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Knut Rassmann, René Ohlrau, Robert Hofmann, Carsten Mischka, Nataliia Burdo, Michail Yu. Videjko, Johannes Müller

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High precision Tripolye settlement plans, demographic estimations and settlement organization

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Author´s addresses:
Carsten Mischka, Johannes Müller,
René Ohlrau
Institut für Ur- und Frühgeschichte der
Christian-Albrechts-Universität zu Kiel
Johanna-Mestorf-Str. 2–6
24118 Kiel, Germany
carsten_mischka@gmx.de
johannes.mueller@ufg.uni-kiel.de
rene.ohlrau@googlemail.com

Knut Rassmann
Römisch-Germanische Kommission
Deutsches Archäologisches Institut
Palmengartenstr. 10–12
60325 Frankfurt am Main, Germany
knut.rassmann@dainst.de

Nataliia Burdo, Michail Yu. Videko
Institute of Archaeology NAS of Ukraine
12 Geroiv Stalingrada Ave.
04210 Kyiv-210, Ukraine
wideiko@gmail.com

Abstract

High precision geomagnetic plans of Tripolye mega-sites were recorded during a German-Ukrainian project from 2011–2013. Here, detailed geophysical plans and their archaeological interpretations are presented. In combination with ethnological information on household sizes, the new plans enable the formulation of models on social organization and population sizes of the mega-sites.

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1. Introduction

1.1. The Tripolye phenomena

Archeological research into Neolithic, Copper Age and Bronze Age societies established a picture of farming and early metallurgical societies organized in small communities of no more than 4000 persons. In the early 1970s, by contrast, Copper Age settlements that included more than 10,000 people were discovered in Western Ukraine. These tremendous results were accomplished by using a new research design based on large scale geomagnetic prospection and the systematic analysis of aerial photographs (i.e. Shmaglij et al. 1973; Shishkin 1973).

1.1.1. The underestimation of the Tripolye phenomena in the west

In western countries, this research did not receive the attention it deserved for decades. The reasons for this are manifold and include the fact that a) most publications were published in Russian, b) Moldavian and Ukrainian archaeologists were somewhat isolated from the international scientific community in Soviet times and c) the traditional European archaeological perspective of *ex orient lux* continually underestimates cultural impacts from the east.

After the fall of the Iron Curtain, the research situation changed. Especially satisfying is the increasing intensity of international cooperation and the number of publications which have appeared since 1990 (e.g. Videjko 1995; Menotti/Korvin-Piotrovskiy 2012; Chapman et al. 2014; Müller et al. 2014).

1.1.2. Starting point of new research on Tripolye mega-sites

The settlement patterns of Tripolye societies are characterized by domestic sites of different sizes. If settlements were established on a more or less plain terrain, usually some kind of radially oriented settlement structure with rings of concentric houses and an empty central space are visible. In contrast, if a settlement was not established on a plain and, e.g., a steep promontory is discernible, the described pattern is not detectable in a clear manner.

While settlements of different sizes existed during the entire historical span of Tripolye in the fifth and fourth millennia BCE (cp. e.g. Diachenko 2012; Diachenko/Menotti 2012), since the 1970s huge mega-sites of unexpected size have been detected (fig. 1). They are a unique phenomenon and are not known from other European regions, neither from the Pontic steppe nor from other areas of prehistoric Europe. 9 Tripolye mega-sites consist of areas larger than 150 hectares and of more than 1000 houses each. The largest sites are Nebeleivka, Taljankin and Maidentske that each consist of up to about 2500 houses and up to approximately 150 hectares of settled space.

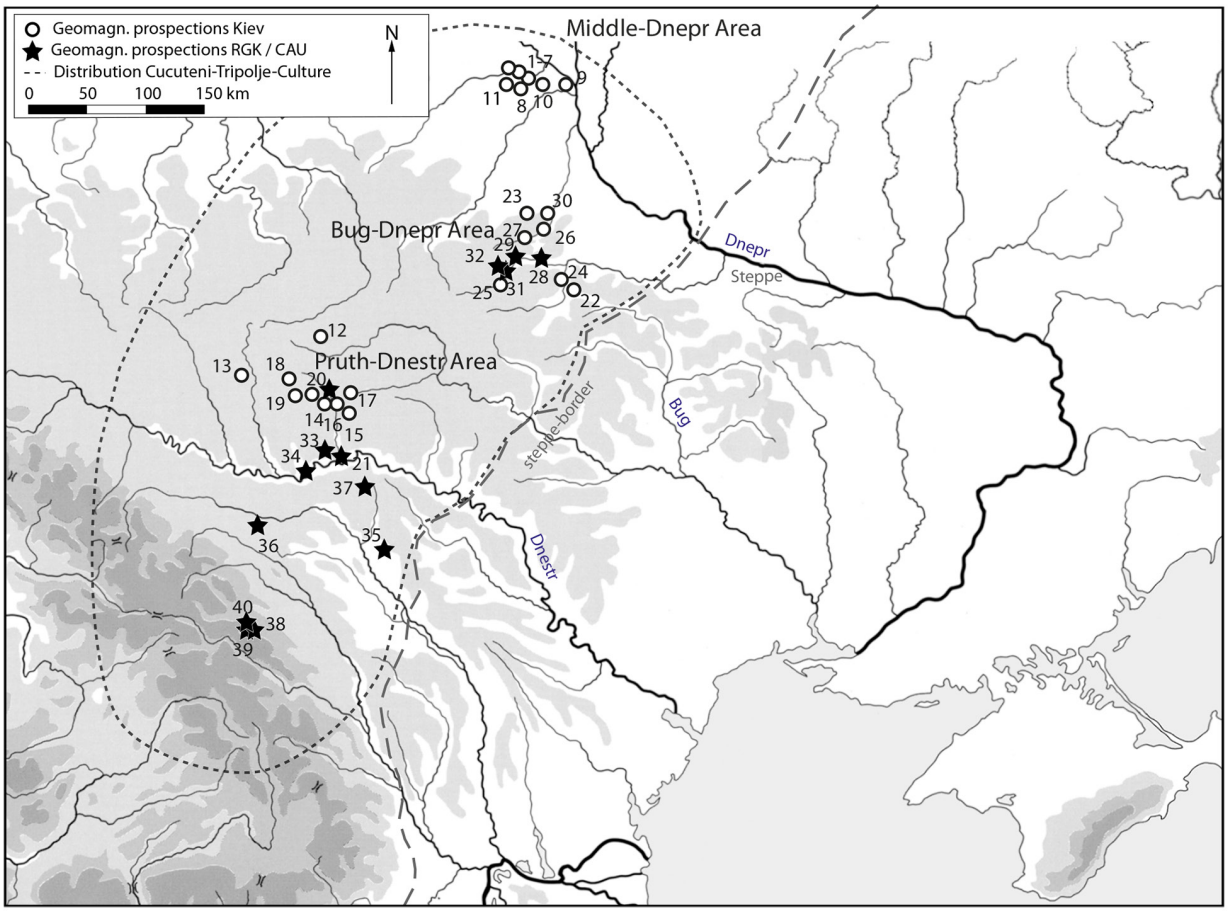

Fig. 1. Location map of Tripolye – Cucuteni groups with key-sites prospected by Ukrainian researchers and the Frankfurt/Kiel team: 1–7 Stajky (ur. Charkove), Vasylynšyn Jar (Grebeny), Vynogradnoe (Grebeny), Janča 1+2; Popovka Levada, 8 Kurjače Polé (Jušky), 9 Grygoryvka (ur. Chatyšče), 10 Ržijščev (Chomyne), 11 Jujšky (ur. Žuravka), 12 Konovka (Ukraina), 13 Brinzeny Ostrov, 14 Trifanešty, 15 Putinešty, 16 Ivanovka,17 Starye Raduljani II, 18 Glavan 1, 19 Glavan (Sof´ja 2a), 20 Lamojna 1, 21 Petreni, 22 Mogyl´na 3, 23 Glybočok, 24 Fedorovka (Mychajlovka), 25 Jatranovka (Yatranivka), 26 Jampol´, 27 Mošurov 1 (early), 27 Mošurov 1 (late), 28 Maidanetske, 29 Talianki, 30 Ol´chovec, 31 Apolianka, 32 Dobrovody, 33 Ochiul Alb, 34 Koban, 35 Horodka; 36 Ruginoasa, 37 Singereni, 38 Poduri, 39 Prohezesti, 40 Rapa Morii.

Already known at the beginning of the 20th century (a first excavation was conducted by Ernst von Stern between 1902–1903, cp. Stern 1905), the famous Tripolye expedition excavated houses of different Tripolye sites and established a basic typological differentiation for the ceramics (e.g. Passek 1935; 1949; cp. also Ryzhov 2012). Furthermore, the team started with palaeo-economic analyses and generated first ^{14}C-dates at a time when the foundations of the new dating method were still being developed. The first results of aerial photographs were a surprise. They implied the existence of huge sites of the described size, a result that was difficult to believe at the beginning of the 1970s.

Consequently, V. P. Dudkin's team developed geomagnetic devices through which geomagnetic plans, e.g. from Taljankin and Maidentske, were produced. They confirmed the results of aerial photography (Shishkin 1973; 1985; Videjko 2002, 105). From then on, different interpretations and explanations of Tripolye mega-sites were discussed. On the one hand, a non-hierarchical organization of population agglomeration that is not labeled "urban" was preferred despite their obvious size (e.g. Kruts et al. 2005). On the other hand, an urban-like character, associated with a strongly hierarchical society, was postulated (e.g. Videjko 1995; Shmaglij/Videjko 2003; Videjko 2005).

Since 2007, geomagnetic prospections completed by a combined team from Frankfurt and Kiel on Neolithic and Copper Age settlements in Romania, Moldova and Ukraine deliver new data and also define a new state of research within this part of the world (Mischka 2008; Mischka 2009; Kruts et al. 2012; Kruts et al. 2013; Müller et al.

2014; Chapman et al. 2014). Large scale, high-resolution geomagnetic prospections, effectuated by the application of 16-channel magnetometers (SENSYS MAGNETO®-MX ARCH), have been groundbreaking in this regard (fig. 2–4).

Fig. 2. The stationing of the GPS-system for the geomagnetic equipment (from left to right: Arne Windler, René Ohlrau, Carsten Mischka).

Fig. 3. The 4-wheel-drive and the geomagnetic device ready to go (from left: René Ohlrau, Carsten Mischka, Knut Rassmann, Arne Windler) at the northern part of the Talianki site.

Fig. 4. Geomagnetic plan in progress: 5 km per hour, 90 hectares surveyed in one week. Talianki site.

2. New goals, methods and results

2.1. Research questions

The main goals of the new fieldwork project can be summarized as follows:

1) *An estimation of population sizes of the mega-sites.* To achieve this aim, a full plan of each site and a dating of each of the house rings or quarters at each analyzed site are necessary. The basic approach consists of the combination of geophysical surveys, target excavations with test trenches and proper radiocarbon dating.

2) *An estimation of the carrying capacity of the environment mainly in respect to subsistence.* For this, a reconstruction of soil developments and the vegetation in combination with the economic and technical potential of Tripolye communities is necessary.

3) *A reconstruction of the economic and social organization of the mega-sites.* For this objective, spatial patterns have to be analyzed in conjunction with special functions and cultural characteristics, e.g., of the households. Analyses of material culture and architectural features with a socio-chronological methodology are distinctive.

Population size – environmental conditions and economy – social organization: With these three parameters, a disentanglement of the reasons for the development and the termination of the mega-sites might be feasible. In this article, we would like to present first steps related to the reconstruction of settlement plans, thus the results of our first geomagnetic surveys.

Our project concentrates on an area of 150 km^2 within the Bug-Dnjestr-Interfluvial area in the Uman region (fig. 5). It is characterized by metamorphic schist, chernozem soils and small valleys with relatively small watercourses. Four mega-sites lie 10–15 km apart from each other.

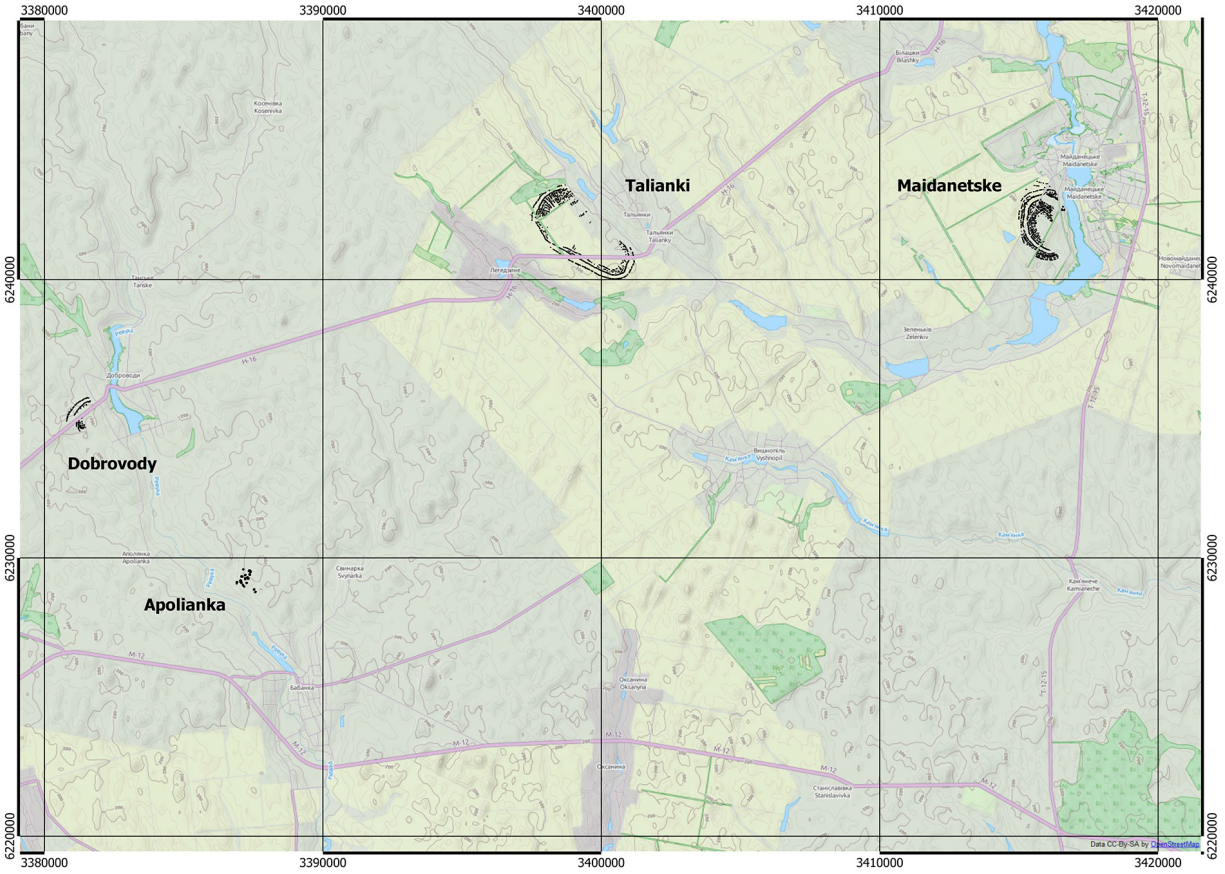

Fig. 5. Location of the mega-sites on the plateau of the Bug-Dnepr-area. Besides the canyon system of the small rivers, the location of three mega-sites at approximately 15 km distance from each other (Dobrovody, Talianki, Maidanetske) is visible. Apolianka is the one idle range Tripolye settlement in the area. The features represent the geomagnetic features of the surveys.

The concentration of mega-sites in the Uman region might be linked to a concentration of small rivers at the southern fringe of the whole plateau. The sites, for which the geomagnetic surveys are described below, belong to Tripolye phase C1 (3800–3600 BCE), except for Apolinaka that is associated with Tripolye phase C2 (ca. 3400 BCE).

2.2. Applied Methods

2.2.1. First stage: geomagnetic prospection

Geomagnetic prospection, as a starting point, is the predominant activity of the first research phase accompanied by the study of former excavation results. The new geomagnetic data has enabled us to verify detailed settlement structures (especially burnt and unburnt houses, settlement pits and numerous other settlement structures such as kilns). The team has even been able to reconstruct the chronology of the settlements with the assistance of more precise radiocarbon dates that were gained by target excavations (based on geomagnetic settlement plans) (Müller et al. in prep.).

In addition to providing information about the precise number of houses for the reconstruction of population size, high resolution geomagnetic dates revealed complete settlement plans, allowing conclusions to be drawn about the spatial syntax of early proto-urban settlements. The diversity in spatial ordering (i.e. houses in rows, circles or unevenly distributed clusters) may suggest that specific social groups varied in size and economic, political and ideological (symbolic) power. We have to take into account the fact that the diverse settlement plans indicate concepts of spatial organization and their

realization over a timespan which encompassed several generations. Therefore, in a second stage, target excavations are necessary to prove the contemporaneity of the discovered structures.

2.2.2. Second stage: the complex new research design

In a second research phase following the geomagnetic prospection, we consequently integrate new methodological developments in archaeology. In the combined and ongoing project of the Academy of Science Kiev, the Romano-German-Commission and Kiel University (cp. Müller 2014), surveys and target excavations have been and are being conducted. The extended palaeo-ecological surveys include studies on soil chemistry, analyses of phytoliths and conventional plant remains. They are used to reconstruct the subsistence potential of the area. Integrated in this program are different samples for dating from our target excavation. The reconstruction of depositional processes within the sites and analyses on material culture, especially of house positions, will enable a socio-chronological identification of internal and external Tripolye developments (cp. fig. 6).

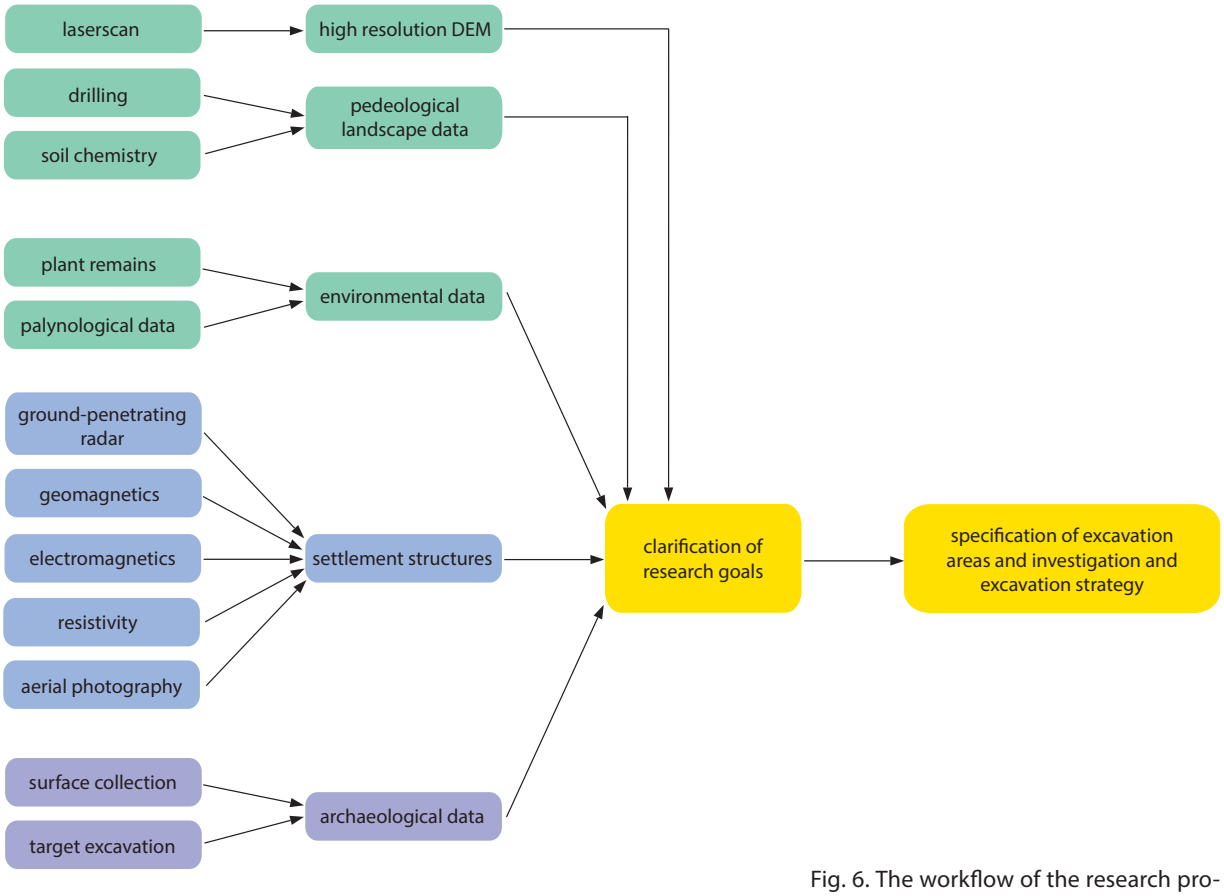

Fig. 6. The workflow of the research project as a combination of different field activities.

3. Results

In addition to other geomagnetic surveys (fig. 1), the project concentrated its activities on four sites, including Talianki, Maidanteske, Dobrovody and Apolianka (fig. 5), which are all located in the Oblast Cherkassy. The results can also be compared with a further survey that was conducted in Moldavia on the Tripolye site of Petreni. Thus, major mega-sites of Tripolye phases C1/C2 are part of our survey.

3.1. Talianki

The mega-site Talianki is positioned at 190–220 m NHN at the southern part of a chernozem plateau that is bordered by the Talianki River to the east and a small watercourse in confluence with the site on the southeastern edge of the settlement (fig. 5; fig. 7–8). Different surveys and excavations were conducted at Talianki.

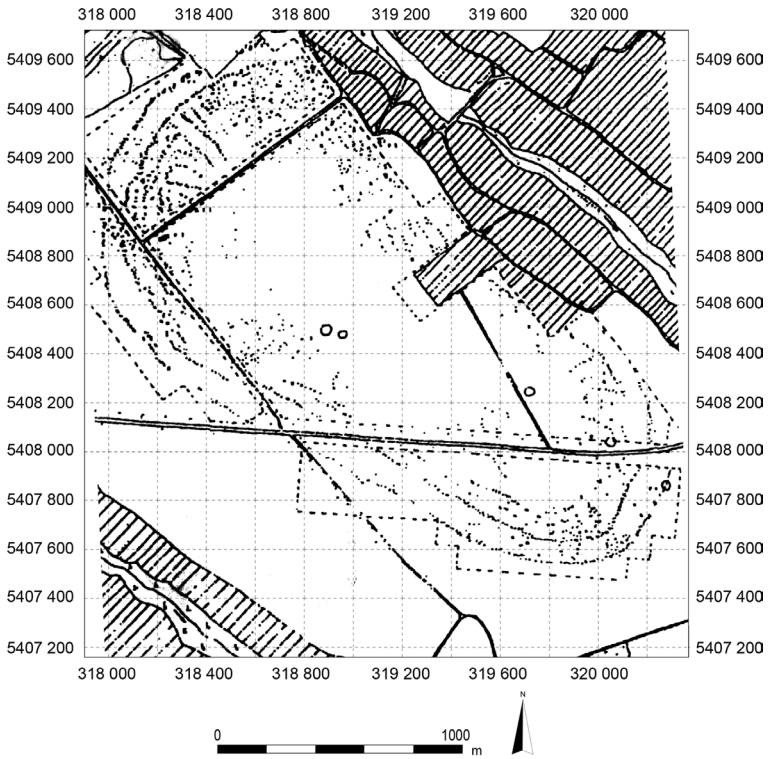

Fig. 7. Talianki. Interpretation of the early geophysical plot/aerial photograph and the geomagnetic results from 2011–2013. Georeferenced prospection of V.P. Dudkin, 1983–1986 (after Kruts et al. 2001, 18 fig. 2a).

Since the early 1970s, early aerial photography and geomagnetic prospections (Dudkin 1978; Shmaglij/Videjko1987) as well as excavations revealed the immense size of the site. An excavation program, under the direction of V.A. Kruts, A.G. Korvin-Piotrovsky, V.V. Chabanyuk and L.A. Shatilo, was carried out from 1981–1999, during which more than 30 houses were excavated. The program was then continued (Kruts 1989; Kruts 2012; Kruts et al. 2001; Kruts et al. 2005). In 2011 and 2012, new geomagnetic surveys were conducted by the RGK Frankfurt a.M., Kiev Academy and Kiel University (Kruts et al. 2012; Kruts et al. 2013).

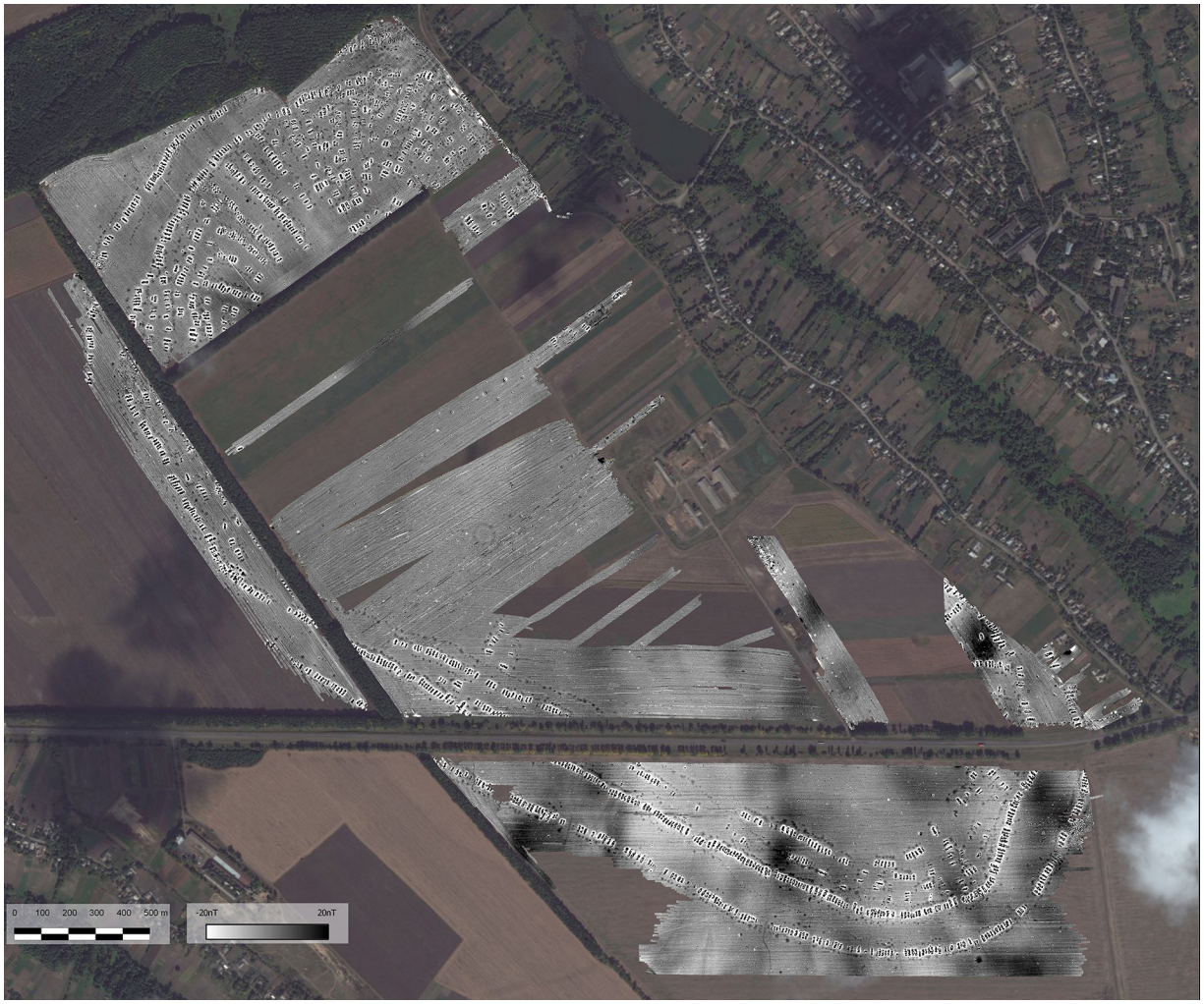

Fig. 8. Talianki. The geomagnetic features.

Within the new geomagnetic survey, 195 hectares were surveyed, of which 120 hectares show signs of domestic features (fig. 8). In connection with older geomagnetic surveys and the results of aerial photography, the whole settlement measures 320 hectares in size (fig. 9). 140 hectares belong to the central part that is, according to current results, free of domestic or other visible structures of the Tripolye period. The settled area includes 170 hectares, so that already about 70 % of the settled part has been surveyed.

While the northeastern area of the settlement is endangered or has even already been destroyed by modern building constructions of the village Talianki or of the main kolkhoz building, the other areas of the mega-site have not yet been affected by huge erosion processes or activities of later periods (fig. 8).

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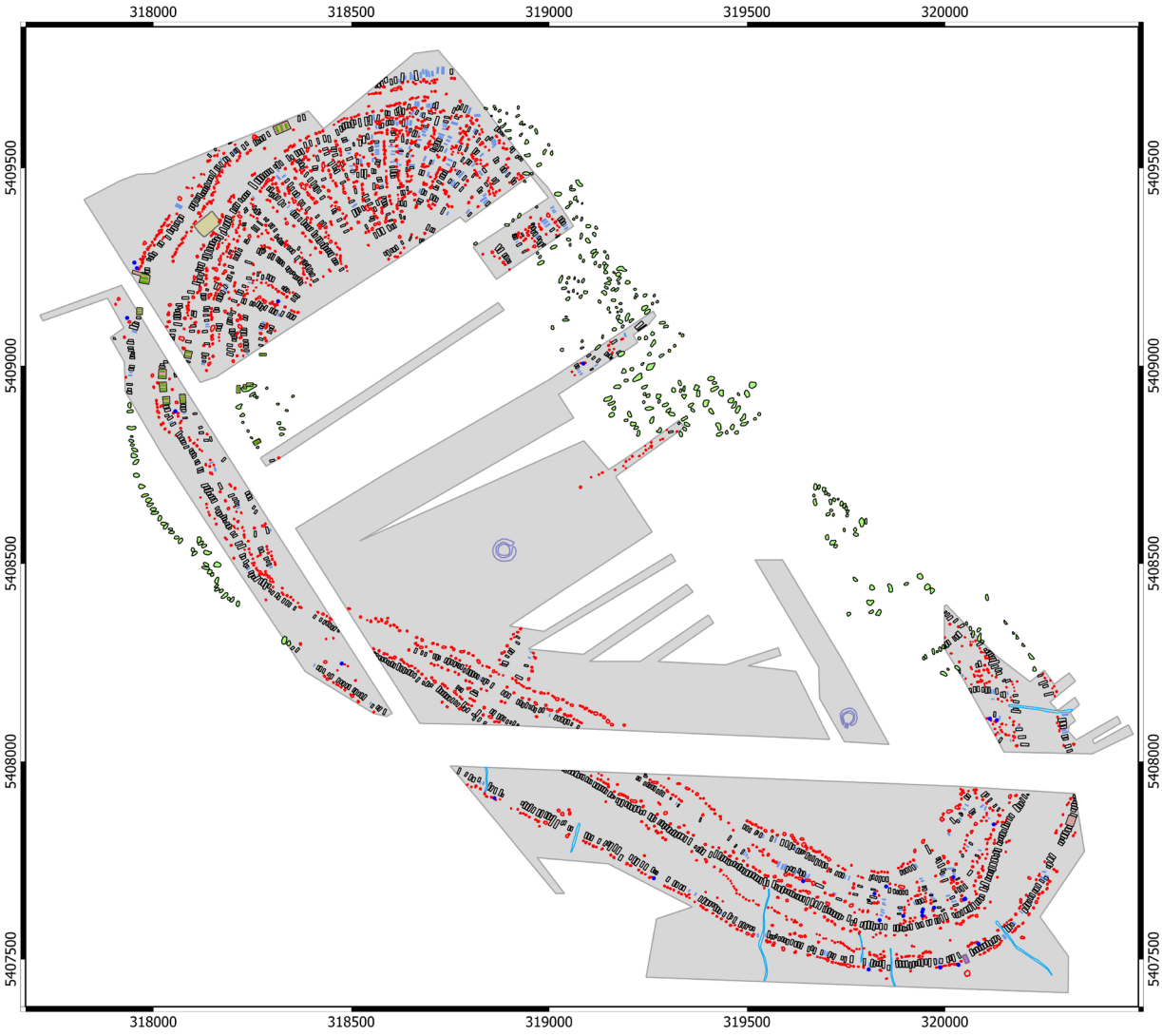
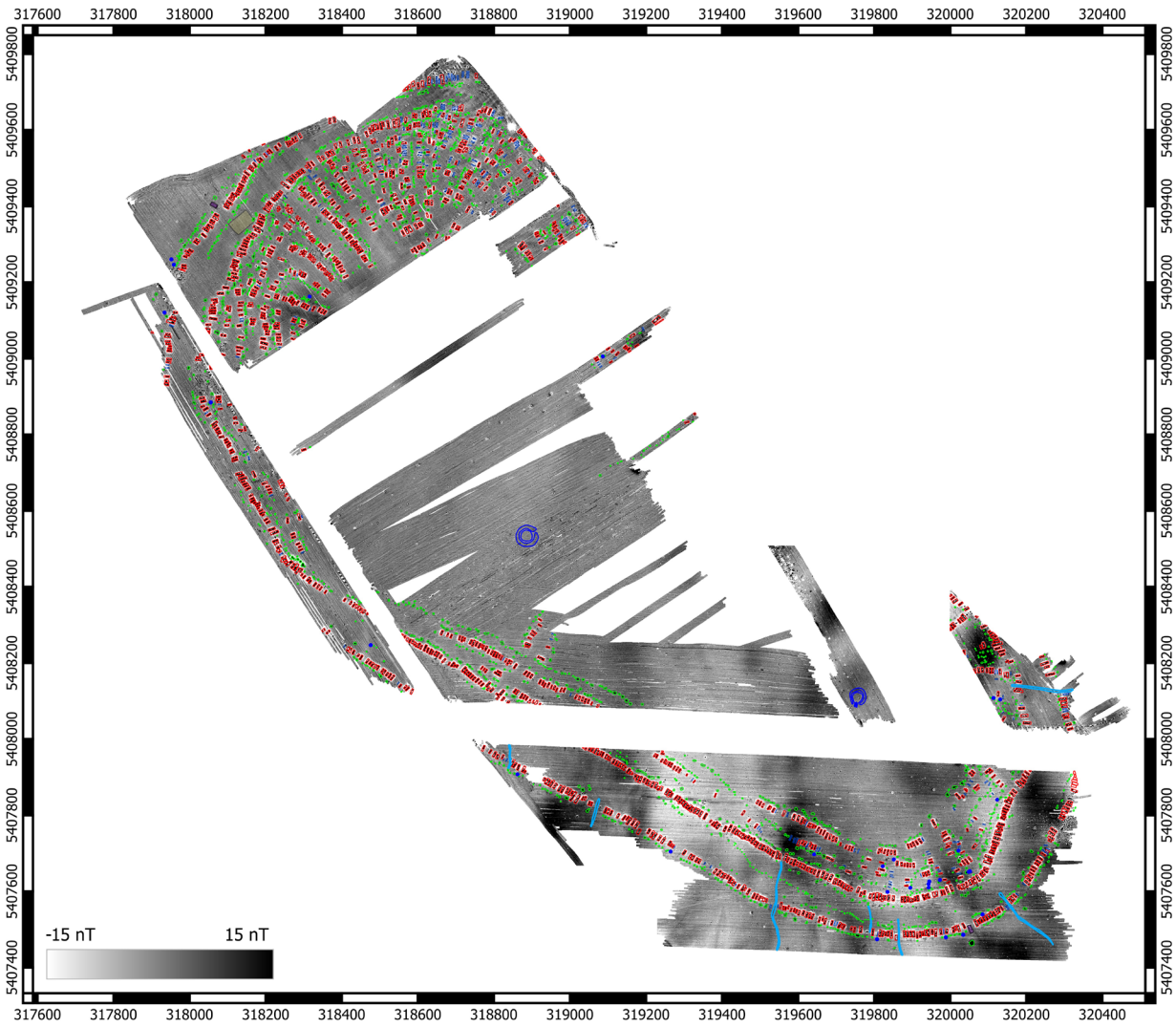


Talianki 2011/12
(Oblast Cherkassy)
KBS: UMT 36n
Redrawing: René Ohlrau

Legend

- Exceptional building
- Burnt building
- Unburnt/eroded building
- Excavated building
- Pit
- Kiln
- Older excavation
- Dudkin survey
- Pathway
- Unknown
- Kurgan
- Survey area

Fig. 9a. Talianki. Interpretation of the geomagnetic features.



Talianki 2011/12
Hybrid Plot
CRS: UTM 36n

Legend

- Exceptional building
- Burnt building
- Unburnt/eroded building
- Pit
- Kiln
- Pathway
- Kurgan
- Unknown

Fig. 9b. Talianki. Interpretation of the geomagnetic features.

The geomagnetic features of the new survey are described as follows:

(1) 1335 burnt rectangular houses are distributed in three circular-oval concentric rings, lined gable by gable and oriented on a radial axis to the central free space (fig. 8; 10). Furthermore, houses are also lined in a northern quarter, again in rows but in both concentric and radial orientation to the center (fig. 11). Some houses could be identified that are lined in concentric orientation within the space in between the described house-rings. In many cases, houses cluster to smaller groups that are separated by empty spaces (fig. 10). In the geo magnetic survey, house positions that were excavated earlier could also be identified (fig. 12).

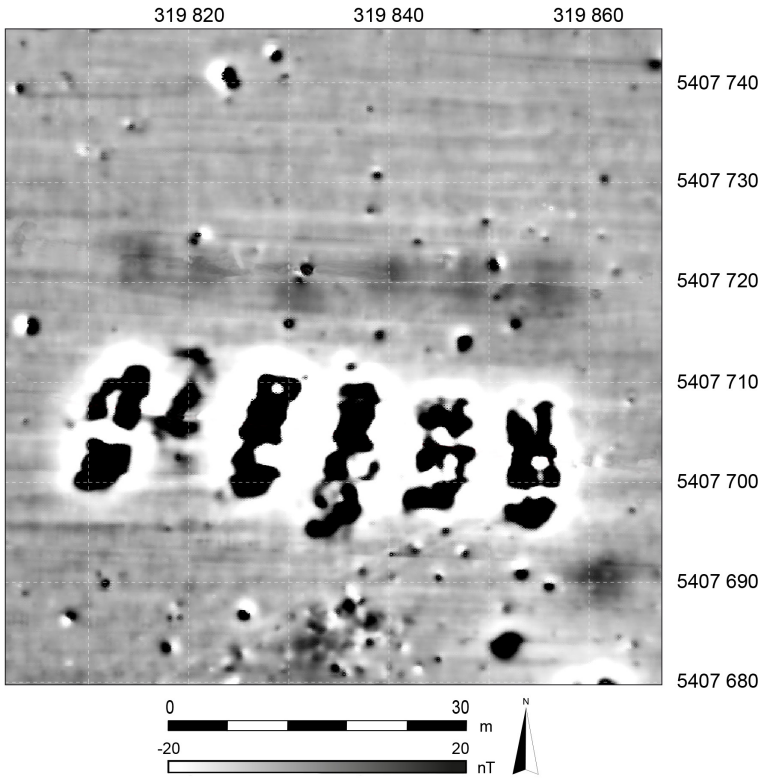


Fig. 10. Talianki. Row of heavily burnt houses in the southern part of the Tripolian settlement.

Fig. 11. Talianki. The geomagnetic features in the northern part of the site.

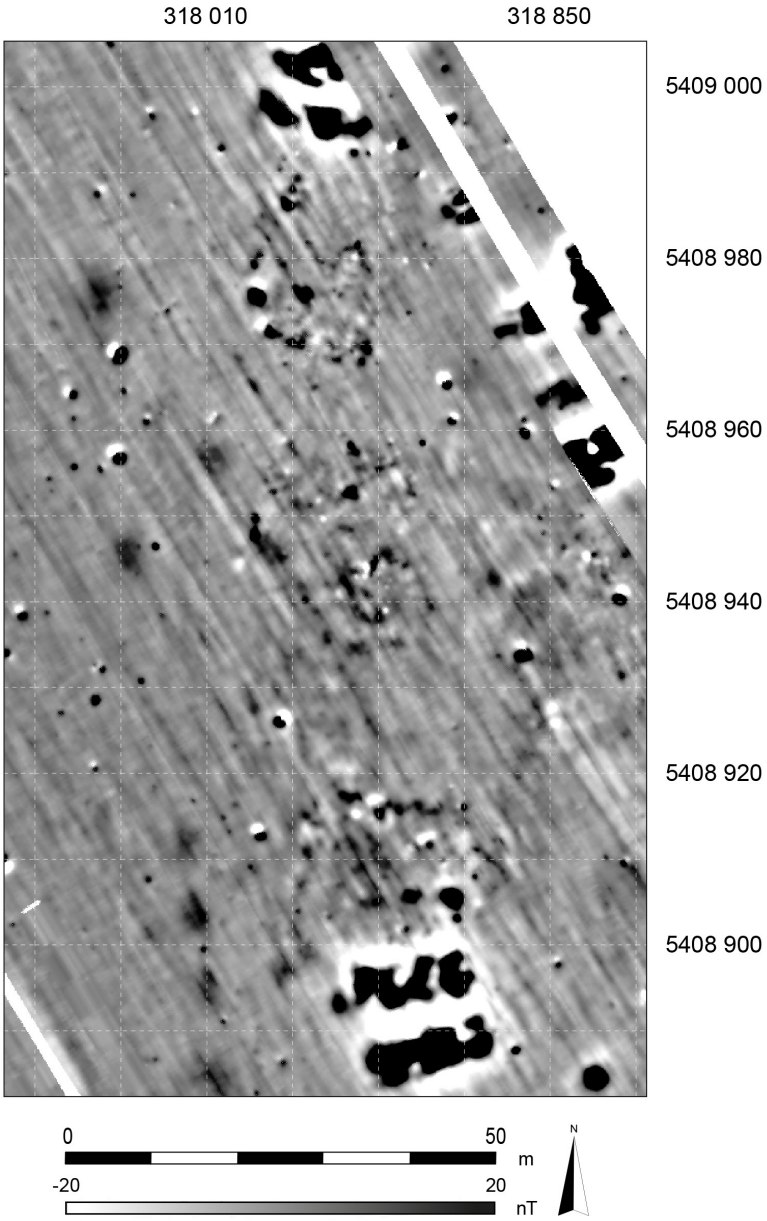


Fig. 12. Talianki. Excavation (2001–2007) area in the northwestern part of the Tripolian settlement.

(2) 221 unburnt or eroded remains of houses could be identified either by geomagnetic features or even by the layout of the pits, along aligned houses (fig. 13–14; fig. 15). In consequence, their specific distribution pattern is similar to that of the burnt houses (fig. 9).

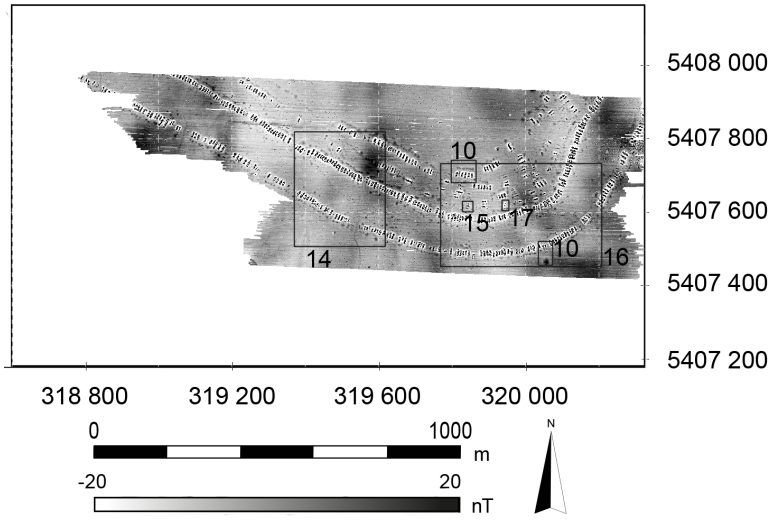


Fig. 13. Talianki. Geomagnetic prospections. Overview of the location of detailed maps.

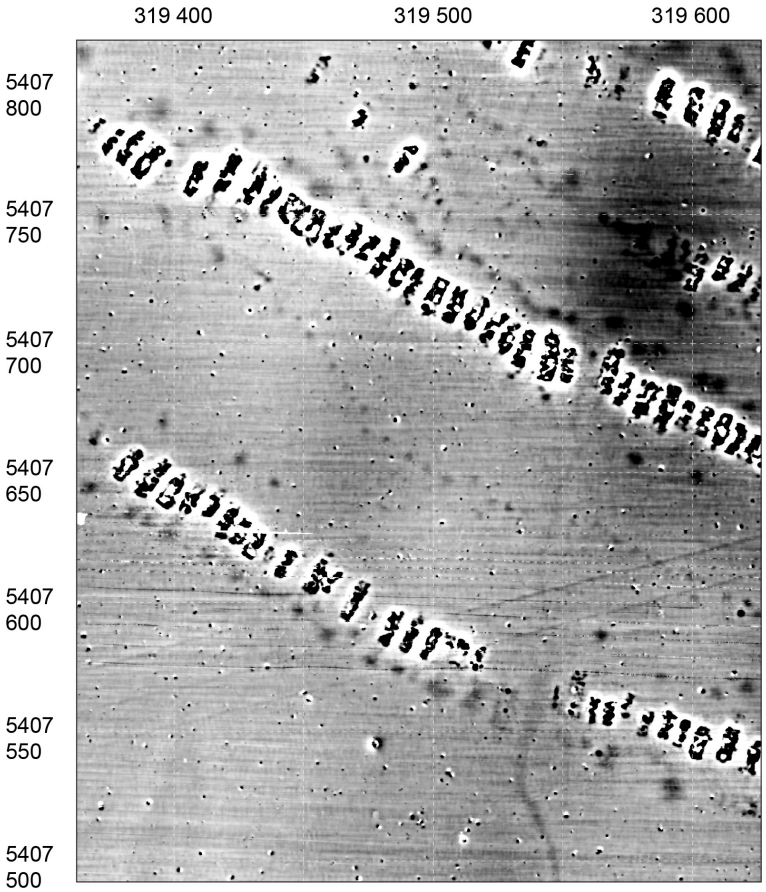


Fig. 14. Talianki. Rows of heavily burnt houses in the southern part of the Tripolian settlement and linear anomalies (pathways?).

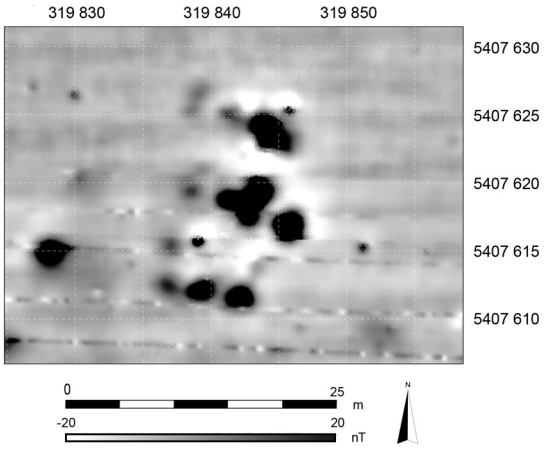


Fig. 15. Talianki. A lightly burnt house in the southern part of the Tripolian settlement.

(3) 1871 pits of different sizes could be identified in the survey (fig. 9). In most cases, they are spatially bound to the houses (e.g. fig. 10) and appear on the outer or the inner gable-side of the respective features. Thus, they form patterns similar to the houses, i.e. alignments of significant orientation in the rings and the quarters. In contrast, other pits form alignments without houses. They are probably from a different phase of the settlement, when the houses were not generally burnt.

(4) 1 possible rectangular structure might be interpreted as a special building (southern settlement). The building does not deviate from the orientation of neighboring houses. Only the bigger size and its position at the edge near to a track are special (fig. 16).

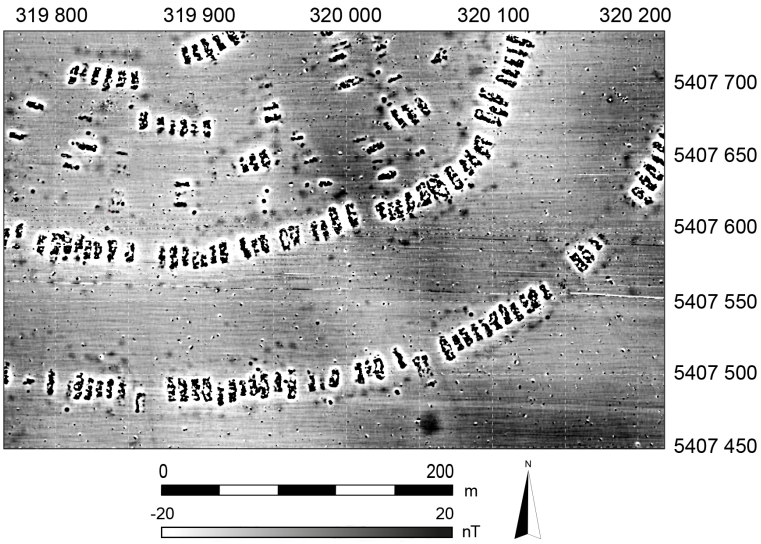


Fig. 16. Talianki. Outer circles and inner rows of burnt houses in the south-eastern part of the measured area.

(5) 28 circular structures with high nT-values were identified as possible kilns. 2 kilns were excavated in 2013 (fig. 16–17).

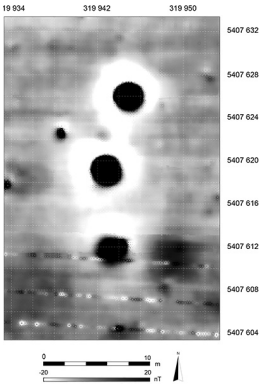


Fig. 17. Talianki. Three circular anomalies of presumably burnt clay, perhaps kilns.

(6) 7 elongated geomagnetic features that are radially oriented to the main outer ring and lead away from the site are interpreted as tracks (fig. 14). If we take other empty spaces within the house-rings into consideration, about 8 gateways could be identified in the southern section at a regular distance of about 250 m from each other (fig. 14).

(7) The geomagnetic features of two kurgans in the central area were identified (fig. 9). Even if the kurgans are probably dated later than the latest domestic occupation, their special position seems to indicate a central spot in the southern section of the site and a position that is perhaps linked to the track system in the center of the site. Together with kurgan-like structures that V.P. Dudkin already discovered in areas which his team surveyed, a line is formed by a total of 5 kurgans (fig. 7).

(8) A rectangular enclosure in the north is not in line with the general layout of houses or other features in that area and might belong to a different period (fig. 9; 11).

The overall settlement plan indicates a main ring of two parallel house rows at a distance of 100–150 m and further rings of lesser distances (ca. 50 m). The huge inner empty space is obviously settled on the northern and southern fringes by clusters of houses that are well structured.

In comparison with the figures known from Maidanetske (cf. below), the number of houses might end up with a ratio of 9 : 3 discovered houses (1550 : 515), thus about 2100 houses for the entire site (ca. 330 unburnt; 1750 burnt houses).

3.2. Maidanetske

The mega-site of Maidanetske is situated west of the Talianki River and west of the village Maidanteske on the chernozem high plateau. The site itself is located in between the confluence of a small watercourse with the Talianki River, 170–190 m NHN (fig. 18). The site has a long research history. First excavations by G. Bzuvenglinsky (Videjko 2012, 107) took place in the 1920s, but both the documentation and the material are lost. After analyses of aerial photographs by K.V. Shishkin (Shishkin 1973), the first full geomagnetic plan was conducted by V.P. Dudkin from 1972–1974 (Dudkin 1978). Dudkin's plans confirmed the results already obtained by aerial photography (fig. 19–20). In field campaigns that started in 1971, several houses were excavated by Ukrainian teams until 1998 (Shmaglij/ Videjko 2003). In 2012 and 2013, the new geomagnetic survey was conducted and excavations started in 2013 with the publication of preliminary results in 2014 (Müller et al. 2014).

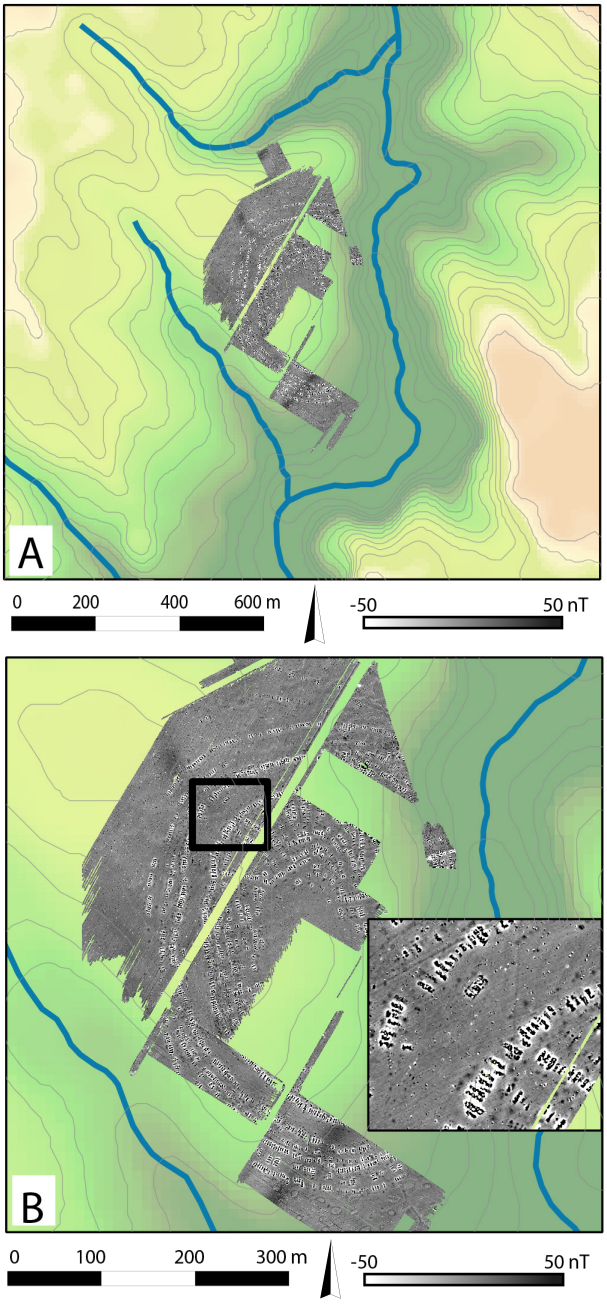


Fig. 18. Maidanetske. Overview and location of the settlement with the location of the site.

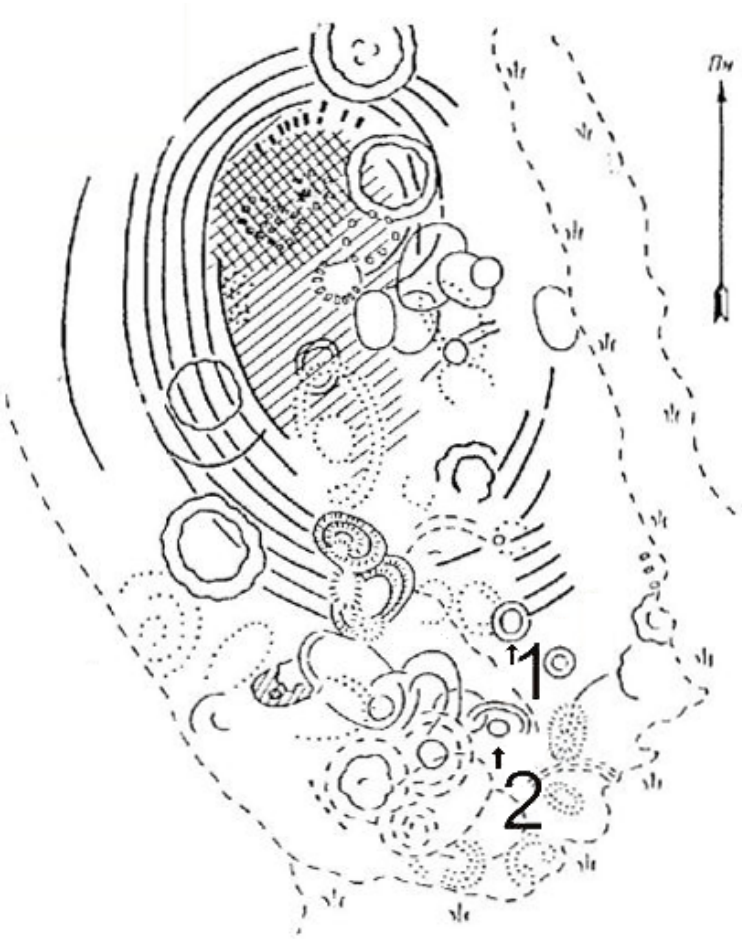


Fig. 19. Maidanetske. Dudkin. Interpretation of the aerial photography.

Fig. 20. Maidanetske. Interpretation of the geomagnetic plan by Dudkin.

The overall size of the site (reconstructed by aerial photography) measures 200 hectares, of which 174 hectares are built space. In the new geomagnetic survey, 150 hectares were surveyed, of which 112 hectares exhibit built structures (fig. 18; 21; 22). Erosion at the site is minimal and no harm has been incurred by recent village activities. Therefore, the discovered features are representative for the Tripolye occupation.

Fig. 21. Maidanetske. The geomagnetic features.

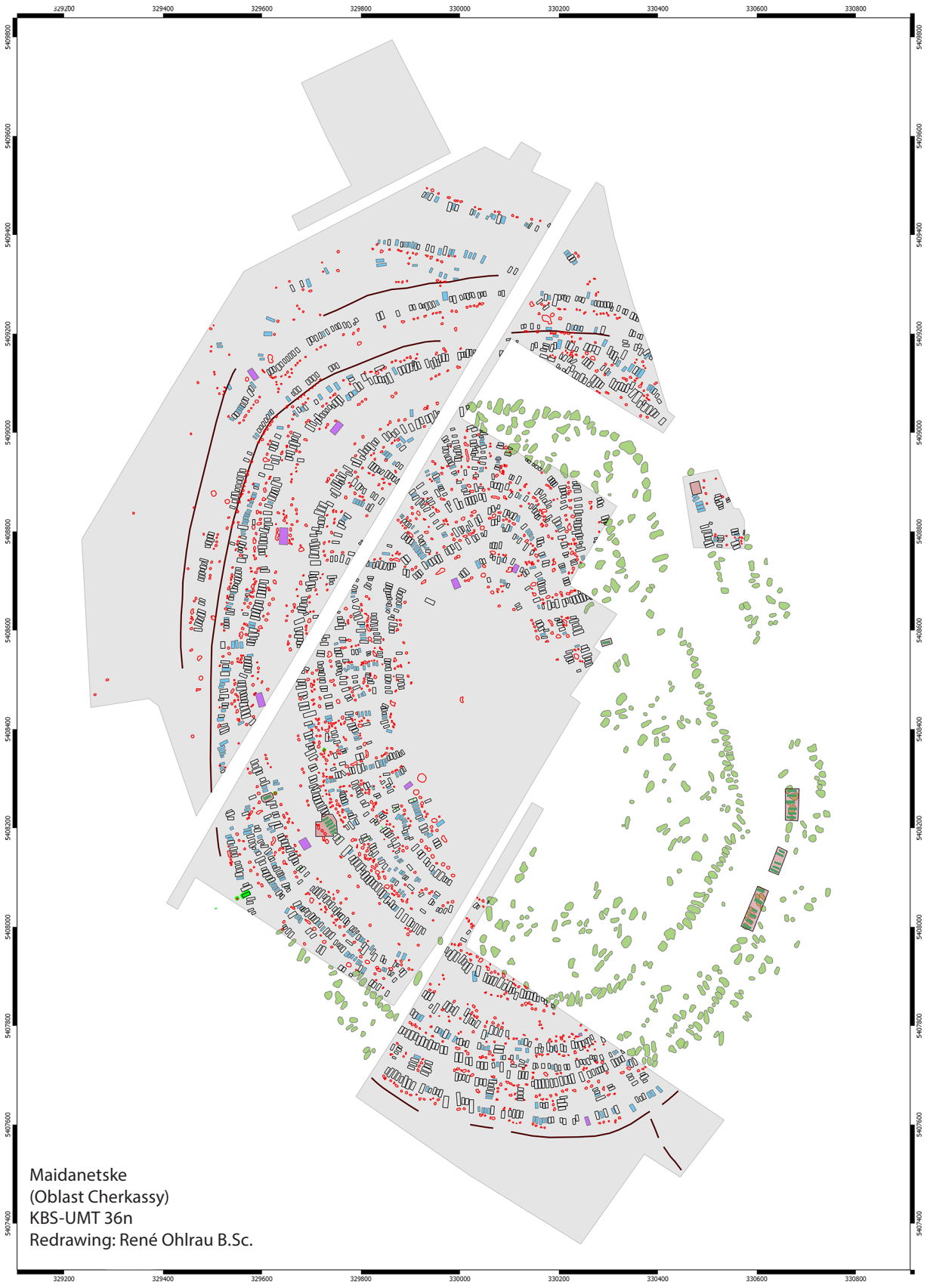
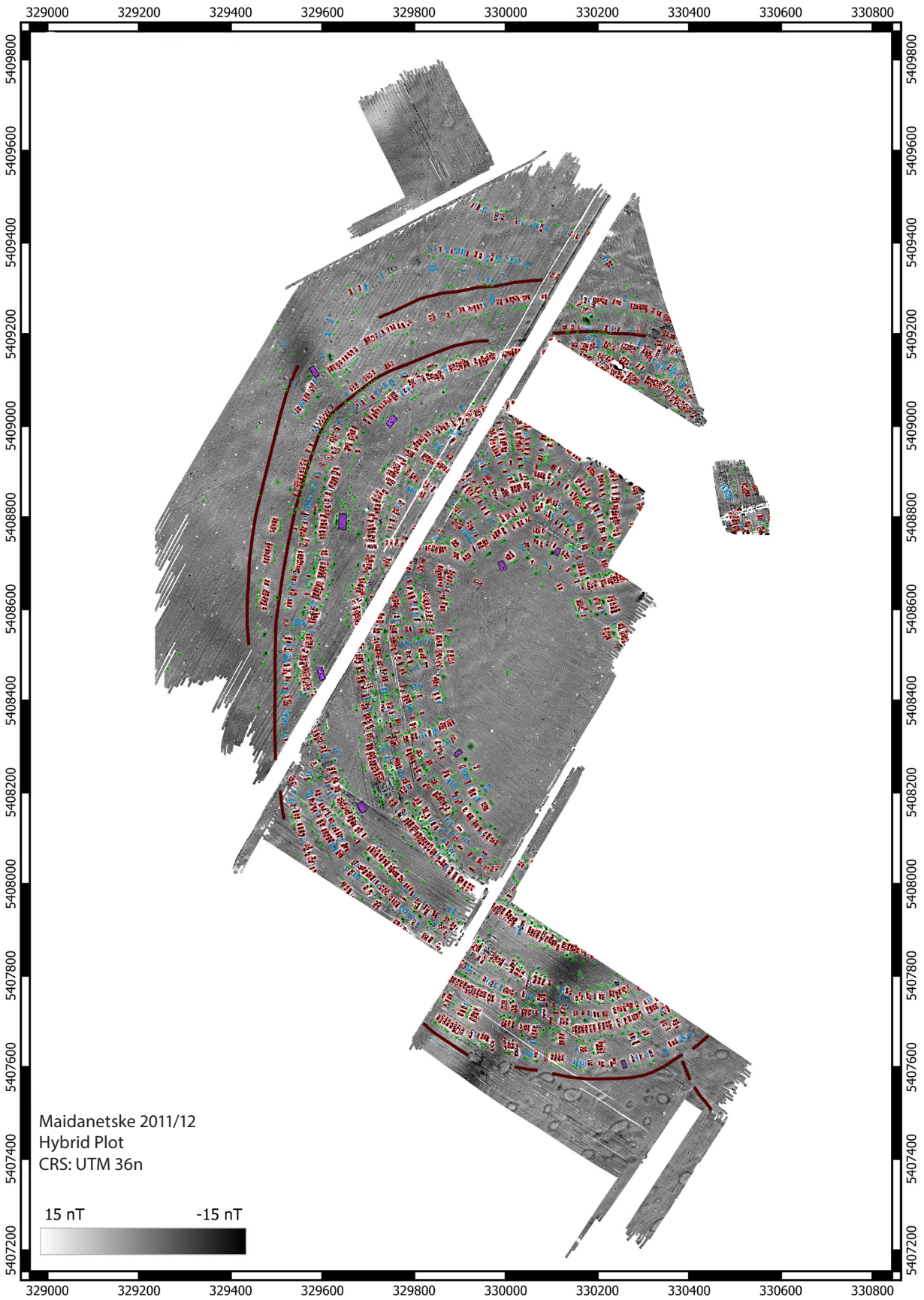


Fig. 22a. Maidanetske. Interpretation of the geomagnetic features.



Legend

- Exceptional building
- Burnt building
- Unburnt/eroded building
- Pit
- Ditch

Fig. 22b. Maidanetske. Interpretation of the geomagnetic features.

The geomagnetic features of the new survey could be divided into several categories:

(1) 1493 burnt rectangular houses that are arranged in at least 9 concentric to oval house rows as well as clusters of radial or concentric oriented gable-front parallel house rows (fig. 21–22; 23–28).

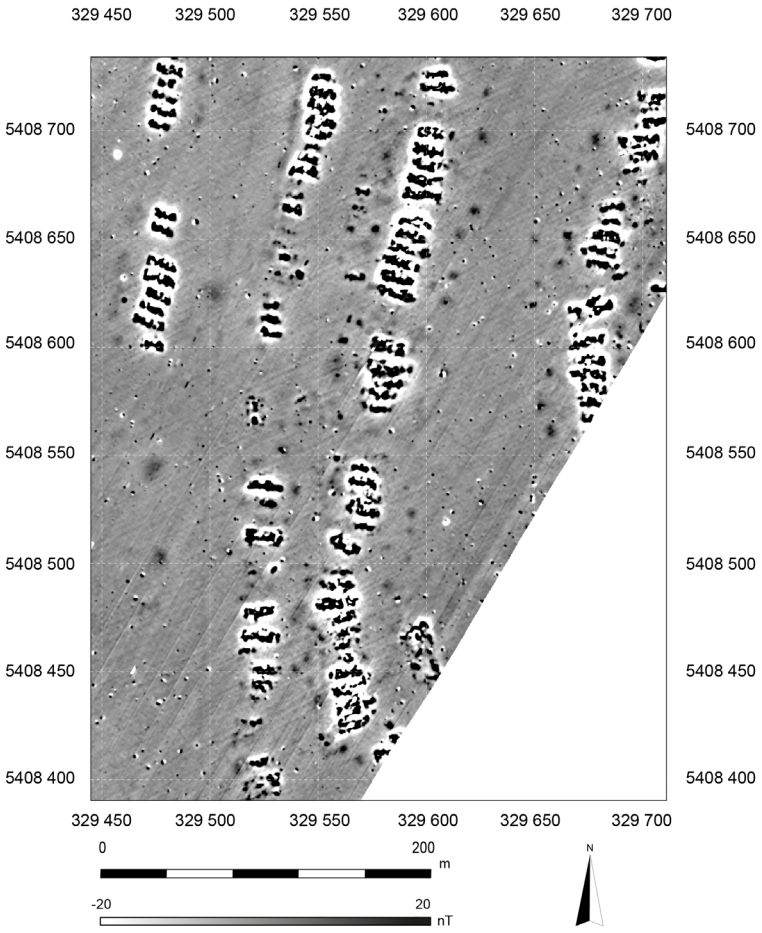


Fig. 23. Maidanetske. Houses of different preservation stages, pits and a mega-structure.

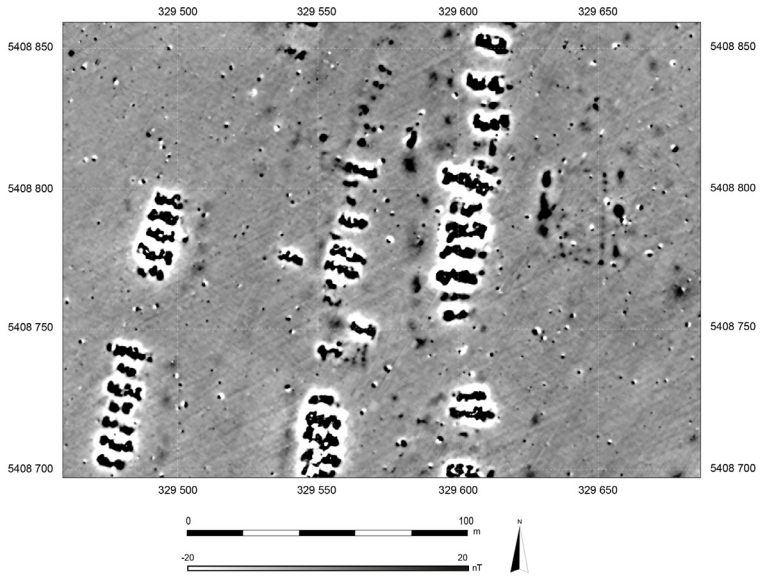


Fig. 24. Maidanetske. Detailed geomagnetic feature of a mega-structure that is linked to huge pits.

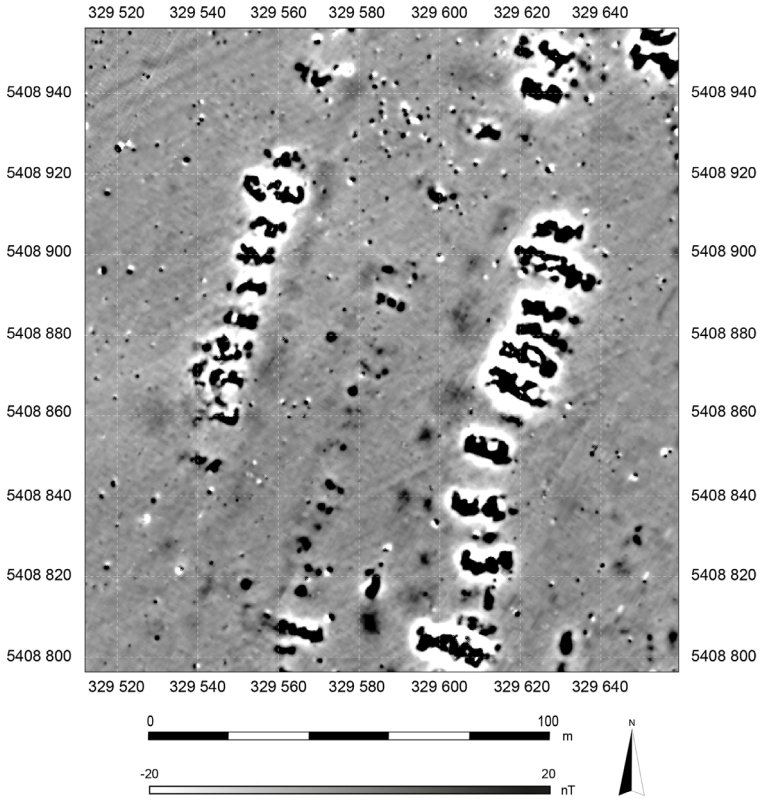


Fig. 25. Maidanetske. Eroded or not-burned houses in a house-row.

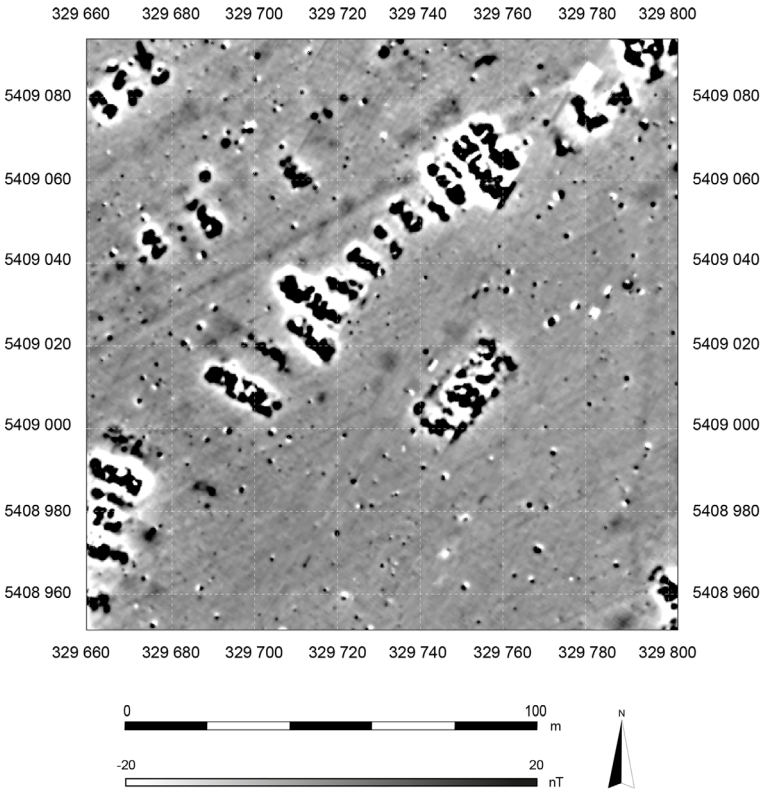


Fig. 26. Maidanetske. Different house sizes, a possible overlap and a mega-structure.

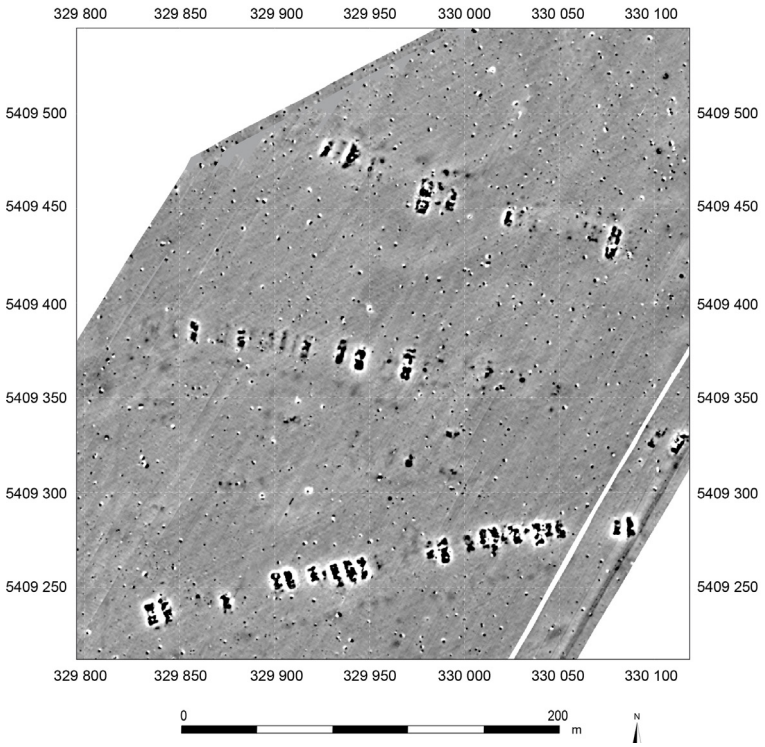


Fig. 27. Maidanetske. House-rows of different orientation in the northern part of the site.

Fig. 28. Maidanetske. A reconstruction of the site in the Maidanetske local museum from 1998. The houses are placed in a forested environment (photo: Johannes Müller, Kiel).

(2) 415 less burnt or even eroded houses that are arranged in a manner similar to the burnt houses (fig. 25–27).

(3) 9 special buildings that are characterized by their extraordinary size and their special spatial position within otherwise mainly empty house rings (fig. 22; 29; 24; 26).

(4) 1537 pits that could be found (a) associated with houses and thus also forming concentric pit alignments in accordance with the width size of the houses (fig. 23–27; 29) (b) in the empty spaces probably demarcating houses that are not visible in the geomagnetic plan (fig. 26; 27) (c) seldom in loose context outside or inside the settlement (fig. 23–24). Pits are of quite different sizes and represent different functions and depositional processes.

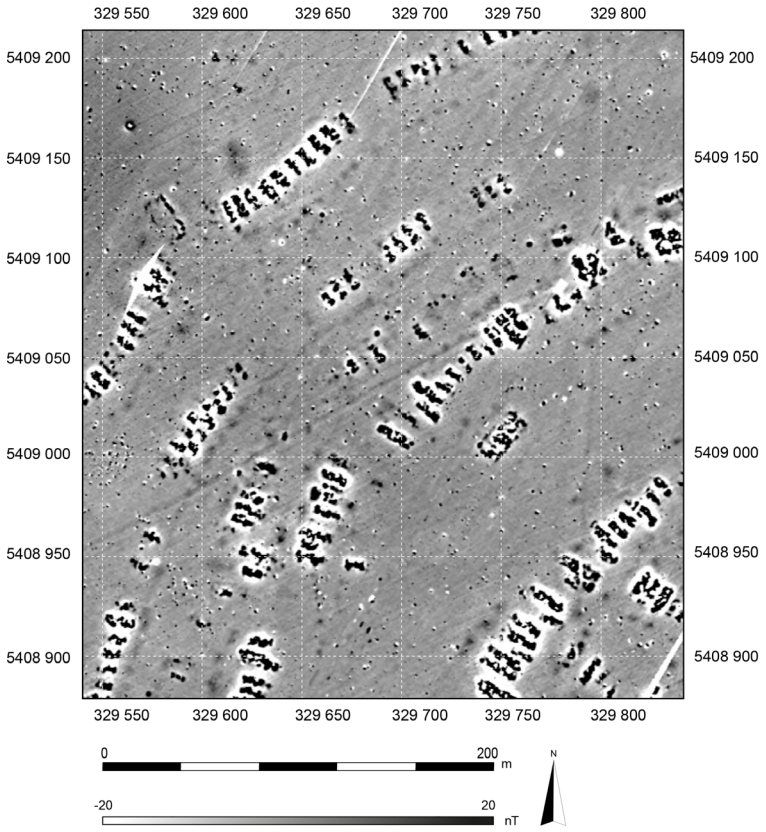


Fig. 29. Maidanetske. Houses, pits and a mega-structure.

(5) Some round anomalies with high nT-values that might represent kilns (fig. 29).

(6) 3 possible ditches that surround parts of the settlement (fig. 21–22).

Taking both the geomagnetic features of the new survey and the features of the old geomagnetic survey and the former excavations into account, the overall patterning of the site is quite clear (fig. 28; 30; cp. 22). Centrally located is an oval space of 26 hectares with nearly no discovered features. Around this central space at least 9 rows of parallel houses with their gables radially oriented towards the center are detected. They form empty rings in between the rows, usually 20–30 m in width. An exception is one main ring with a distance to up to 100 m between the neighboring house rows. To the south and to the north of the site, the mentioned ditches are visible, partly overlapping with pits.

Beside the main design of Tripolye Maidanetske (an empty central space, concentric to oval house rows, the main ring, ditch systems), in the inner part of the site the settlement of the empty space obviously also started with the construction of house clusters that do not fit into the general ring-pattern. Here both radial as well as concentric oriented houses are visible.

To the north, at least two lines of gable parallel houses with associated pits are displayed in the plan. Their positioning differs from the orientation of the other concentric rows (fig. 27). They obviously represent a different phase of the settlement.

Special buildings are positioned both radially oriented to the center – mostly within the gateways of the settlement – or on a concentric axis mainly within the main ring of the site. They are charac-

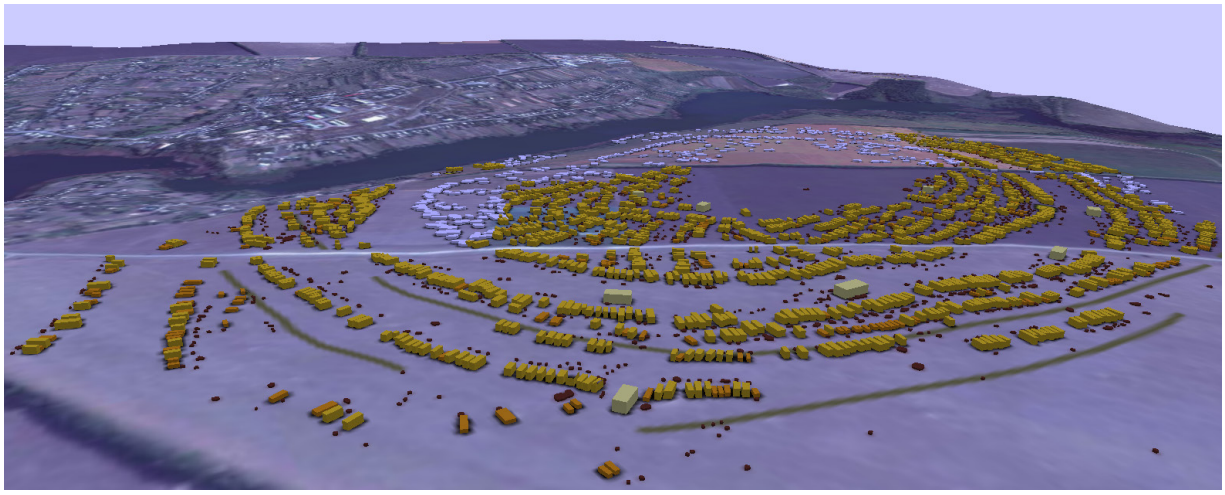


Fig. 30. Maidanetske. The reconstruction of Maidanetske as a mega-site, based on excavation results and geomagnetic surveys (reconstruction: René Ohlrau, Kiel).

terized by wall trenches (*Wandgräbchen*). At least the spatial position of the 4 western special buildings in the main ring might indicate a distance of about 250 m.

Amoeba-like structures to the south might be interpreted as geological structures, for example, as bog iron at certain depressions and not as the remains of mounds (fig. 21).

The combination of Dudkin's plan with the new plan permitted us to calibrate the old results with the new results. It became clear that Dudkin identified more or less only half of the geomagnetic structures that were identified in the same areas by the new survey, even only one fourth of the non-burnt houses. In consequence, we end up with 2300 burnt and about 670 unburnt house structures in Maidanteske (tab. 1).

Prospection	burnt	eroded/ unburnt	∑
2011/ 2012	1492	414	1906
Superposition Dudkin	810	103	913
Dudkin	435	64	499
Extrapolation factor	1.85	4.02	---
Extrapolation	805	257	1062
Total	2297	671	2968

Tab. 1. The estimated number of houses in Maidanetske based on new and old geomagnetic surveys (after Videjko 1995, 49).

3.3. Dobrovody

At the western fringe of the recent village of Dobrovodv, the Tripolye site is situated at an elevation of 180–210 m NHN. The site is positioned west of the small Hnizdechna River at a confluence with a smaller watercourse (fig. 31). The plain triangle in between the canyons of both rivers at their confluence limits the dimension of the prehistoric site: Tripolyen Dobrovodv is positioned between the mentioned watercourses on chernozems. If the results of aerial photography, geomagnetic surveys, small excavations and field walking are taken into account, the site might measure about 150 ha. Considering K.V. Shishkin's aerial photo, without the empty central place we are talking about 130 hectares of settled space. As modern parceling of the area into small plots, encroachments, and a modern cemetery enter the site, some damage has already been done and a complete survey of the site is no longer possible (fig. 32).

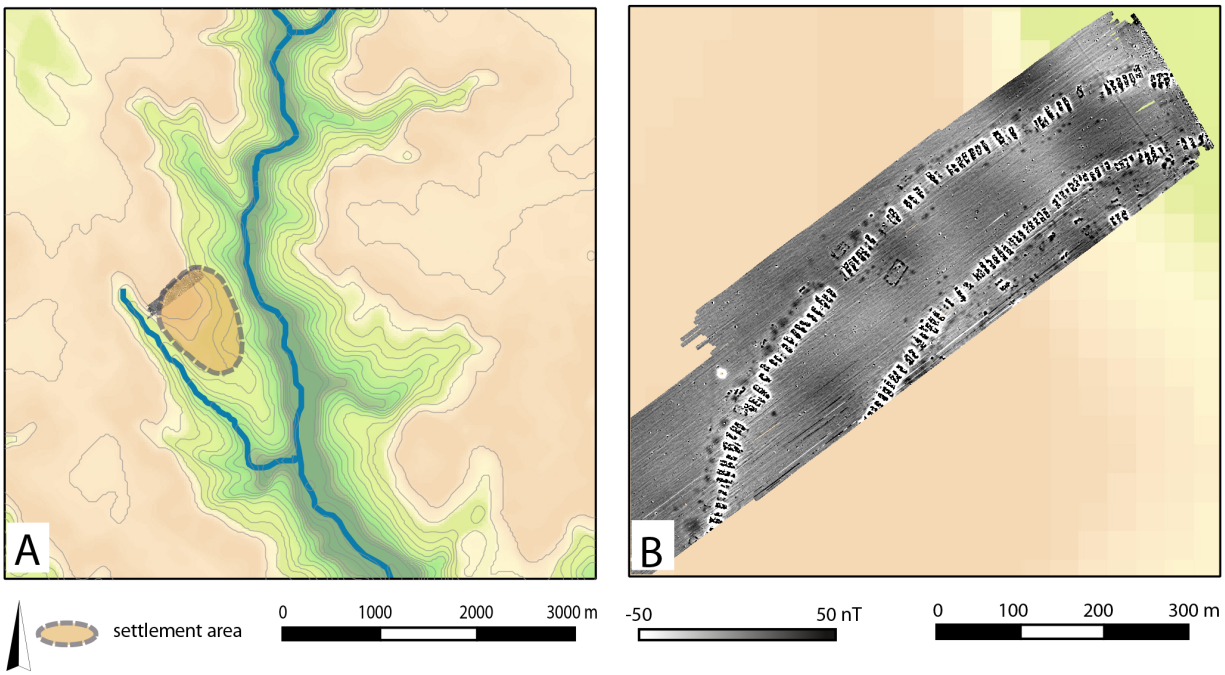


Fig. 31. Dobrovody. Localization and extension of the site between two watercourses.

First geomagnetic prospections and excavations were conducted by N.M. Shmaglij and T. Movsha 1974–1984 (Movsha 1985a; Movsha 1985b). In 2012 and 2013, geomagnetic surveys were carried out at the site in the northern and western central areas. While subterranean artificial pipes, masts and heavy dipoles derogate the interpretation of the geomagnetic features in the southern surveyed area, the northern surveyed area is free of modern disturbances.

Within the ca. 24 hectares that were surveyed, 4 concentric rows of houses, associated with pits at the outer and the inner sides of the concentric house chains, possible tracks and special buildings were discovered (fig. 32–33). Based on geomagnetic features within the surveyed area, 244 burnt houses, 50 unburnt or partly eroded houses, 231 pits of different sizes and 3 special buildings could be identified.

Only 17,5 hectares of the settled area (probably 14 % of the whole settled area) have been surveyed to date. Despite the small area that was surveyed, principles of the overall layout can already be observed:

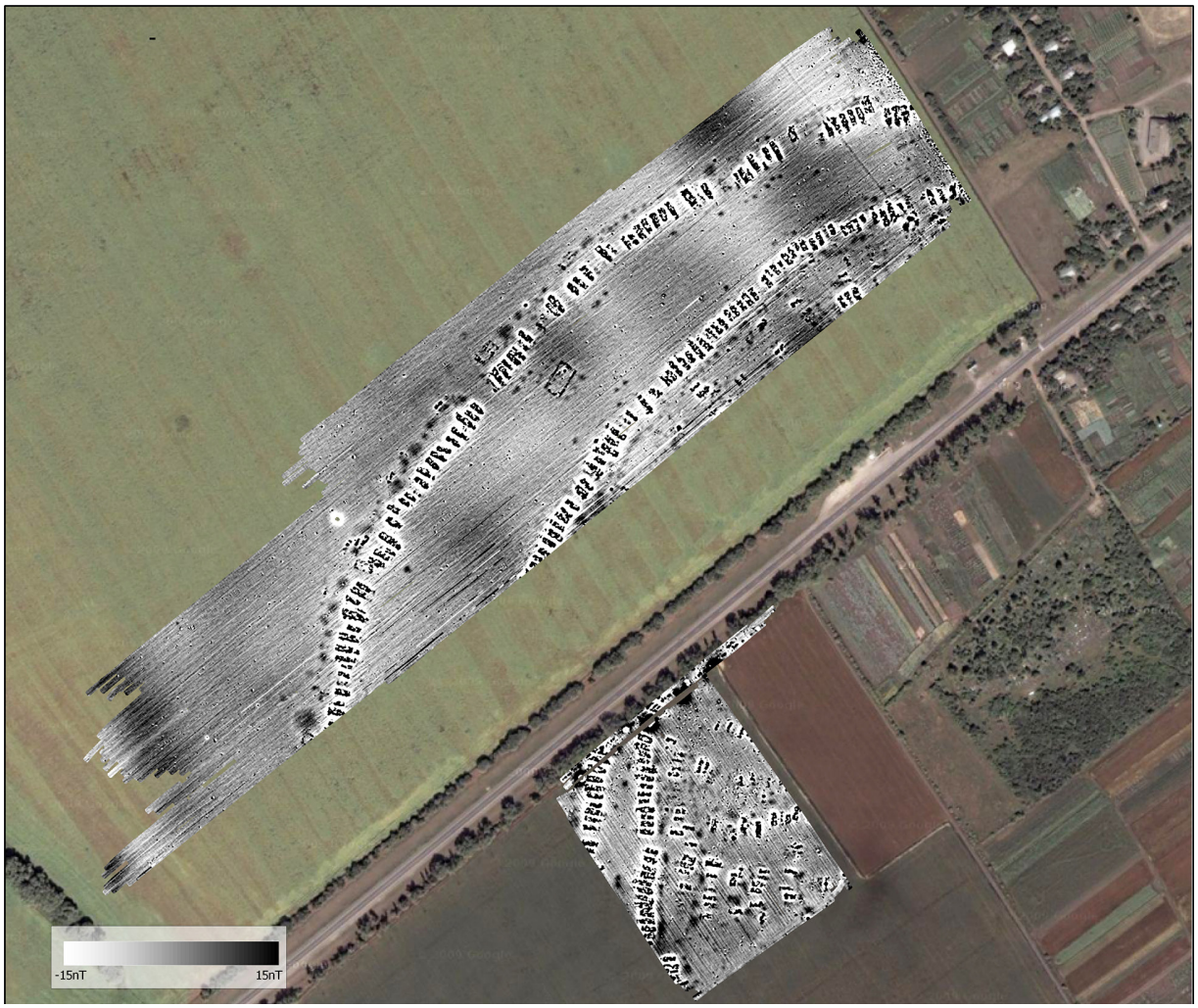
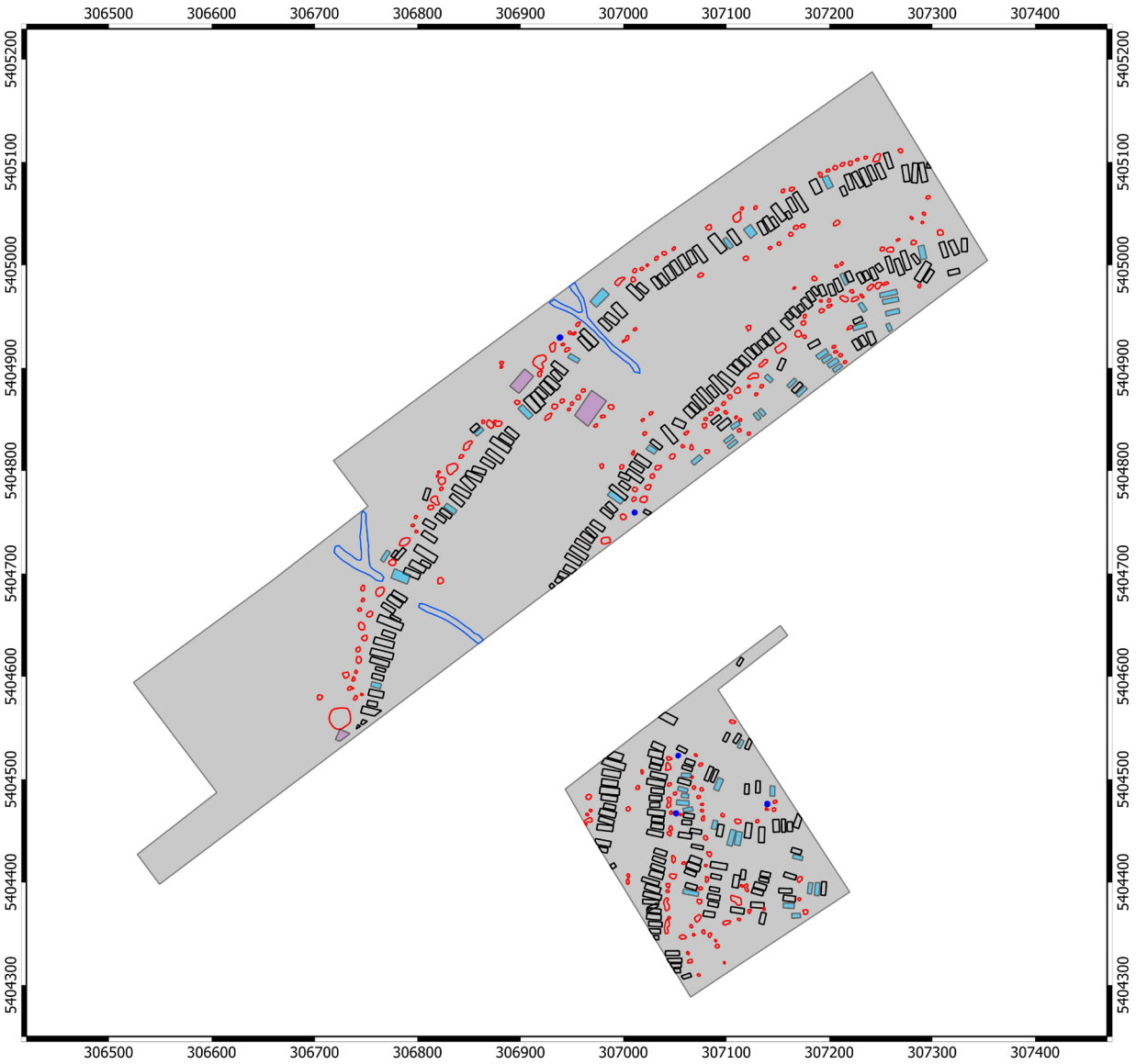


Fig. 32. Dobrovody. The geomagnetic features.

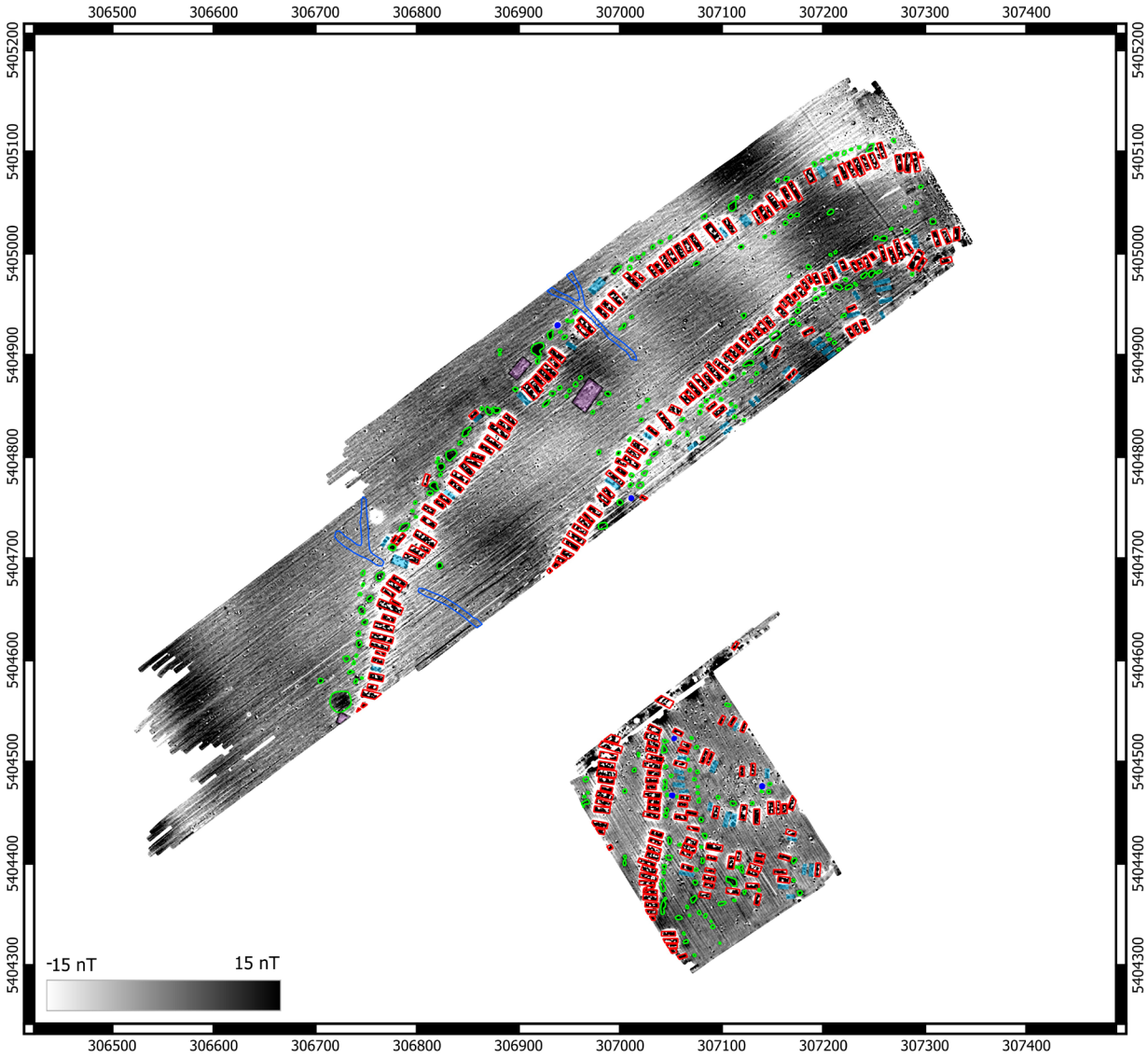


Dobrovody 2012
(Oblast Cherkassy)
KBS: UMT 36n
Redrawing: René Ohlrau B.Sc.

Legend

- Exceptional building
- Burnt building
- Unburnt/eroded building
- Pit
- Kiln
- Pathway
- Survey area

Fig. 33a. Dobrovody. Interpretation of the geomagnetic features.



Dobrovody 2012
Hybrid Plot
CBS: UMT 36n

Legend

- Exceptional building
- Burnt building
- Unburnt/eroded building
- Pit
- Kiln
- Pathway

Fig. 33b. Dobrovody. Interpretation of the geomagnetic features.

(1) The distance between the two outer house rows (rows 3–4) amounts to about 100 ± 50 m. Within the free space, only some pits and a special building were detected. Because of the distance between the two house circuits, the inner space represents the main ring of the settlement.

(2) The distance between the two inner house rows (rows 1–2) is smaller (50 ± 20 m). If the circuits 3–4 and 1–2 are contemporaneous, the distance between rows 2–3 would amount to about 100 m. While the space between rows 3 and 4 and 1 and 2 obviously appears to be empty, the space between rows 2–3 and inside 1 seems to be filled with other pits and houses.

(3) While houses within the house-circuits are positioned with parallel gables on concentric axes, houses within the built space between the rows are positioned with parallel gables either on concentric or radial axes.

(4) Radially oriented geophysical structures are interpreted as pathways that lead through the outer circuit into the site. In principle, they start within the main ring and pass settled areas between house rows and gables outside the settlement. Erosion can be excluded. Therefore, the visible pattern seems to indicate a real spatial ordering of Tripolye times.

(5) Pits are positioned at the gable sides of the houses, in outer row 4 primarily to the northern "outward" side, for the other rows mainly positioned at the inner side.

(6) Three houses or rectangular enclosures are labelled "special buildings" and are oriented on concentric axes (fig. 33–34). They all are characterized by prominent *Wandgräbchen*, which might indicate the demarcation of open spaces and not roofed areas.

The biggest building is positioned within the main ring and seems to be spatially linked to a second special building that was built at the outer side of the main ring (fig. 34). The third, only partially documented special building, is found at the outer row of the main ring. The first mentioned building possesses three pits on each longer side, a spatial feature also known from the special buildings in Maidanetske. At the two other buildings, pits are extraordinary large compared to the other pits of the site.

(7) The central place that is indicated by aerial photography was not yet included in the geomagnetic survey.

(8) At five spots, nT-values might indicate kilns (fig. 32–33).

In general, the geomagnetic plan underlines a unified concept of settlement planning for the whole site. Nevertheless, some overlaps between burnt house features and smaller differences in the house plans indicate different phases of the site (fig. 33). Furthermore, the size of the interspaces between built quarters and house rows within the site describe probable differences in the orderly housing scheme of the settlement.

In summary, the typical structures of a mega-site are visible: the typical main ring of a double row of houses, the clusters of houses and pit complexes, and signs of radial house rows.

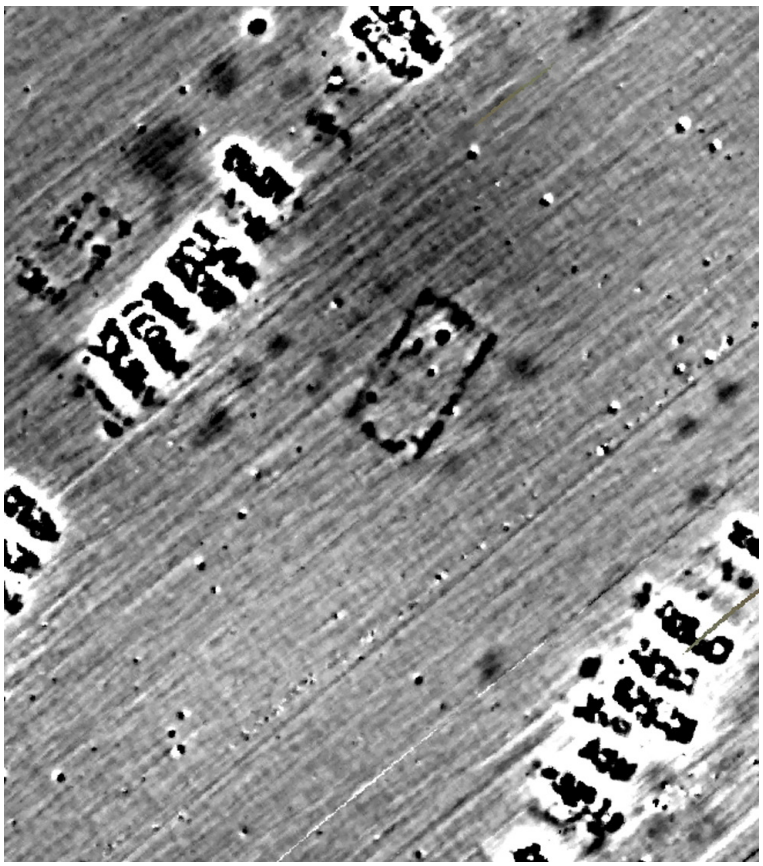


Fig. 34. Dobrovody. Mega-structure and house-rows.

If the surveyed areal represents an average for the site, we are able to calculate ca. 1500 burnt and 300 unburnt houses, 1400 pits and 15 special buildings.

3.4. Apolianka

A further Tripolye site is situated on the chernozem plain to the east of the terraces of the Hnizdechna River near Apolianka on a small elevation (180–200 m NHN). Even if the site itself is placed within the junction of two watercourses, the association to this kind of topographical position is not necessarily clear (fig. 35).

Field walking on site clearly verified signs of erosion. Ploughing already reached house features that were indicated by daub and artefact scatters on the surface. In geomagnetic features it later became clear that some houses were already eroded to the top of the *Wandgräbchen* and nothing was left of the other burnt remains. Furthermore, a recently destroyed garage was placed on the site. In consequence, it remained unclear in some cases whether we were dealing with prehistoric or modern features.

Nevertheless, the geomagnetic survey that was conducted in 2012 identified settlement features of a smaller site measuring 19 hectares within the survey area of 39 hectares, including 22 burnt, 8 unburnt or eroded houses and 33 pits (fig. 36–37). In contrast to the mega-sites, special buildings did not appear in the survey that probably covered most of the settlement.

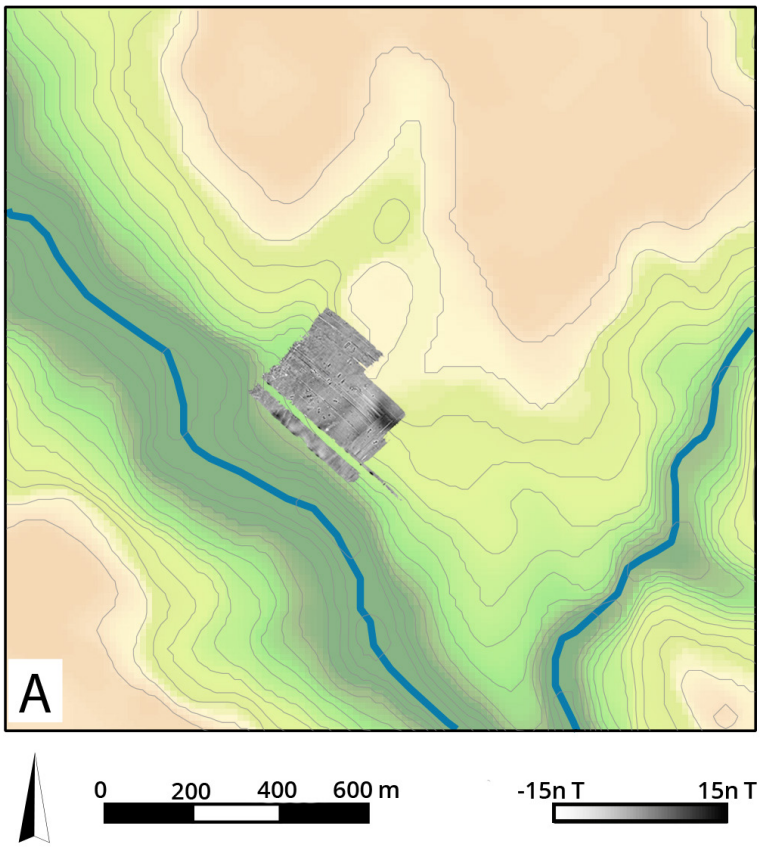


Fig. 35. Apolianka. Localization and extension of the site between two watercourses.

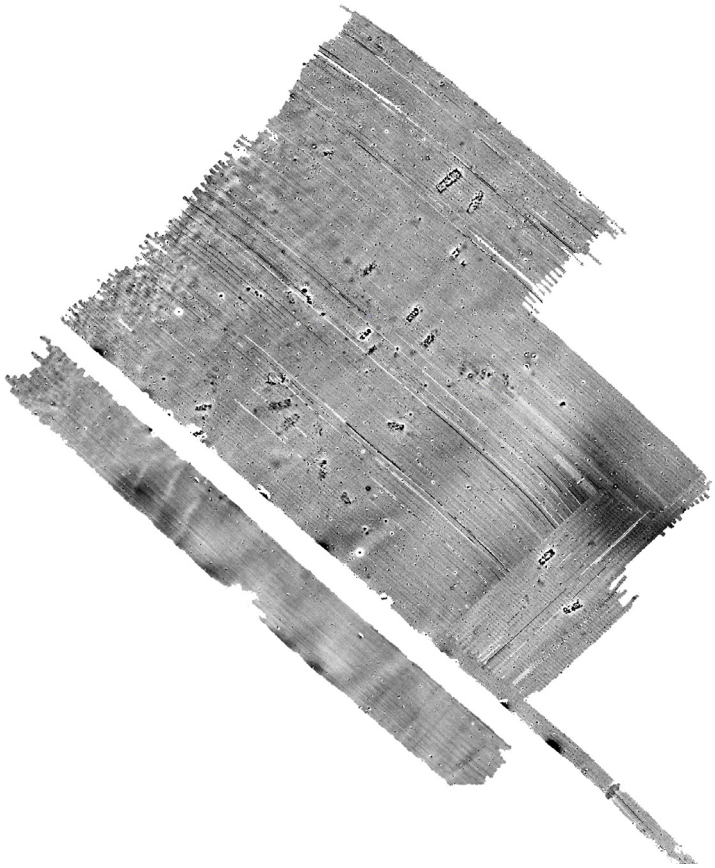
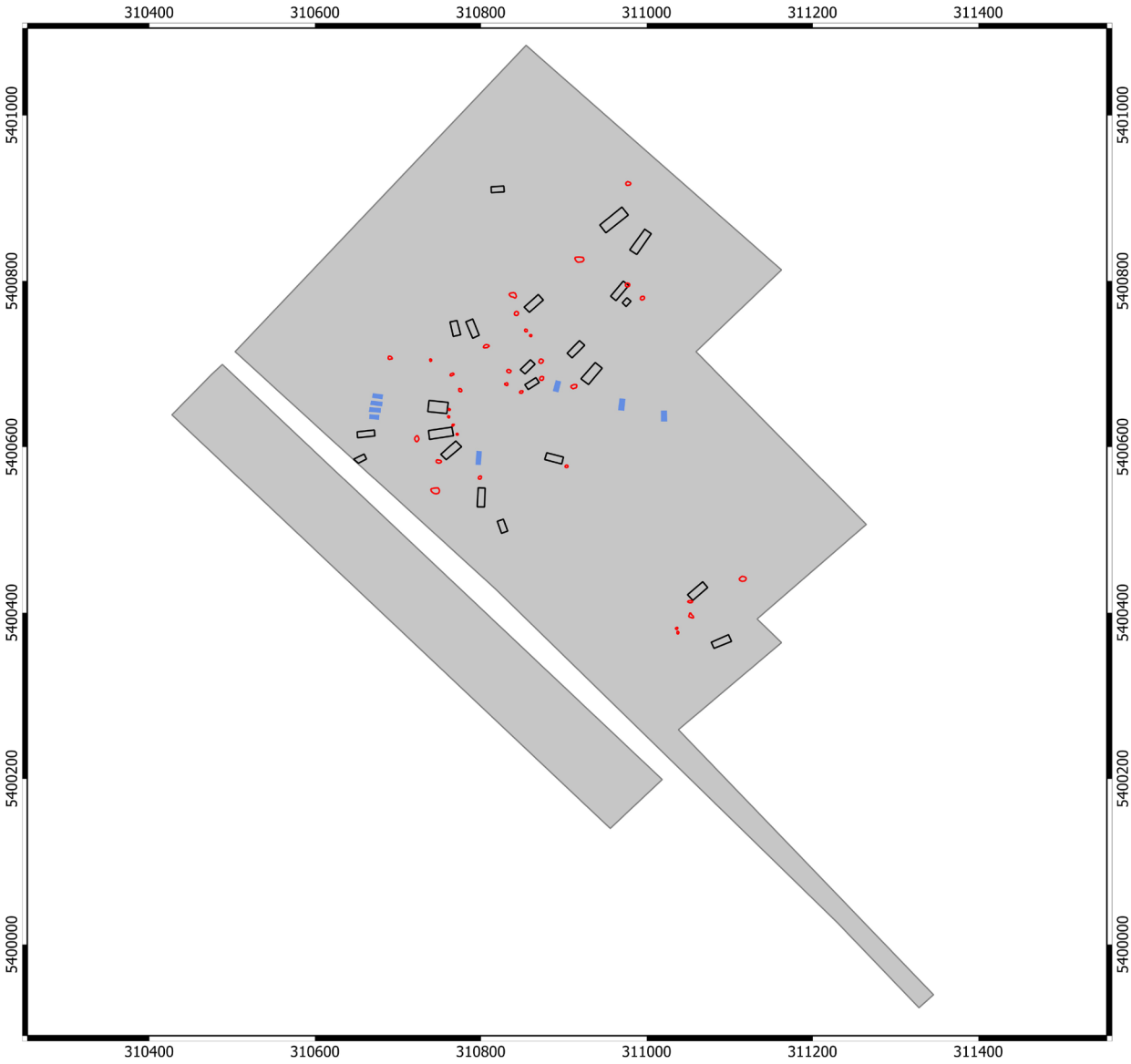


Fig. 36. Apolianka. The geomagnetic features.

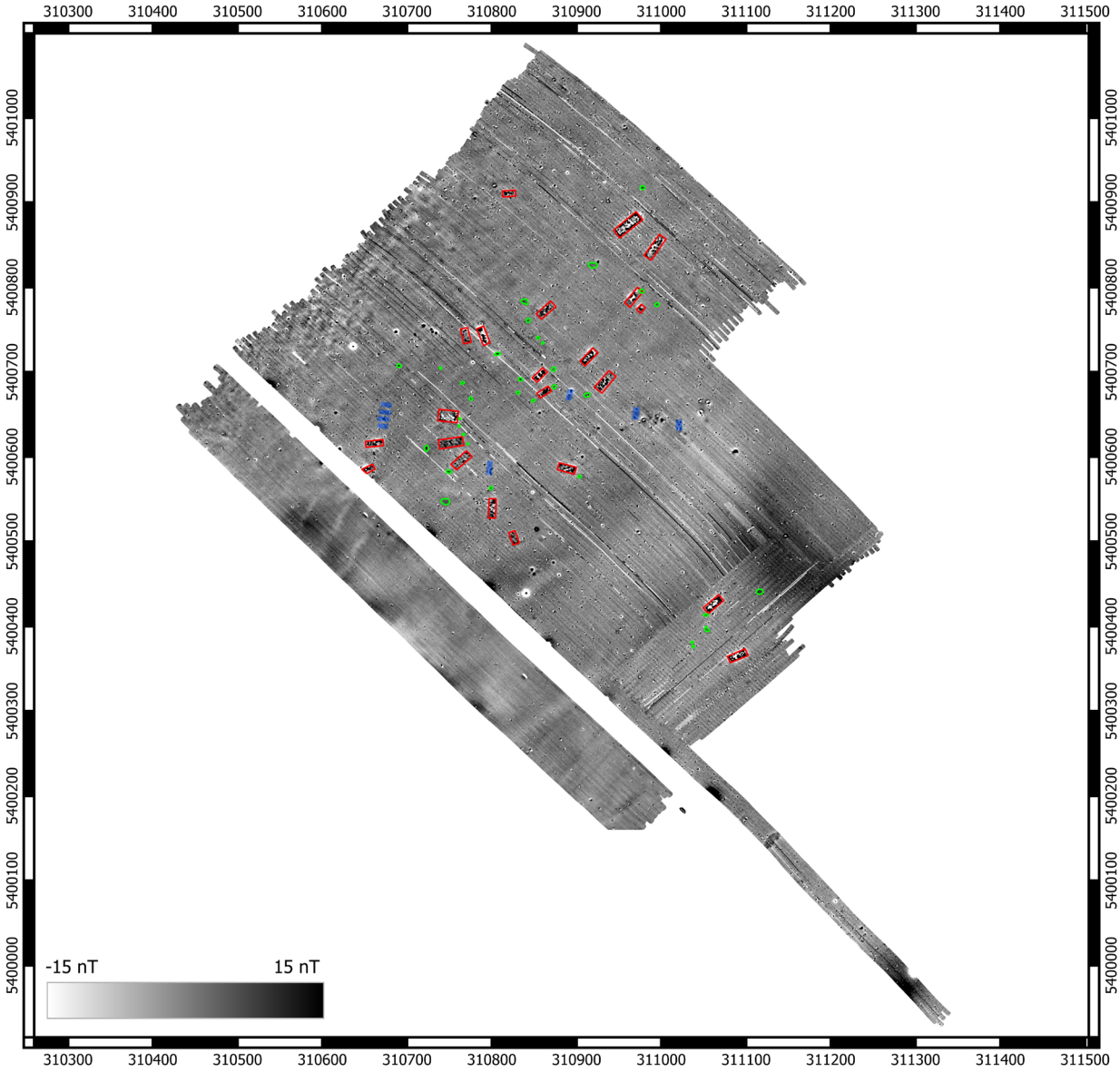


Apolianka 2012
(Oblast Cherkassy)
KBS: UMT 36n
Redrawing: René Ohlrau B.Sc.

Legend

- Burnt building
- Unburnt/eroded building
- Pit
- Survey area

Fig. 37a. Apolianka. Interpretation of the geomagnetic features.



Apolianka 2012
Hybrid Plot
CRS: UMT 36n

Legend

- Burnt building
- Unburnt/erodedbuilding
- Pit

Fig. 37b. Apolianka. Interpretation of the geomagnetic features.

In the southwest section of the survey, the radial orientation of some of the geomagnetically revealed house features contrasts to the linear orientation of other bigger houses in the north and the southeast. Perhaps different phases are visible. Furthermore, spaces without geomagnetic phases at the outer spaces of the surveyed area might already show that we are dealing with the boundaries of at least one of the settlements (especially to the southwest). The terrain backslides to the west. Signs of erosion are detectable in the geomagnetic plan.

In spite of these limitations for the interpretation of the detected geomagnetic features, the size of the settlement appears to have been much smaller than that of the other sites. In total, we would estimate about 30 houses on 30 hectares. In addition, the differences between the houses are much more pronounced than at the other surveyed sites. Moreover, a clear association between pits and houses is not present. Thus, Apolianka is a smaller Tripolye site with partially different principles for the organization of social space than at the mega-sites.

3.5. Other sites

Apart from the geomagnetic surveys that are presented in this article, the surveys of the Nebelivka and Petreni sites are of particular interest. At Nebelivka that lies 15 km south of Apolianka, a British-Ukrainian team conducted fieldwork, including excavations (Chapman/Videjko 2011; Chapman et al. 2014). The site itself measures 120 hectares. The general density of houses is lower than at Talianki and Maidanetske. Nebelivka was apparently abandoned at an earlier stage of site history than Maidanetske and Talianki. Nevertheless, all types of features described for the other sites here were also visible in Nebelivka. Thus, the general layout of mega-sites is comparable.

A much smaller site, which is the biggest in the western distribution of Tripolye, is Petreni in Moldavia. Here, the geomagnetic survey confirmed the features that V.P. Dudkin had already interpreted (fig. 38–39), but on a more elaborated scale. Petreni is not a mega-site, as it measures less than 100 ha in size, but the clear design of at least four house circles and the built space in between, arranged concentrically around the center, are striking. Two ditch/palisade-like structures might imply two phases. The site is surrounded by circular geomagnetic features. They might signal huge waste pits, but possibly also kilns, originally interpreted as towers. In the center, houses follow the layout of a probable track system, and a central structure was excavated in 2012.

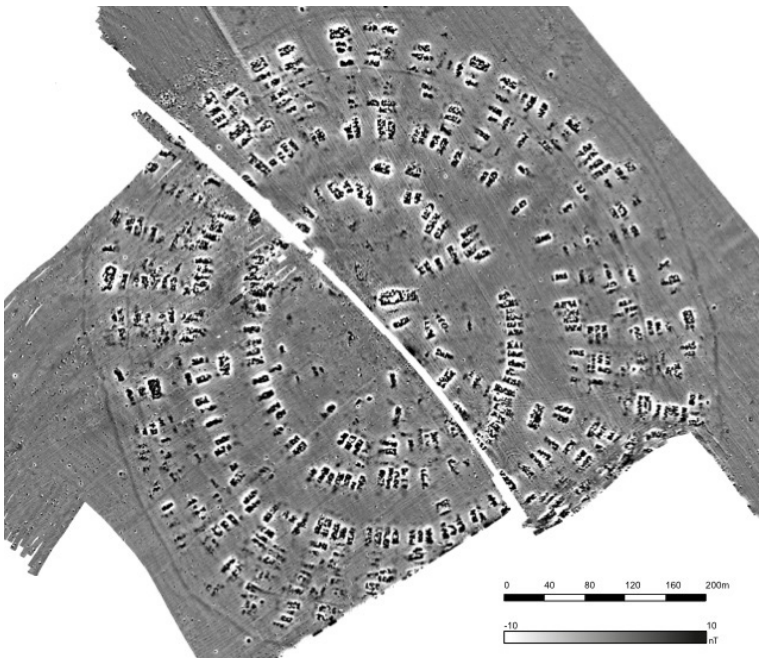


Fig. 38. Petreni. The geomagnetic features.

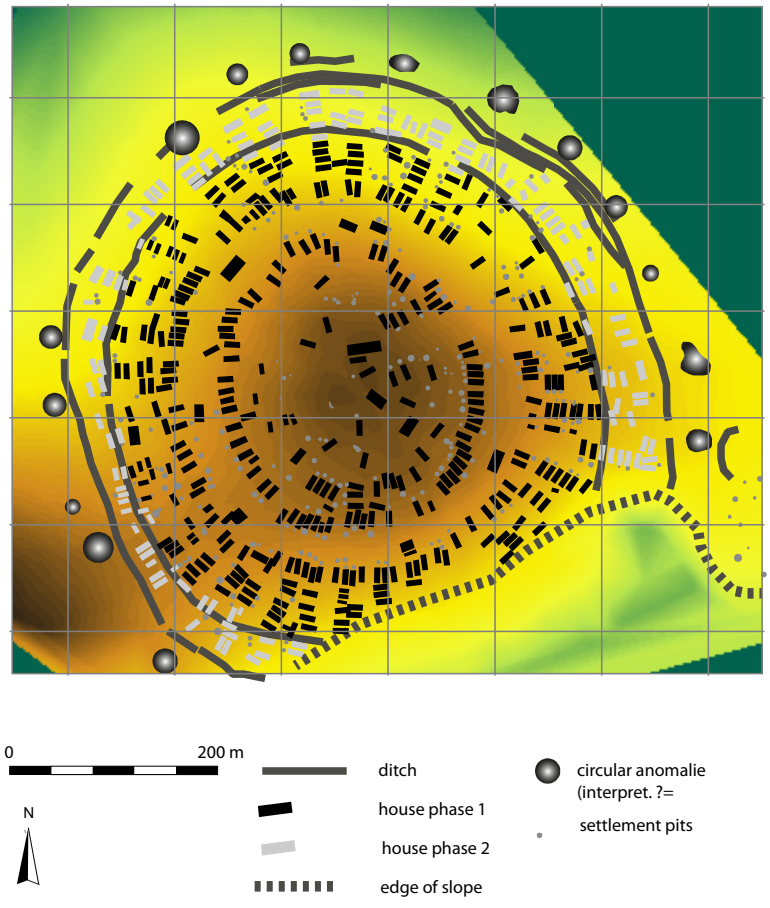


Fig. 39. Petreni. Interpretation of the geomagnetic features.

4. Interpretations

The new geomagnetic surveys displayed the huge number of houses and the clear spatial organization of the sites under investigation. The principle of concentric rings of houses around an inner space that is left empty at the mega-sites is visible at each site. While the density of houses at Nebelivka remains small in relation to the occupied and enclosed areas, domestic quarters were also created at the inner side of the inner rings at both Talianki and Maidanetske. It is striking at Maidanetske that the community obviously started to settle most parts of the internal area. At medium-sized sites, such as Petreni, and smaller sites, such as Apolianka, a similar occupation principle is still visible.

In contrast to the geomagnetic surveys before 2005, after 2005 geomagnetic devices with high-resolution also detected pits, kilns, track ways and other features besides the known "large" structures. The majority of pits reflect the spatial pattern of the houses, as they are localized at one of the gable ends of the houses. If pits without geomagnetically visible houses appear in such concentric pit alignments, the existence of unburnt houses is probable. Recent excavations (forthcoming) confirm different types of pits. Their different functions are reflected in their different localizations, e.g., non-waste pits are situated in non-house areas.

Tracks and trackways existed at the sites and structured the entire settlements. Their existence is particularly visible in the geomagnetic plans of Talianki and Maidanetske. We are also able to reconstruct tracks in empty spaces between the house rows and remaining "house-free" bridges. In general, it appears that in the southern part of Maidanetske a track entered the site radially through the outer house rings every 200 m.

In Maidanetske, the organization of the site was reconstructed by a spatial analysis of the distribution of normal houses, mega-structures and recently identified and excavated kilns (Ohlrau 2014). In result, the site was divided into quarters. Within them public activities or institutions are displayed by one mega-structure per quarter and a kiln as a kind of centralized production feature, again per quarter. In fact, the average size of these units (ca. 150 houses) and their spatial size correlate with the spatial distances of the tracks, where they were visible. Obviously, the internal organization of the mega-sites implies a hierarchical system of political institutions. Whether such a society was stratified or not stratified remains a matter of discussion.

The results of the dating of the settlement structures at Maidanetske (Müller et al. in prep.) enable us to calculate the population size of one mega-site on a solid basis for the first time. Whereas preliminary population estimations were either based on a general assumption that the contemporaneous existence of structures was visible from the symmetrical ground plan, or on calculations of the carrying capacity, the current radiometric dates make the contemporaneous existence of the houses more reliable. The reflection of house classes in the geomagnetic plan, as were detected in former and recent excavations, displays different types, but in general, standardization is obvious (cp. Chernovol 2012, 200). If we construct a model of population size on this baseline, at least 2297 houses existed contempora-

neously at Maidanetske, perhaps even 2968. An average house size of 77 m² enables us to calculate the number of inhabitants on the basis of known space requirements for persons in sedentary societies. Ethnographical observations confirm that a person needs 5–15 m² in a house, averaging 6.9 m² (tab. 2).

Area/ Person (m²)	Houses 2297	Houses 2633	Houses 2068	
	176869 m²	202741 m²	228536 m²	77 m² pro Haus
5	35373.8	40548.2	**45707.2**	
6.97	25375.75	**29087.66**	32788.2	
15	**11791.22**	13516.33	15235.7	

Tab. 2. Population estimations for Maidanetske based on estimated maximal and minimal areas per person and estimated maximal and minimal numbers of contemporary houses.

The estimated population of Maidanetske thus amounts to about 12,000 inhabitants according to conservative estimations, but with the possibility of about 46,000 inhabitants and a probable average of 29,000 inhabitants.

Thus, the combination of geophysical surveys with ethnographical interpretation and sociological theory introduces a new opportunity for interdisciplinary research. While here a few remarks point to the potential of the new spatial data, further analysis will derive more detailed reconstructions of spatial and social behavior.

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