is present on the surface, a plan survey is conducted to determine the possible limits and extent of the archaeological site.

Subsequent to the verification and confirmation of the presence of archaeological sites, a geophysical survey is conducted, employing magnetic gradiometry in a dual fluxgate gradiometer configuration (Popov et al. 2025: 25).

Results

The results below are presented for each site, following the sequence of steps set out at the beginning. The following data concern the sites at Medovene, Kamenovo, Brestovene, and Pobit kamak[4]. These sites form the core of the study of the Late Bronze Age and are the only sites on which stone forms were discovered during the excavations in the area. The field surveys revealed medium to high concentrations of archaeological material, including pottery sherds, plaster, flints, stone objects, and small ceramic finds (spindle whorls, loom weights). These findings corresponds to the location of the soil marks observed in the satellite imagery during the field inspection. This observation suggests that the highest concentration of archaeological materials and finds – bones and charcoal – are found in the area of dark soil marks[5]. Single archaeological materials are often found outside the soil marks, but they are in much lower concentration and may have been dispersed during agricultural cultivation.

[4] The data from the geophysical surveys have not yet been published, and the author would like to thank Assist. Prof. P. Minkov, PhD (NAIM-BAS) and Assist. Prof. Zh. Vasileva, PhD (NAIM-BAS) for the information provided.

[5] Some of the archaeological finds were presented in a temporary exhibition entitled »Bulgarian Archaeology 2024« at the National Archaeological Institute with Museum at the Bulgarian Academy of Sciences and in the accompanying catalog.

Figure 3. Aerial photograph of the LBA site near the village of Medovene (photo by Eng. V. Valchev).

Most of the soil marks are more clearly visible in Google Earth Pro when the monitored area is left fallow or ploughed, that is, during the months of February to April and October to November. During these periods, the soil marks become more visible and display an intensely dark colour, usually dark brown to black, standing out clearly from the surrounding terrain. In other cases, a clear distinction from the surrounding terrain can be discerned in the presence of emerging vegetation (May to July), where the presence of archaeological features is indicated by denser vegetation or by the absence of such features and the presence of areas without plants. The soil marks are related to the so-called vegetation indicators, where areas with less and anomalous vegetation indicate the presence of archaeological features (Orlando & Villa 2011: 156). This is also clearly visible when photographing the terrain with a drone (Fig. 3) According to some studies, agricultural plants are „thicker, taller or ripen later", which is explained by a higher moisture content of the soil, or they develop more slowly and less well when there is insufficient moisture, as was the case in the presence of an archaeological feature with stones (Aqdus et al. 2008: 361).

The dimensions of the soil marks at the Late Bronze Age archaeological sites of Medovene, Brestovene, Kamenovo and Pobit kamak have been documented, with variations in size ranging from 10-20 m for the smaller marks to 50-60 m for the largest. The majority of the marks exhibit an average diameter of 30–40 m and are often grouped in groups of several traces.

I. Medovene

The archaeological site is situated in the village of Medovene, Kubrat municipality, Razgrad region, in the Sayaorman area, on privately owned agricultural land. The topography of the site is predominantly flat, exhibiting a gradual incline toward the southern direction (Minkov et al., forthcoming c). The southern and eastern boundaries of the region are delineated by contemporary forested regions, while the western landscape is distinguished by a shallow, north-south trending ravine. This site is part of a network of dry valleys that are characteristic of the Ludogorsko Plateau (Minkov et al., forthcoming *c*).

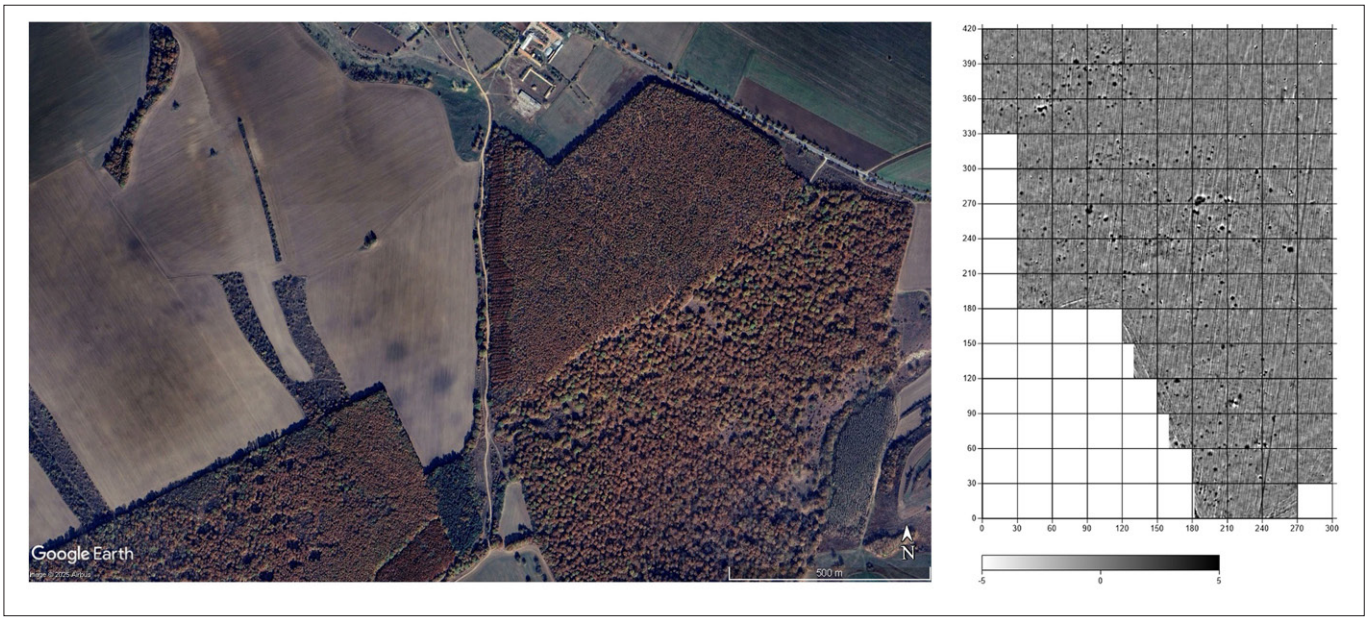

Figure 4. Soil marks at Medovene (source: Google Earth Pro) and the results of the geophysical survey (Assoc. Prof. Dr. Eng. N. Tonkov and A. Atanasov, NAIM-BAS; Minkov et al. forthcoming c).

Preliminary observation

When observing satellite images from Google Earth Pro using the History view tool throughout different seasons, under different climatic conditions and with different land cultivation, large dark soil mark with an approximately circular/oval shape were identified. Review of the images over different time periods shows the highest contrast after terrain treatment, in the absence of grown crops. The soil marks occupy the southern part of the site, clearly differing from the surrounding environment. They are compactly located among themselves, with no preliminary planning or organisation noticeable. It can be said that the distances between them are approximately the same.

Visit, search, registration

The site was visited and registered in 2021 (Popov & Georgiev, forthcoming *a*). During the site visit, large soil marks of dark brown soil were clearly visible, containing pottery sherds, individual finds, and animal bones. Charcoal and plaster are often visible on the surface of some of the soil marks. Some of the soil marks are discernible on the ground as slightly elevated, smooth, positive shapes. Consequently, in addition to the color indicator, there is also a criterion related to the terrain relief is identified that corresponds to the observed dark soil marks. The registered remains have been interpreted as a Bronze Age settlement.

Geophysical Survey[6]

In 2024, geophysical investigations were conducted, with magnetic gradiometry serving as the primary survey method. The study utilised a dual-configuration fluxgate gradiometer (GRAD 601) manufactured by Bartington Instruments in the United Kingdom (Minkov et al., forthcoming *c*).

A total area of almost 94 decares was examined (Minkov et al., forthcoming c). The results indicated the presence of a notably elevated concentration of potential archaeological anomalies, which were subsequently categorised into three relatively compact clusters: northwestern, central, and southern (Minkov et al., forthcoming *c*).

The northwestern cluster displays the highest anomaly density while covering the smallest area. The central cluster is the most extensive in both size and number of recorded anomalies, characterised by a moderately compact spatial distribution (Minkov et al., forthcoming c). Within this group, two larger anomalies stand out and may corre-

[6] The information on the area of all geophysical surveys mentioned below (at the sites near Kamenovo, Brestovene, Medovene, and Pobit Kamak) was obtained from data in annual archaeological reports and includes data to be published in Bulgarian with a summary in English (Minkov et al., forthcoming a; Minkov et al., forthcoming c; Minkov et al., forthcoming d; Minkov et al., forthcoming e; Vasileva et al., forthcoming)

spond to structures of residential or economic function. The southern cluster was only partially surveyed due to the presence of a forested massif in the western and southwestern sections of the site, as well as a dirt road running parallel to the forest boundary (Minkov et al., forthcoming *c*).

Conclusions

In consideration of the results that have been presented, it is possible to formulate a number of conclusions. The archaeological anomalies are distributed across two compact groups, coinciding with the area of the dark soil marks. However, there is no topographical overlap between the shape and size of the anomalies and the dark soil marks. That is to say, there is no correspondence between the field data and the results of the geophysical survey. However, the presence of colored markers and a high concentration of ceramic materials indicate the existence of a site that was recorded during field searches and whose boundaries were refined through geophysical surveys (Fig. 4).

II. Kamenovo

The site is situated in a region of cultivated agricultural land within the village of Kamenovo, in the Kubrat municipality, in the Yurtluka area. The site is naturally confined to the east and northeast by a dry riverbed, which belongs to a larger network of arid river channels (Minkov et al., forthcoming a; Minkov et al., forthcoming b). The topography of the area under consideration is predominantly flat, exhibiting a minor inclination toward the south-southeast. The geographical entity under scrutiny is composed of two distinct regions, a northern portion that is comparatively diminutive in size and a southern region that is the primary and most sizable part of this geographical area of concern 2023 (Minkov et al., forthcoming *b*) and (Minkov et al., forthcoming e).

Preliminary observation

The presence of a group of dark soil marks, which are round to oval in shape, is indicative of this phenomenon. The soil marks under consideration are located in a relatively narrow linear section, oriented northwest-southeast. The colour contrast between the two is pronounced, creating a striking visual effect that immediately draws the viewer's attention. The soil marks exhibit a random distribution across the terrain, with no discernible pattern or arrangement. One of the soil marks exhibits an extensive, concentric soil mark of a deep grey colour.

Visit, search, registration

The site near Kamenovo was also registered in 2021 (Popov & Georgiev, forthcoming *a*). In a manner consistent with the preceding site, dark soil marks were identified on the terrain, devoid of relief forms and „swelling" on the surface (as observed in Medovene). In the southern portion of the site, which constitutes the primary area of interest, there is a notable concentration of pottery sherds, burnt organic matter, animal bones, and individual artefacts, including ceramic plugs, wheel models, and moulds. One of the dark soil marks, which is also the largest, exhibits a light grey hue due to the presence of intensely saturated ash in the central portion of the soil mark. In the northern section of the site, the soil marks are less prevalent, with the site extending north and east into a contemporary forest. It is noteworthy that in this region of the site, a prominent central soil mark is evident, accompanied by several smaller soil marks of round to oval configuration, exhibiting no discernible pattern in their arrangement.

Geophysical survey

Geophysical surveys of the site began in 2022 and continued in 2024 (Minkov et al. 2024: 187-191; Minkov et al., forthcoming *b*; Minkov et al. forthcoming *e*). The results obtained demonstrate a topographic pattern analogous to that observed in Medovene. In the southern part of the site, there is a medium to high concentration of anomalies, which are divided into two groups: northern and southern, with a clear break between them (Minkov et al., forthcoming b; Minkov et al., forthcoming, e). Within the two prominent anomalies, there is an observable internal stratification of individual anomalies into discrete, smaller groups, as evidenced by the analysis of magnetograms. This principle applies universally, irrespective of the magnitude of the anomaly in question (Minkov et al., forthcoming b). This approach enables the discernment of anomalies that might be pits, farm buildings, residential features, or features with ambiguous functions and characteristics. In the northern part of the site, a much simpler picture

Figure 5. Soil marks at Kamenovo (source: Google Earth Pro) and the results of the geophysical survey (Assoc. Prof. Dr. Eng. N. Tonkov and A. Atanasov, NAIM-BAS; after: Minkov et al. 2024: 189, fig. 7).

can be observed. The terrain contains two groups of anomalies, which are dispersed and scattered across the terrain in a chaotic and dispersed manner. There is an absence of any discernible internal arrangement or layout. The observed frequency of anomalies is notably low, and the spatial extent of the site is delineated with clear boundaries (Minkov et al., forthcoming *b*; Minkov et al. forthcoming *e*).

Archaeological excavations

The archaeological excavations at the site were conducted in 2023 (Minkov et al., forthcoming *a* and Minkov et. al 2024). One of the registered anomalies has been the subject of preliminary investigation. The investigation established that the anomaly found in the geophysical survey is precisely what was observed. This feature, which is approximately 4.50 m x 4.50 m in size, was dug to a depth of 3.25 m in sterile sediment. Presently, however, its function remains unclear, as only half of it has been studied (Minkov et al. 2024: 191-193; Minkov et al., forthcoming *a*). The site is characterised by the presence of loose soil and a substantial quantity of ash, which significantly facilitates the investigation of this depth. It is noteworthy that the feature itself is situated within a layer of dark reddish-brown sediment, which likely represents a cultural layer saturated with small fragments of plaster and charcoal. A noteworthy discovery was made during the registration process of the site on the terrain, specifically at the location of the feature in question. This registration revealed the presence of clay stoppers and wheel models, exhibiting a striking similarity to those previously identified during the in-depth study.

Conclusions

It is important to note that this is the only site in the area where a complete chain of operations was carried out during the survey. These include satellite monitoring, field surveys, geophysical surveys and archaeological excavations. This allowed for a comprehensive observation of the individual elements of the site. The results of the preliminary observation and geophysical survey differ in terms of the overlap of the large soil marks and the actual anomalies “located beneath them.” There is no correspondence in terms of their location, size, and grouping on the ground. The geophysical survey and the subsequent archaeological research showed complete agreement in the results obtained for one of the anomalies, and subsequently in its study (Fig. 5).

III. Brestovene

The site's geographical location within a region of cultivated agricultural land in the vicinity of the village of Brestovene, municipality of Zavet, in the Kodzhaekinlik area, renders it a subject of particular interest. The southernmost extent of the area is delineated naturally by a dry riverbed, which constitutes a segment of a larger interconnected system of channels (Minkov et al., forthcoming d). A contemporary unpaved route traverses the system's medial sector, tracing the path of one of the riverbeds present in this geographic location. The site is divided into two primary sectors: eastern (East) and western (West). Both sectors demonstrate a gradual southward incline toward the primary dry riverbed (Minkov et al., forthcoming *d*).

Preliminary observation

The site is identified by the presence of dark soil marks, which are irregularly round to oval in shape and of approximately equal size. Several of these marks display a light grey central area, which is similar to one of the soil marks identified near Kamenovo. Preliminary field observations suggest that the soil marks may extend southwards into the adjacent forested area, indicating a possible connection between the two parts of the site.

Visit, search, registration

The archaeological site was registered in 2022 (Popov & Georgiev forthcoming *b).* During a site visit, large soil marks of dark brown soil are clearly visible on the surface of the terrain, which differs from the surrounding light brown soil. The presence of ceramic materials and artefacts is particularly pronounced within these soil marks. The soil marks, which during the observations have grey central parts, turn out to be saturated with ash.

Geophysical search

Geophysical surveys were carried out in 2024 (Popov et al. 2025; Minkov et al., forthcoming *d*). Two local square grid systems - Sector West and Sector East were established within the archaeological site (Minkov et al., forthcoming d). The geophysical survey of the first sector (West) covered an area of almost 40 decares. The results reveal two main zones with a concentration of anomalies: one in the northwest and one in the southeast (Minkov et al., forthcoming d). Numerous negative archaeological features, likely pits, were recorded in these areas, along with several anomalies that may correspond to residential or economic structures. The anomalies are dispersed across the terrain and do not form dense clusters or coherent patterns (Minkov et al., forthcoming d). It is possible that the dirt road running through the southeast has disrupted and affected the southeastern edge of this sector of the site (Minkov et al., forthcoming *d*).

In the sector East, an area of almost 39 decares has been surveyed (Minkov et al., forthcoming d). The geophysical survey results indicate the presence of a medium to high concentration of potential archaeological anomalies within the designated area (Minkov et al., forthcoming d). In the northwestern part, relatively compactly arranged archaeological features (probably pits) have been identified (Minkov et al., forthcoming d). In the southern part of the sector, isolated anomalies have also been recorded, providing information about dugins (Minkov et al., forthcoming *d*).

The observations made on the eastern periphery of the sector corroborate the aforementioned assertions. The easternmost corner of the sector exhibited a solitary anomaly, which could potentially delineate the perimeter of the site (Minkov et al., forthcoming *d*). It has been observed that within the plowed furrow located at the easternmost edge of the site, there are minor anomalies that are clearly discernible. At this juncture, however, it is challenging to ascertain whether these anomalies are authentic archaeological features (Minkov et al., forthcoming *d*).

Conclusions

Here, too, the observations of a discrepancy between the large soil marks visible during the observation and registration of the site and the results obtained for the anomalies from the subsequent geophysical survey should be repeated. The presence of a relatively low number of anomalies, against the background of the large soil marks located at close distances, is of interest (Fig. 6).

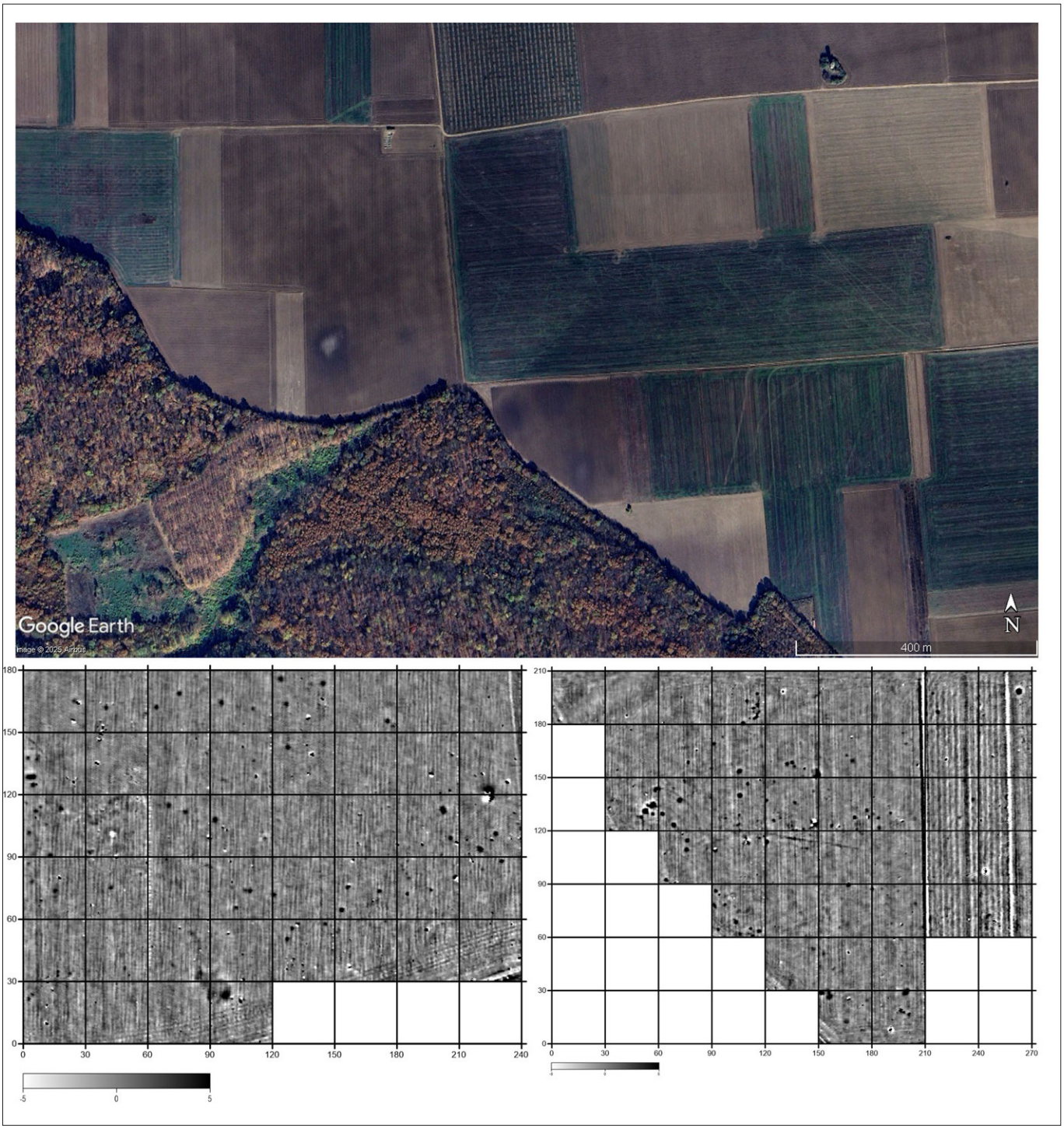

Figure 6. Soil marks at Brestovene (source: Google Earth Pro) and the results of the geophysical survey (Assoc. Prof. Dr. Eng. N. Tonkov and A. Atanasov, NAIM-BAS; Minkov et al. forthcoming d).

IV. Pobit kamak

The archaeological site under consideration is located within the confines of the village of Pobit Kamak, which is part of the Kubrat municipality within the Razgrad region. More specifically, the site is situated in the area referred to as Dabravata. The site is located within the confines of privately owned arable land. The site's topography is defined by a vast, level expanse that slopes towards the south (Vasileva et al., forthcoming). The northern, southern, and eastern boundaries of the site

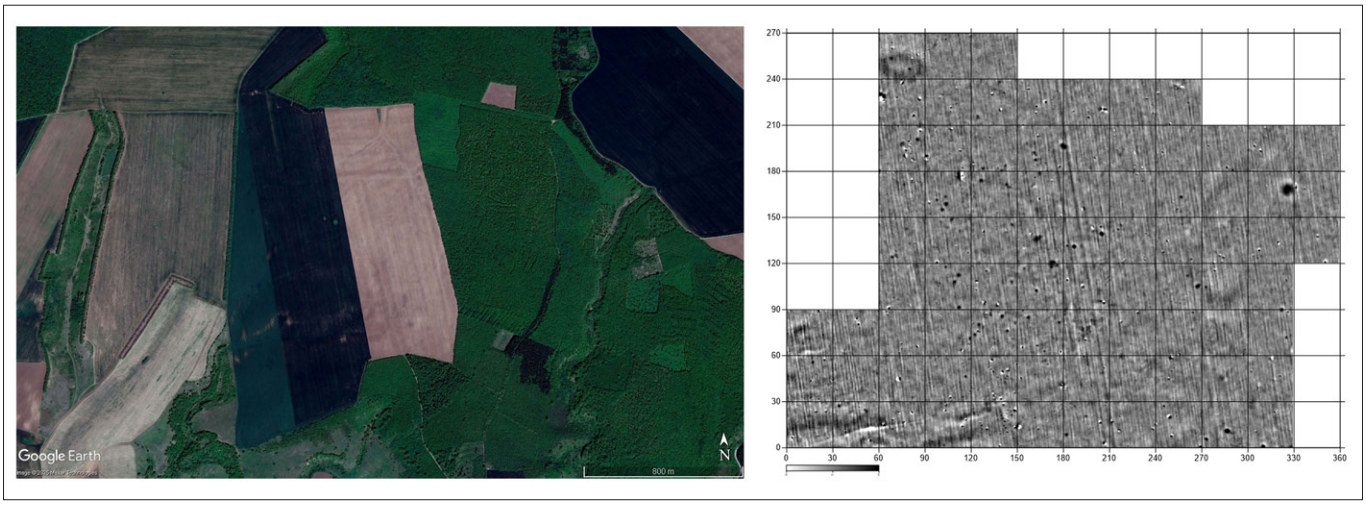

Figure 7. Soil marks at Pobit kamak (source: Google Earth Pro) and the results of the geophysical survey (Assoc. Prof. Dr. Eng. N. Tonkov and A. Atanasov, NAIM-BAS; Vasileva et al. forthcoming).

are represented by contemporary forest massifs (Vasileva et al., forthcoming). The topography of the region, as observed from a western vantage point, is characterised by the presence of a shallow ravine that exhibits an east-west orientation. This topographical feature is a constituent element of a dry valley, a common geographical phenomenon that is characteristic of the Ludogorsko Plateau (Vasileva et al., forthcoming). The identification of this site is of particular interest, given the aforementioned eponymous find of stone moulds for the metallurgy of the Late Bronze Age from the Lower Danube region.

Preliminary observation

This site presents the most challenging observation when utilising the capabilities of Google Earth Pro. In spite of the variations in terrain or the season, this site poses significant challenges in the observation of soil marks. However, under certain conditions, individual soil marks became faintly visible, barely distinguishable from the surrounding terrain. Based on this, and on information that a collective find of stone moulds was discovered there in the past, the site was visited in person.

Visit, search, registration

The archaeological site at Pobit Kamak was registered during surveys in 2021 (Popov, Georgiev, forthcoming b). The site was visited multiple times over several years and seasons, with varying terrain treatment. On one occasion, stains were observed on the surface, similar to those from the previous sites. Furthermore, a modest assemblage of pottery sherds, individual artefacts and a single fragment of a stone mould were collected from the surface of the site. The soil marks are amorphous, not compact and are significantly scattered across the terrain, as a result of agricultural treatment. This significantly complicates its registration, determination of its boundaries and area.

Geophysical search

In 2024, geophysical investigations were conducted on an area of nearly 75 decares (Popov et al. 2025; Vasileva et al., forthcoming). The analysis revealed a moderate density of potential archaeological features, which are dispersed across the surveyed area rather than forming consolidated clusters. The distribution of these elements exhibits a general northwest-southeast orientation (Vasileva et al., forthcoming). While the majority of the detected anomalies are relatively small in scale, a single, notably large feature was identified in the northeastern sector of the site, suggesting localised variation in subsurface activity (Vasileva et al., forthcoming).

Conclusions

The results obtained from the observation and geophysical survey suggest that it is possible to register the presence of a site, even when the initial fac-

tors are not the most favourable. In such cases, a long and repeated visit to the site in different seasons and with different treatments of the terrain is necessary. That is, if for some sites this is visible and accessible from the preliminary observation, then for others, a more in-depth and permanent repetition of direct observations on site is necessary. Criteria such as the presence of archaeological materials and finds are mandatory to indicate its presence (Fig. 7).

Discussion

A methodological approach was implemented in the research conducted in the Ludogorsko Plateau, with a focus on the sites from the Late Bronze Age. This approach entailed the following interconnected stages: initial observation of satellite images, selection of a potential site for further investigation, registration of the site, execution of a geophysical survey, and, in a single instance, the undertaking of archaeological excavations.

This system raises several important questions and draws some conclusions. The cited sites share similar geographical and topographic characteristics: they are located on elevated ridges next to flooded ravines, which are close to each respective site. A slight southward slope of the terrain is usually observed, a consistent and stable feature of Late Bronze Age sites. When viewed on satellite images, these sites are identified by large dark soil marks, which on the ground correspond to extensive soil marks of soil darker than the surrounding terrain, saturated with pottery sherds, animal bones, stone, ceramic finds, as well as, in a single case, the discovery of a bronze needle and moulds for casting metal objects. Thus, with certain agricultural processing of the area where the site is located under similar conditions, it is possible to identify archaeological sites from the Late Bronze Age.

An additional observation from the geophysical surveys also indicates an overlap in the data obtained. The sites exhibit anomalies, with the concentration varying for each. For example, the sites near Medovene and Kamenovo have the highest concentration of anomalies, followed by Brestovene and Pobit kamak. It is worth noting that the concentration of archaeological materials does not correspond to the number of geophysical anomalies. They are usually divided into two or three groups according to terrain, for which various explanations can be given – horizontal stratigraphy; consolidation of separate "neighbourhoods" within the site, etc. At some of the sites, the so-called sectorization is also determined by natural features, such as at Brestovene, where the site is located on two of the terraces, above the existing ravine, with no recorded direct connection between them.

The data and results of the preliminary studies presented here were obtained from four sites that share similar characteristics in terms of chronology and material culture. Despite the observations concern four sites, it can be assumed that this represents a sustainably established model, which is traced in a uniform natural environment, characterised by relatively similar climatic, geographical, topographic and hydrographic factors and conditions.

This enables the use of modern methods of preliminary observation to be used to identify and track, using Google Earth Pro's History feature, relatively consistent results for objects of the same category within the same territory. This is particularly important for the creation, analysis, and interpretation of different information units or clusters of such units, and for developing theoretical models of spatial presence, settlement, and internal migrations within a distinct and enclosed area.

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